4.5 VISUAL QUALITY

4.5.1 Methods Used To Determine Environmental Consequences

Using the information obtained for the existing environment (maps and matrixes), conclusions were drawn regarding the way proposed alternatives would change the visible environment and the way these changes would alter the visual quality within the various segments. This process also identified how this alteration would be perceived by various viewers and user groups, including recreational/scenic travelers, commuters, as well as people in the affected residential and rural areas, and what the resulting visual impact would be. The location of each viewer group, the relative number in each group, the duration of views, and the quality of views were considered when assessing the potential quality of the visual experience under each of the alternatives.

The federal guidelines specifically state the affected environmental discussion should provide information that identifies the different viewer groups in the study area. The highway viewers are identified under two classes: (1) those with a view of the road and (2) those with a view from the road. Quantitative information was provided for each viewer affected by the proposed project.

4.5.1.1 Methods to Determine Physical Change

Using the project descriptions for the various alternatives, the likely physical changes that would be visible were determined. These physical changes may include new, widened or realigned roadways; change in the vertical alignment of roadways, as well as cut and fill; new roadway structures such as bridges; retaining walls, lights, and signs; removal of natural vegetation, agricultural crops, or landscaping; addition of landscaping; changes in light, glare, or shadow patterns; and other related changes.

4.5.1.2 Methods to Determine Visual Quality Change

The effect that the physical change in the visible environment would have on visual quality was determined next. The same rating process was applied to the future visible environment as was used in the analysis of the existing visual quality. In this way, the difference in visual quality – whether beneficial or adverse – could be predicted. This is called the visual quality change. Table 4.5-1 shows how visual quality change is rated.

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Table 4.5-1
VISUAL QUALITY CHANGE RATINGS

Existing Condition ⇩	Very low	Low	Moderately low	Moderate	Moderately high	High	Very high ⇦ Future Condition
Very high	Substantial adverse change	Substantial adverse change	Substantial adverse change	Substantial adverse change	Less than substantial adverse change	Minimal adverse change	No change
High	Substantial adverse change	Substantial adverse change	Substantial adverse change	Less than substantial adverse change	Minimal adverse change	No change	Minimal beneficial change
Moderately high	Substantial adverse change	Substantial adverse change	Less than substantial adverse change	Minimal adverse change	No Change	Minimal beneficial change	Less than substantial beneficial change
Moderate	Substantial adverse change	Less than substantial adverse change	Minimal adverse change	No Change	Minimal beneficial change	Less than substantial beneficial change	Substantial beneficial change
Moderately low	Less than substantial adverse change	Minimal adverse change	No change	Minimal beneficial change	Less than substantial beneficial change	Substantial beneficial change	Substantial beneficial change
Low	Minimal adverse change	No change	Minimal beneficial change	Less than substantial beneficial change	Substantial beneficial change	Substantial beneficial change	Substantial beneficial change
Very low	No change	Minimal beneficial change	Less than substantial beneficial change	Substantial beneficial change	Substantial beneficial change	Substantial beneficial change	Substantial beneficial change

Source: Visual Assessment for Highway Projects, Federal Highway Administration, 1981.

4.5.1.1 Methods Used to Determine Visual Impact of the Road

The combination of viewer sensitivity, as determined in the analysis of existing conditions, and visual quality change results in visual impact, either beneficial or adverse. These two factors were considered together to determine potential visual impact of the road. In order to effectively compare the visual impacts of each project alternative, a scoring system was incorporated into the analysis methodology in order to develop an overall visual impact rating for each segment and project alternative. The revised methodology considered both the visual impacts of the new roadway to the surrounding landscape, and the quality of the visual environment as seen from the proposed roadway. The rating of the views of the road for each segment was accomplished by developing a composite visual impact score based on the landscape unit ratings. The determination of ratings for visual impact with numeric scores is shown in Table 4.5-2.

Table 4.5-2
VISUAL IMPACTS RATINGS

Visual Sensitivity ⇩						
Very high	Substantial beneficial impact (10)	Less than substantial beneficial impact (5)	No impact (0)	Less than substantial adverse impact (-5)	Substantial adverse impact (-10)	
Moderately high	Substantial beneficial impact (9)	Less than substantial beneficial impact (4)	No impact (0)	Less than substantial adverse impact (-4)	Substantial adverse impact (-9)	
Moderate	Substantial beneficial impact (8)	Minimal beneficial impact (3)	No impact (0)	Minimal adverse impact (-3)	Substantial adverse impact (-8)	
Moderately low	Substantial beneficial impact (7)	Minimal beneficial impact (2)	No impact (0)	Minimal adverse impact (-2)	Substantial adverse impact (-7)	
Very low low	Less than substantial beneficial impact (6)	Minimal beneficial impact (1)	No impact (0)	Minimal adverse impact (-1)	Less than substantial adverse impact (-6)	
	Substantial beneficial change	**Less than substantial or minimal beneficial change**	**No change**	**Less than substantial or minimal adverse change**	**Substantial adverse change**	**⇦ Visual Quality Change**

Source: Visual Assessment for Highway Projects, Federal Highway Administration, 1981.

By applying a visual impact score to each landscape unit within a segment, an average score was derived by dividing the total score by the number of landscape units that describe the segment. The visual impact rating for the segments will be based on the following:

If the score is:	**Then the rating is:**
-10 to –7	High Impact
-6 to –4	Medium Impact
-3 to +10	Low Impact

While some landscape units were evaluated as having a positive (beneficial) visual impact from the introduction of a new highway facility or existing highway improvements, the average rating over the entire segment tended to be neutral or negative. Only a few segments were determined to have a positive visual impact. Therefore, all segments that had a zero (0) or positive evaluation (+1 to +10) were identified as having a low “adverse” impact.

4.5.1.2 Methods Used to Determine Visual Quality from the Road

It is assumed that the view from the road will be generally of high quality in areas that have existing high quality views and be of low quality in areas that have existing low quality views. Most of the segments being analyzed are either on an existing roadway alignment or proposed new alignments. In both situations, the visual quality would remain as they exist today particularly for new alignments that have never experienced the types of views that will be exposed to the traveler. The current landscape unit rating system has an Existing Visual Quality value. There are seven visual quality values: very low, low, moderately low, moderate, moderately high, high, and very high. Using a scoring system from 1 to 7, an average existing visual quality rating was developed for each segment. The final segment analysis for visual quality from the road was rated as low, medium, or high.

4.5.2 Special Concern Areas

Special visual concern areas include the Blue Ridge Parkway, the Appalachian Trail, Roanoke Mountain, and Mill Mountain - all of which are frequently visited and valuable scenic features within the study area. At the request of the NPS, special consideration was given to the visual quality impact to these areas due to their importance to the region and volume of potential visitors.

4.5.2.1 Appalachian Trail

Portions of the Appalachian Trail are located within the viewshed of the I-73 Location Study. The trail is approximately 2,050 miles (3,300 kilometers) in length between Maine and Georgia. The trail traverses private lands, as well as public lands held by federal and state agencies. Within the study area, the Appalachian Trail is located in Botetourt County, entering the area under I-81 north of Exit 150. The trail continues southeasterly crossing U.S. Route 460, enters the Jefferson National Forest, and then turns easterly, remaining north of the Blue Ridge Parkway.

4.5.2.2 Blue Ridge Parkway

The Blue Ridge Parkway was enabled by Congress in the 1930s as a scenic drive to connect the Shenandoah National Park with the Great Smoky Mountains National Park. The Blue Ridge Parkway was the first national rural parkway and park road to be conceived, designed, and constructed as a leisure type driving experience. It is the NPS's most visited area in the country. The location of the Blue Ridge Parkway was selected to provide the best in a variety of scenic, historic, and natural features that evoke the regional image of the central and southern Appalachian Mountains. In order to maximize scenic views and give Blue Ridge Parkway visitors the impression that they are in a park that reaches to the horizon, the Blue Ridge Parkway was located in mountainous terrain that normal roads would have avoided. Access to the Blue Ridge Parkway within the study area is presently from interchanges at U.S. Route 460 in Botetourt County and U.S. Route 220 and Route 24 in Roanoke County.

Methods Used to Determine Impacts to the Blue Ridge Parkway

The views from and of the Blue Ridge Parkway were important considerations in evaluating the potential impacts to the visual quality. In order to protect these views from and of the Blue Ridge Parkway, a process was developed to incorporate Blue Ridge Parkway planners and landscape architects into the early phases of the I-73 Location Study to assist in identifying possibilities for lower impact crossing opportunities. Through several meetings with Blue Ridge Parkway landscape architects, the study team was able to identify three of the current five proposed alternative segment crossings. The NPS provided guidance, which is outlined in a document entitled Analysis for Potential Crossings of the Blue Ridge Parkway by Interstate 73 (Johnson, Orr, et al., 1998).

A system of viewshed mapping was developed based on a 100-foot (30-meter) corridor along the Blue Ridge Parkway from milepost 102 to milepost 132, modeled on the current system used by the Blue Ridge Parkway to assess the quality of landscapes (Johnson, Orr, et al., 1998). All five of the Blue Ridge Parkway crossings

are evaluated according to how many places they can be seen along the Blue Ridge Parkway, assessed every 100 feet (30 meters). The resultant map indicates the relative visibility of each corridor segment and is presented with analysis in Chapter 4.0.

There are both quantitative and qualitative aspects to visual assessment of the Blue Ridge Parkway. Each is required in order to develop a model to assess and compare both the extent of the visual impact and the quality of the areas that are potentially affected and should be mitigated.

Visibility Analysis

Modeled on the current system used by the Blue Ridge Parkway to assess the visibility of landscapes (Gary Johnson and Will Orr, 1998) a system of viewshed mapping was developed. This system provides a summary of the land that could be visible along the Blue Ridge Parkway from milepost 102 to milepost 132. In the model, a three-mile-spread grid, composed of 30 by 30-meter cells, is draped over the topography, and grid cells are assessed as to how many times they could be seen from the Blue Ridge Parkway. The model assumes maximum potential visibility, so is developed without vegetation or buildings blocking the topographic view. All five of potential I-73 crossings are evaluated according to how many places they can be seen along the Blue Ridge Parkway. The resultant comparison indicates the relative visibility of each corridor segment. Comparative data are assessed according to the following:

- Count shows the number of 30 meter cells visible from the crossing.
- Minimum View Cell shows a value of the cell least seen by the Blue Ridge Parkway at point of crossing.
- Maximum View Cell is an important measure. This measurement tells the relative exposure of the most visible 30 meter cell.
- Mean View Cell states the average times a cell is seen along the corridors.
- Sum of View Cells is most important for this study. This column indicates a summary of the amount of cells affected times the relative score, or times that they can be seen.
- Variety of View Cells indicates how many different scores there were between the minimum and maximum cell scores.

Potentially crossing corridor segments are compared for the maximum cell values and their sum of cell views to find potentially low impact crossings.

Qualitative Analysis

The visual impact on the Blue Ridge Parkway is discussed in three areas: foreground, middleground, and cinematic experience. Mitigating measures are discussed generally. They would be applied to any of the crossings, and individually for each of the five proposed Blue Ridge Parkway crossings. The visual effects on the Blue Ridge Parkway would include foreground changes of views from the introduction of a new interstate highway. They would also include middle-ground changes both by highway location, cut and fill slopes, and terrain alterations. Secondary effects may include future development outside the Blue Ridge Parkway boundaries in privately held lands adjacent to the interstate and its interchanges. A third type of visual impact on the Blue Ridge Parkway would be the change in the cinematic park experience. The “cinematic experience” is defined as the experience of a Blue Ridge Parkway visitor traveling along sequentially, as a film is viewed. This visual impact would occur from foreground to background, although in the urbanized areas around Roanoke the background effect would be minimal.

4.5.2.3 Roanoke Mountain

Managed as an expanded overlook off of the Blue Ridge Parkway at milepost 120.4, the Roanoke Mountain one-way loop road rises to the top of the mountain, overlooking the Garden City area to the north, and surveying the Clearbrook area to the south. It is located east of U.S. Route 220.

4.5.2.4 Mill Mountain

Roanoke City's flagship park, a 542-acre (219-hectare) high-point preserve, is discussed more fully in the parklands section of this document. There are several overlooks placed on the north and northwestern side of the mountain, overlooking the Roanoke Valley.

4.5.3 Community Values

Roanoke City's flagship park, a 542-acre (219-hectare) high-point preserve, is discussed more fully in the parklands section of this document. There are several overlooks placed on the north and northwestern side of the mountain, overlooking the Roanoke Valley Community Values

4.5.4 No-Build Alternative

The No-Build Alternative would result only in physical changes to the visual environment in the study area from the implementation of projects in the VDOT Six-Year Improvement Program. The visual changes would include changes to the cut and fill slopes, removal of signage and/or entrance features, and appurtenances that accompany safer highway construction.

4.5.5 TSM Alternative

Upgrading U.S. Route 220 from its current four-lane, divided, primarily unlimited-access condition to reduce safety concerns would result in a number of visual changes to the existing corridors. Particularly in the Northern Piedmont landscape district, the cuts would be made deeper and the fills higher, to ease grades and to bring the road into compliance with safety standards. None of these landscape units would experience high visual impacts under this alternative. Due to the established nature of U.S. Route 220 and its impact on development in the region, visual mitigation options are limited. The TSM Alternative would have the lowest visual impact compared to the build options but would also have the lowest visual quality benefit.

The TSM Alternative would minimally affect views from Mill Mountain since U.S. Route 220 already dominates the views. Middleground views from the overlooks would include TSM improvements 1, 2, 3, and 4 (see Table 2.4-2). Middleground views from and of the Blue Ridge Parkway and its overlooks, the Appalachian Trail and Roanoke Mountain would include the widenings associated with TSM improvements 1, 2, 3, and 4.

4.5.6 Build Alternatives

4.5.6.1 Visual Effects

Individual segments were assessed for visual effect of the proposed location of an interstate facility based on the identified landscape units. The visual effect of the proposed location of an interstate facility was analyzed in terms of views of the road and views from the road. Views of the road were rated as "impacts" where a low rating would represent a low (negative) impact and a high rating would represent a high (negative) impact. Views from the road were rated based on the "quality" of the view. A low visual quality rating would represent a less attractive setting compared to a high visual quality rating. High quality views tend to be in very scenic areas. Uniqueness was analyzed by identifying the number of landscape units that were found to have a unique feature or features and present the results in terms of a percent of units with unique features.

The effects of each segment are combined to describe the effect of an option in the subsequent sections. Build Alternative options as well as the TSM Alternative were evaluated as the sum of the effects of the landscape units along each option. Visual Effects on the Blue Ridge Parkway, the Appalachian Trail and on Mill Mountain were also compared by option and are discussed in section 4.5.5. Table 4.5-3 provides the scores and ranking of the visual effects for the TSM Alternative and Build Alternative options, including the ALC. The ranking is from 1 to 13 in the order of the score from high to low. In this table, a number 1 ranking in visual quality represents the option with the best views from the road. A number 1 ranking in visual impact represents the least impact for viewers of the road. For uniqueness, a number 1 ranking indicates that the option had the lowest percent of unique units. It should be noted that the visual quality scores were

developed for purposes of comparing alternatives. The same holds true for the visual impact scores. The visual quality scores should not be compared to the visual impact scores and the conclusion reached that one will offset the other. The visual quality analysis does not suggest that both scores should be treated equally or recommend that one score be given greater weight over the other. It is up to the decision-makers to determine how much value they will place on either score.

Table 4.5-3
VISUAL RATING OF TSM AND BUILD ALTERNATIVES

Option	Uniqueness		Visual Quality (Views from the Road)			Visual Impact (Views of the Road)		
	Percent Unique	Rank	Rating	Score	Rank	Rating	Score	Rank
TSM	33%	6	Medium	3.98	13	Low	0.15	1
Option 1	40%	9	Medium	4.80	1	Low	-3.14	11
Option 1a	34%	7	Medium	4.78	2	Medium	-3.82	13
Option 2	32%	5	Medium	4.58	5	Low	-3.01	10
Option 2a	30%	2	Medium	4.74	3	Low	-3.34	12
Option 2b	31%	4	Medium	4.29	8	Low	-2.22	7
Option 2c	30%	2	Medium	4.52	6	Low	-2.93	9
Option 3	39%	8	Medium	4.04	11	Low	-0.45	3
Option 3a	44%	12	Medium	4.11	10	Low	-0.55	4
Option 3b	40%	9	Medium	4.00	12	Low	-0.41	2
Option 3c	40%	9	Medium	4.12	9	Low	-0.99	6
Option 4	48%	13	Medium	4.73	4	Low	-0.72	5
ALC	28%	1	Medium	4.42	7	Low	-2.53	8

4.5.6.2 Build Alternative – Option 1

Option 1 (Table 4.5-4) would have a high visual impact of the road in areas encountering the mountainous portions of this region with lower impacts in the flatlands were views are less noticeable. An exception occurs in the area east of Martinsville where greater populations exist. The visual quality from the road is consistently medium throughout this option with the exception of the crossing of the Blue Ridge Mountains where it is high. Forty percent of the landscape units associated with Option 1 were considered unique.

Table 4.5-4
OPTION 1 VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
372	19	7	87	4.57	Medium	-63	-3.32	Low
399	3	1	20	6.66	High	-23	-7.66	High
400	4	1	20	5.00	Medium	-12	-3.00	Low
152	16	9	89	5.56	Medium	-53	-3.31	Low
385	2	2	10	5.00	Medium	0	0.00	Low
369	8	2	36	4.50	Medium	-7	-0.87	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
333	7	2	26	3.71	Medium	-22	-3.14	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	65	26 **(40%)**	312	4.80	**Medium**	-204	-3.14	**Low**

In the Great Valley and Blue Ridge landscape regions, the highway would span the Roanoke River, then rise to Lynville Mountain. There would be high visual impacts in the mountainous areas but would be within a less developed area. The majority of this section will be introduced to already urbanized areas causing mainly low to medium visual impacts. Due to the views around Lynville Mountain, the visual impact would be high for the residences within the viewshed. Travelers of the road would experience high quality views. As Option 1 enters the south end of the Blue Ridge Mountain landscape region, there would be a high visual impact where the highway would divide the farms. The traveler would benefit from exposure to this rarely noticed landscape.

As Option 1 passes the Upper Piedmont landscape region, the majority of the visual impacts will be low. The notable exceptions would be the crossing of the Blackwater River and Snow Creek. All other areas would have low to medium visual impacts of the road and medium to high quality views from the road. Portions covering the Lower Piedmont landscape region would require only moderate cuts and fills, but would require forest clearing for virtually all of its length and would have to traverse the Mill Creek lowlands. This and the growing presence of residences associated with the proximity to Martinsville contributes to the medium visual impact assessed to this section. The remainder of this option would have low visual impacts of the road with medium quality views from the road.

4.5.6.3 Build Alternative – Option 1a

Option 1a (Table 4.5-5) is ranked as having the highest visual impact of all Build Alternative options. Option 1a varies from Option 1 between the Red Valley area and north of Martinsville. The visual effects at the northern portion of this Option and for areas to the far south would be the same as Option 1. Crossing into the Upper Piedmont within Franklin County, Option 1a exposes areas visible by several residential communities giving rise to the medium visual impact. There would be clearing, grading and cut and fill on the south slope of Clower Mountain, visible to the Wirtz community. Additional medium visual impacts would be experienced by the Bonbrook's ridgetop community settlement. The residential developments in the Little Creek valley would also have noticeable views of the road. Passing to the west of Rocky Mount, Option 1a would cross the Blackwater River basin and the Grassy Hill areas creating high visual impacts of the road. Travelers of the road would experience high quality views. The remainder of Option 1a, which departs from Option 1, covers mostly areas that would experience low visual impacts. Thirty-four percent of the landscape units associated with Option 1a were considered unique.

Table 4.5-5
OPTION 1a VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
372	19	7	87	4.57	Medium	-63	-3.32	Low
399	3	1	20	6.66	High	-23	-7.66	Medium
400	4	1	20	5.00	Medium	-12	-3.00	Low
144	7	1	39	5.57	High	-41	-5.85	Medium
381	5	2	31	6.20	High	-22	-4.40	Medium
192A	10	5	52	5.20	Medium	-53	-5.30	Medium
321	3	1	12	4.00	Medium	-5	-1.66	Low
387	2	2	13	6.50	High	-10	-5.00	Medium
329	10	2	39	3.90	Medium	-15	-1.50	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
333	7	2	26	3.71	Medium	-22	-3.14	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	76	26 **(34%)**	363	4.78	**Medium**	-290	-3.82	**Medium**

4.5.6.4 Build Alternative – Option 2

Similar to Option 1, Option 2 (Table 4.5-6) would have a high visual impact of the road in areas encountering the mountainous portions of this region. In addition, medium visual impacts occur south of the Blue Ridge Parkway and along a segment that stretches from Red Valley to Sydnorsville east of Rocky Mount. The impacts in most of the remaining portions of this option are low. With few exceptions, the visual quality from the road is consistently medium throughout this option. Thirty-two percent of the landscape units associated with Option 2 were considered unique.

Table 4.5-6
OPTION 2 VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
376	5	2	27	5.40	Medium	-28	-5.60	Medium
294	4	0	20	5.00	Medium	-26	-6.50	High
118B	2	1	11	5.50	High	-4	-2.00	Low
400	4	1	20	5.00	Medium	-12	-3.00	Low
153	14	3	72	5.14	Medium	-78	-5.57	Medium
202A	2	0	10	5.00	Medium	0	0.00	Low
385	2	2	10	5.00	Medium	0	0.00	Low
386	2	2	12	6.00	High	-5	-2.50	Low
329	10	2	39	3.90	Medium	-15	-1.50	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
391	7	1	21	3.00	Medium	0	0.00	Low
390	1	1	6	6.00	High	0	0.00	Low
349	2	0	7	3.50	Medium	-6	-3.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	69	22 **(32%)**	316	4.58	**Medium**	-208	-3.01	**Low**

Option 2 begins by following the existing I-581, where no significant changes are anticipated. The crossing of the Blue Ridge Parkway and the northern face of the Blue Ridge Mountains would have a high visual impact from the displacement of the pastures and crop fields adjacent to the Mount Pleasant community. The highway placement south of the Blue Ridge Parkway would be a noticeable change to the residents of the valley. The impacts would also be visible from the Blue Ridge Parkway, Roanoke Mountain and the foreground valleys. The views from the road would be moderate with some high quality views in the elevated sections.

Although some portions cross the Blue Ridge Mountains, the overall visual impact would be low. One segment includes an area that would experience a high visual impact, however this is offset by the visual benefit from the likely removal of an existing auto salvage yard. The segment passing east of Rocky Mount includes highly scenic areas that may equate to some high visual impacts with the introduction of a new highway. The majority of the segment would experience medium visual impacts and medium to high quality views. The remainder of this option would have low visual impacts with medium to high quality views from the road.

4.5.6.5 Build Alternative – Option 2a

The only difference between Options 2 and 2a is that Option 2a (Table 4.5-7) uses a shorter, more eastern approach to cross from Roanoke County to Franklin County. Although this route is shorter, it does slightly increase the visual impact of the road but also increases the quality views from the road. Several areas would experience high visual impacts in crossing the Blue Ridge Mountain. The highway would become a

dominant visual element in the landscape adjacent to the community of Mount Pleasant, visible from the Blue Ridge Parkway and Roanoke Mountain. Due to the views around Lynville Mountain, the visual impact would be high for the residences within the viewshed. Travelers of the road would experience high quality views of Lynville Mountain in the foreground and background views of Roanoke Mountain in the distant west. Thirty percent of the landscape units associated with Option 2a were considered unique. This equals the second lowest percent of unique landscape units identified compared to all other Build options.

Table 4.5-7
OPTION 2a VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
376	5	2	27	5.40	Medium	-28	-5.60	Medium
287A	8	0	46	5.75	High	-46	-5.57	Medium
399	3	1	20	6.66	High	-23	-7.66	High
400	4	1	20	5.00	Medium	-12	-3.00	Low
153	14	3	72	5.14	Medium	-78	-5.57	Medium
202A	2	0	10	5.00	Medium	0	0.00	Low
385	2	2	10	5.00	Medium	0	0.00	Low
386	2	2	12	6.00	High	-5	-2.50	Low
329	10	2	39	3.90	Medium	-15	-1.50	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
391	7	1	21	3.00	Medium	0	0.00	Low
390	1	1	6	6.00	High	0	0.00	Low
349	2	0	7	3.50	Medium	-6	-3.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	74	22 **(30%)**	351	4.74	**Medium**	-247	-3.34	**Low**

4.5.6.6 Build Alternative – Option 2b

Option 2b (Table 4.5-8) is only slightly different than Option 2. Option 2b uses U.S. Route 220 to cross the Blue Ridge Parkway and parts of the north side of the Blue Ridge Mountains. The visual impact and visual quality would be less than Options 2 and 2a. The landscape of U.S. Route 220 in Roanoke City provides a high diversity of scenery. Except for possible future lanes and/or ramps, no significant changes are anticipated. Although the crossing of the Blue Ridge Parkway follows U.S. Route 220 some shifting of the horizontal alignment would be necessary. Some encroaching elements of businesses would be removed, such as signs and entrances affected by previous widenings, but the placement of fences and guardrails for service road safety would offset visual gain from their removal. The portion that crosses the Blue Ridge Parkway would likely have a high visual impact only for those in homes located south of the Blue Ridge Parkway. The view to the west from atop this small ridge, however, would have some visual benefits for travelers along this corridor. Thirty-one percent of the landscape units associated with Option 2b were considered unique.

Table 4.5-8
OPTION 2b VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
375	3	1	9	3.00	Medium	0	0.00	Low
118C	4	0	12	3.00	Medium	0	0.00	Low
118	1	0	2	2.00	Low	3	3.00	Low

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
118B	2	1	11	5.50	High	-4	-2.00	Low
400	4	1	20	5.00	Medium	-12	-3.00	Low
153	14	3	72	5.14	Medium	-78	-5.57	Medium
202A	2	0	10	5.00	Medium	0	0.00	Low
385	2	2	10	5.00	Medium	0	0.00	Low
386	2	2	12	6.00	High	-5	-2.50	Low
329	10	2	39	3.90	Medium	-15	-1.50	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
391	7	1	21	3.00	Medium	0	0.00	Low
390	1	1	6	6.00	High	0	0.00	Low
349	2	0	7	3.50	Medium	-6	-3.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	68	21 **(31%)**	292	4.29	**Medium**	-151	-2.22	**Low**

4.5.6.7 Build Alternative – Option 2c

Option 2c (Table 4.5-9) is the same as Option 2 with only a minor change in alignment in southern Franklin County. Option 2c uses a more direct route to connect Sydnorsville with a portion of U.S. Route 220 just north of the Franklin/Henry County line. This would slightly increase the visual impact of the road compared to Option 2 but would also increase the quality of views from the road. Dense forest immediately adjacent to the roadside near Synorsville prevents background views, despite its proximity to Fork Mountain. The majority of this small variation would produce visual impact in some areas but they would be moderate or low. The visual quality from the road ranges from low to high which generates a medium overall score. The very end runs down a steep north slope toward a creek. The valley at the north end would be spanned with a bridge, creating a medium visual impact for the community along Route 605. Thirty percent of the landscape units associated with Option 2c were considered unique. This equals the second lowest percent of unique landscape units identified compared to all other Build options.

Table 4.5-9
OPTION 2c VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
376	5	2	27	5.40	Medium	-28	-5.60	Medium
294	4	0	20	5.00	Medium	-26	-6.50	High
118B	2	1	11	5.50	High	-4	-2.00	Low
400	4	1	20	5.00	Medium	-12	-3.00	Low
153	14	3	72	5.14	Medium	-78	-5.57	Medium
326B	2	0	8	4.00	Medium	5	2.50	Low
326	4	1	16	4.00	Medium	0	0.00	Low
387	2	2	13	6.50	High	-10	-5.00	Medium
329	10	2	39	3.90	Medium	-15	-1.50	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
391	7	1	21	3.00	Medium	0	0.00	Low
390	1	1	6	6.00	High	0	0.00	Low
349	2	0	7	3.50	Medium	-6	-3.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
Final Option Rating	71	21 **(30%)**	321	4.52	**Medium**	-208	-2.93	**Low**

4.5.6.8 Build Alternative – Option 3

Option 3 (Table 4.5-10) uses mainly the existing highway system represented by I-595, U.S. Route 220, and U.S. Route 58 Bypass. Since most of these corridors are already affected by the existence of the highway system, the visual impacts are predominately low. Medium and high visual impacts do exist but only in isolated areas. The visual quality of views from the road is typically medium with some segments of high quality. Thirty-nine percent of the landscape units associated with Option 3 were considered unique.

Table 4.5-10
OPTION 3 VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
375	3	1	9	3.00	Medium	0	0.00	Low
118C	4	0	12	3.00	Medium	0	0.00	Low
377B	3	0	13	4.33	Medium	0	0.00	Low
377	4	1	19	4.75	Medium	-4	-1.00	Low
379	2	2	12	6.00	High	-1	-0.50	Low
397	2	2	12	6.00	High	-3	-1.50	Low
380	5	2	24	4.80	Medium	-16	-3.20	Low
382	9	0	37	4.11	Medium	-9	-1.00	Low
383	5	0	14	2.80	Medium	19	3.80	Medium
384	2	1	9	4.50	Medium	5	2.50	Low
386	2	2	12	6.00	High	-5	-2.50	Low
388	10	3	32	3.20	Medium	3	0.30	Low
389	7	5	27	3.85	Medium	-10	-1.42	Low
390	1	1	6	6.00	High	0	0.00	Low
392	1	1	3	3.00	Medium	0	0.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	69	27 **(39%)**	279	4.04	**Medium**	-31	-0.45	**Low**

4.5.6.9 Build Alternative – Option 3a

The only difference between Options 3 and 3a is that Option 3a (Table 4.5-11) follows the Norfolk Southern Rail alignment to the west of U.S. Route 220 to cross the Blue Ridge Parkway. This would slightly increase the visual impact of the road compared to Option 3 and would have little effect on the quality of views from the road. Forty-four percent of the landscape units associated with Option 3a were considered unique

Table 4.5-11
OPTION 3a VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
375	3	1	9	3.00	Medium	0	0.00	Low

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
105	4	2	18	4.50	Medium	-8	-2.00	Low
378	2	0	10	5.00	Medium	0	0.00	Low
379	2	2	12	6.00	High	-1	-0.50	Low
397	2	2	12	6.00	High	-3	-1.50	Low
380	5	2	24	4.80	Medium	-16	-3.20	Low
382	9	0	37	4.11	Medium	-9	-1.00	Low
383	5	0	14	2.80	Medium	19	3.80	Low
384	2	1	9	4.50	Medium	5	2.50	Low
386	2	2	12	6.00	High	-5	-2.50	Low
388	10	3	32	3.20	Medium	3	0.30	Low
389	7	5	27	3.85	Medium	-10	-1.42	Low
390	1	1	6	6.00	High	0	0.00	Low
392	1	1	3	3.00	Medium	0	0.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	64	28 **(44%)**	263	4.11	**Medium**	-35	-0.55	**Low**

4.5.6.10 Build Alternative – Option 3b

Option 3b (Table 4.5-12) has the lowest ranking in visual quality but also the lowest visual impact among the Build Alternative options. Option 3b is only slightly different than Option 3. Option 3b uses new alignment parallel to the east of U.S. Route 220 to cross parts of the north side of the Blue Ridge Mountains. The visual impact would be reduced compared to Option 3 and the visual quality would have little change. The portion that crosses the Blue Ridge Parkway would likely have a high visual impact only for those in homes located south of the Blue Ridge Parkway. The view to the west from atop this ridge, however, would have some visual benefits for travelers along this Option. North of the Franklin County line Option 3b would be far enough from existing U.S. Route 220 to go unnoticed. As the alignment approaches the county line, the two roads would align closer and the presence of this Build option alignment would be clearly observed. The visual impact of the road for these segments would be low with low to medium quality views from the road. Forty percent of the landscape units associated with Option 3b were considered unique

Table 4.5-12
OPTION 3b VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
375	3	1	9	3.00	Medium	0	0.00	Low
118C	4	0	12	3.00	Medium	0	0.00	Low
118	1	0	2	2.00	Low	3	3.00	Low
296	5	1	23	4.60	Medium	-4	-0.80	Low
379	2	2	12	6.00	High	-1	-0.50	Low
397	2	2	12	6.00	High	-3	-1.50	Low
380	5	2	24	4.80	Medium	-16	-3.20	Low
382	9	0	37	4.11	Medium	-9	-1.00	Low
383	5	0	14	2.80	Medium	19	3.80	Medium
384	2	1	9	4.50	Medium	5	2.50	Low
386	2	2	12	6.00	High	-5	-2.50	Low
388	10	3	32	3.20	Medium	3	0.30	Low
389	7	5	27	3.85	Medium	-10	-1.42	Low
390	1	1	6	6.00	High	0	0.00	Low

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
392	1	1	3	3.00	Medium	0	0.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	68	27 **(40%)**	272	4.00	**Medium**	-28	-0.41	**Low**

4.5.6.11 Build Alternative – Option 3c

Option 3c (Table 4.5-13) is the same as Option 3 with only a minor change in alignment in southern Franklin County. Option 3c uses an alternative route that departs westward from U.S. Route 220 south of Rocky Mount and return to U.S. Route 220 just north of the Franklin/Henry County line. This would slightly increase the visual impact of the road compared to Option 3 and would have little effect on the quality of views from the road. The northern segment includes a series of enclosing views of a single farmhouse and fields. There are no background views and middleground views, because this part of Option 3c would be enclosed within the surrounding woodlands. Minor cuts and fills would be visible to the south. The visual axis would run along the power line that crosses this option for both northbound and southbound travelers. The valley at the north end would be spanned with a bridge, creating a medium visual impact for the community along Route 605. Forty percent of the landscape units associated with Option 3c were considered unique

Table 4.5-13
OPTION 3c VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
375	3	1	9	3.00	Medium	0	0.00	Low
118C	4	0	12	3.00	Medium	0	0.00	Low
377B	3	0	13	4.33	Medium	0	0.00	Low
377	4	1	19	4.75	Medium	-4	-1.00	Low
379	2	2	12	6.00	High	-1	-0.50	Low
397	2	1	12	6.00	High	-3	-1.50	Low
380	5	2	24	4.80	Medium	-16	-3.20	Low
382	9	0	37	4.11	Medium	-9	-1.00	Low
319	3	1	11	3.66	Medium	-2	-0.66	Low
321	3	1	12	4.00	Medium	-5	-1.66	Low
387	2	2	13	6.50	High	-10	-5.00	Medium
388	10	3	32	3.20	Medium	3	0.30	Low
389	7	5	27	3.85	Medium	-10	-1.42	Low
390	1	1	6	6.00	High	0	0.00	Low
392	1	1	3	3.00	Medium	0	0.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	68	27 **(40%)**	280	4.12	**Medium**	-67	-0.99	**Low**

4.5.6.12 Build Alternative – Option 4

Option 4 (Table 4.5-14) would be a western alignment that would start from I-81 at the Dixie Caverns Interchange. This option has a high visual impact south of Boones Mill and two segments with medium visual impacts. The remaining segments have low visual impacts. Most segments have medium quality views from the road with a few high quality views in segments located in the mountainous areas and south of Boones

Mill. Forty-eight percent of the landscape units associated with Option 4 were considered unique. This represents the highest percent of unique landscape units identified compared to all other Build options.

Table 4.5-14
OPTION 4 VISUAL IMPACT RATING

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
371	18	7	99	5.50	High	94	-5.22	Medium
378	2	0	10	5.00	Medium	0	0.00	Low
394	2	1	12	6.00	High	-1	-0.50	Low
397	2	2	12	6.00	High	-3	-1.50	Low
116B	8	4	49	6.12	High	-57	-7.12	High
192A	10	5	52	5.20	Medium	-53	-5.30	Medium
321	3	1	12	4.00	Medium	-5	-1.66	Low
237B	12	5	38	3.16	Medium	0	0.00	Low
389	7	5	27	3.85	Medium	-10	-1.42	Low
349	2	0	7	3.50	Medium	-6	-3.00	Low
393	4	3	17	4.25	Medium	-10	-2.50	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final Option Rating	71	34 **(48%)**	336	4.73	**Medium**	-51	-0.72	**Low**

A large variety of visual impacts and quality views would be associated with the segment that stretches from I-81 to the south side of the Blue Ridge Parkway. The amount of cut and fill that would be required to align an interstate highway would create high visual impacts in some areas. The remainder of the segment would have low to moderate impacts. Travelers would benefit from the prospective views of the cities below. The sparsely settled valley along Boone's Chapel Road would have medium visual impacts of the highway, as it would span the entrance to their valley.

The crossing of the Roanoke/Franklin County line may allow interstate travelers better opportunity to observe the beauty of the agricultural valley along Route 613. The segment south of Boones Mill includes some very scenic areas. Although cuts and fills would affect all of the southern parts of this segment, a heightened impact would be experienced in one specific area because of its creek-defined viewshed. Another area would experience heightened impacts due to the number of houses that would be separated from their backyard middleground and background views.

The alignment to the west of Rocky Mount would cross the Blackwater River basin and the Grassy Hill areas creating high visual impacts of the road. Travelers of the road would experience high quality views. Between Rocky Mount and the Henry County line, the visual axis would run along the power line that crosses for both northbound and southbound travelers. There would be a substantial beneficial impact on the north segment in Henry County were intensive logging currently exist. The landscape could be enhanced by the construction of the highway, with grading and erosion-controlling practices. Other areas would have low to medium impacts.

The remainder of this option includes the connection from U.S. Route 220 Bypass to the U.S. Route 58 Bypass. This area may see a revision of the current on and off ramps, deceleration and acceleration lanes, and signage as a result of upgrades to achieve interstate status. In order to bring the last section of U.S. Route 220 up to interstate highway standards portions of the existing highway would require changes to the horizontal and vertical alignment.

4.5.6.13 Adopted Location Corridor

The ALC (Table 4.5-15) would have medium visual impact of the road in some portions of this region with lower impacts along the I-581/U.S. Route 220 corridor where major urban development has already occurred

and the flatlands where views are less noticeable. An exception occurs in the area east of Martinsville where greater populations exist. The visual quality from the road is consistently medium throughout the ALC with the exception of the crossing of the Blue Ridge Mountains where it is high. Twenty-eight percent of the landscape units associated with the ALC were considered unique. This is the lowest percent of unique landscape units identified compared to all other Build options.

Table 4.5-15
ADOPTED LOCATION CORRIDOR Visual Impact Rating

Segment #	# of Landscape Units	# of Unique Units	Visual Quality (From Road)			Visual Impact (Of Road)		
			Total Score	Average Score	Rating	Total Score	Average Score	Rating
374	4	2	20	5.00	Medium	0	0.00	Low
375	3	1	9	3.00	Medium	0	0.00	Low
118C	4	0	12	3.00	Medium	0	0.00	Low
118	1	0	2	2.00	Low	3	3.00	Low
118B	2	1	11	5.50	High	-4	-2.00	Low
400	4	1	20	5.00	Medium	-12	-3.00	Low
153	14	3	72	5.14	Medium	-78	-5.57	Medium
202A	2	0	10	5.00	Medium	0	0.00	Low
385	2	2	10	5.00	Medium	0	0.00	Low
369	8	2	36	4.50	Medium	-7	-0.87	Low
373	5	1	23	4.60	Medium	-24	-4.80	Medium
333	7	2	26	3.71	Medium	-22	-3.14	Low
398	1	1	1	1.00	Low	0	0.00	Low
Final ALC Rating	57	16 **(28%)**	252	4.42	**Medium**	-144	-2.53	**Low**

The ALC begins by following the existing I-581, where no significant changes are anticipated. The ALC uses U.S. Route 220 to cross the Blue Ridge Parkway and parts of the north side of the Blue Ridge Mountains. The landscape of U.S. Route 220 in Roanoke City provides a high diversity of scenery. Although the crossing of the Blue Ridge Parkway follows U.S. Route 220, some shifting of the horizontal alignment would be necessary. Some encroaching elements of businesses would be removed, such as signs and entrances affected by previous widenings, but the placement of fences and guardrails for service road safety would offset visual gain from their removal. The portion that crosses the Blue Ridge Parkway would likely have a high visual impact only for those in homes located south of the Blue Ridge Parkway. The view to the west from atop this small ridge, however, would have some visual benefits for travelers along this corridor.

Medium visual impacts occur south of the Blue Ridge Parkway and along a segment that stretches from Red Valley to Sydnorsville east of Rocky Mount. The segment passing east of Rocky Mount includes highly scenic areas that may equate to some high visual impacts with the introduction of a new highway. The majority of the segment would experience medium visual impacts and medium to high quality views.

Portions covering the Lower Piedmont landscape region would require only moderate cuts and fills, but would require forest clearing for virtually all of its length and would have to traverse the Mill Creek lowlands. This and the growing presence of residences associated with the proximity to Martinsville contribute to the medium visual impact assessed to this section. The remainder of the ALC would have low visual impacts of the road with medium quality views from the road.

4.5.7 Special Visual Concern Areas

4.5.7.1 Appalachian Trail

Segment 372 of Option 1 and 1a is the only segment that could affect the visual environment as seen from the Appalachian Trail. The trail would only come within approximately 1 mile (1.6 kilometers) of Segment 372 from the Blue Ridge Parkway to U.S. Route 11. Segment 372 would enter the visual experience of the

southbound Appalachian Trail hiker at the Fullhardt Knob Shelter, in the middleground distance, as the segment moves east of Coyner Mountain and aligns to cross the Blue Ridge Parkway in the Mountain Pass Road area. Project Team members took photos along the portion of the Appalachian Trail from Fulhardt's Knob to U.S. Route 220 during summer when foliage was heavy and during winter when foliage was non-existent.

Segment 372 would be potentially visible to trail hikers for the three-mile (five-kilometer) hike from Fullhardt's Knob Shelter to U.S. Route 11. Toward the top of Tinker Mountain, another two miles (three kilometers) would be exposed to background views and displace farmland scenes, which are the primary subject of view from this part of the Appalachian Trail. These views are often impeded however, by trees and foliage that line the trail. There are three distinct locations where Segment 372 would be visible from the Trail in this vicinity:

- From a Blue Blaze Trail overlook 0.6 miles (one kilometer) south of the Fullhardt's Knob Shelter.
- As the Appalachian Trail is adjacent to an open field in the Humbert farms area.
- On an open knob field north of Cloverdale, also on the property of the Humbert dairy farms.

As the segment moves northward toward I-81, the Appalachian Trail descends its forested ridgetop location at 2,660 feet (811 meters) to 1,700 feet (518 meters), winding around Fullhardt's Knob and exiting the George Washington and Jefferson National Forest in the Humbert Farms section of Botetourt County. The descent lasts approximately 3.0 miles (4.8 kilometers), 1.7 miles (2.7 kilometers) of which may be exposed to segment 372. The wood's edge area at the bottom of the descent and a high cleared knob in the Humbert Farms area have the highest exposure, with foreground views to the new highway interchange area.

As the Appalachian Trail moves across the Great Valley from the Troutville parking lot to the base of Tinker Mountain, the views of I-73 would be minimal to nonexistent, as the existing topography and I-81 block the views over the next 3.0 miles (4.8 kilometers). As Tinker Mountain is climbed, the hiker would again experience segment 372, in the middleground to background distance, beyond I-81 and the commercial development in Cloverdale.

Since the ALC does not include Segment 372, the Appalachian Trail will not be visually impacted from this Build option.

4.5.7.2 Blue Ridge Parkway

The Blue Ridge Parkway was enabled by Congress in the 1930s as a scenic drive to connect the Shenandoah National Park with the Great Smoky Mountains National Park. The scenic resources along the Blue Ridge Parkway were originally planned to provide the Blue Ridge Parkway experience as a boundaryless cinematic travel experience through the Blue Ridge region, with views into the Upper Piedmont landscape district and the Great Valley landscape region, and they have been maintained for the past 60 years. Typical sustainable highland Virginia farm scenes are the building blocks of the Blue Ridge Parkway scenery.

Figure 4.5-1 illustrates the relative visibility of each of the five proposed crossings of the Blue Ridge Parkway. Areas shown in the darker colors are areas in the landscape that would be seen from the most places along the Blue Ridge Parkway. These include ridge tops and mountaintops, open fields near the Blue Ridge Parkway and other landscape features that have high visibility from the Blue Ridge Parkway. The areas in the lighter shades are places that would be seen from fewer locations along the Blue Ridge Parkway, grading out to white areas, which would not be seen at all from any location within the study area along the Blue Ridge Parkway. This rough scale model uses a 100-foot (30-meter) assessment. The cell most seen from the entire Roanoke Valley is seen 251 times, which means that if a point is placed along the Blue Ridge Parkway every 100 feet (30 meters), a visitor can see this point 251 times along this drive. They range from 0 to 251, depending on how visible these points are.

Segment 105 Blue Ridge Parkway Evaluation

Quantitative Analysis: The quantitative analysis of the potential visual impact of segment 105 of Option 3a on the Blue Ridge Parkway found the following:

- Number of places along the segment that would be seen from the Blue Ridge Parkway: 329
- Minimum view cells: 0
- Maximum view cells: 112
- Mean view cell: 18.88
- Sum of view cells: 6,213
- Variety of view cells: 72

Qualitative Analysis: Segment 105 would cross the Blue Ridge Parkway in the Back Creek area at milepost 124.1 in a relatively sharp curve to the right. Approaching from the north the Blue Ridge Parkway traverses the south slope of Buck Mountain heading down to the creek with an axial vista focused on Mason's Knob. The sharp curve to the right would indicate the completion of the downward drive and the viewer's focus would begin to turn toward the farmlands and the former Beasley's orchards region. From the south, Beasley field would be followed by woods, the experience of crossing Back Creek and a secondary road, then curving abruptly to the left. Then the assent of the wooded Buck Mountain would begin. From each approach, effects would include removal of vegetation and landform, exposing more of the Norfolk Southern railroad tracks, Route 615 and the railway signal line under the Blue Ridge Parkway. The elevation of the Blue Ridge Parkway above these existing features would result in a lesser impact on the vista than would ordinarily be expected.

The potential foreground impacts associated with segment 105 would be moderate. The presence of interstate pavement, barriers, guardrails, and grading in the foreground would be noticed by the travel experience for Blue Ridge Parkway visitors. Effects to the middleground would be high, especially to the north of the Blue Ridge Parkway. Currently screened by Park woods, industrial areas would become visible as the section of the interstate carries the open vista west. Impacts to the middleground include the cut and fill slopes, bridge abutments, pavement, and guardrails, as well as the soundwalls that may be required in this area due to rapid suburban development out in this area of Roanoke County.

Segment 105 effects on the cinematic experience would be relatively low due to the location of the crossing. The travel sequence along the Blue Ridge Parkway would stay generally uninterrupted throughout the transition from woods to interstate back to woods.

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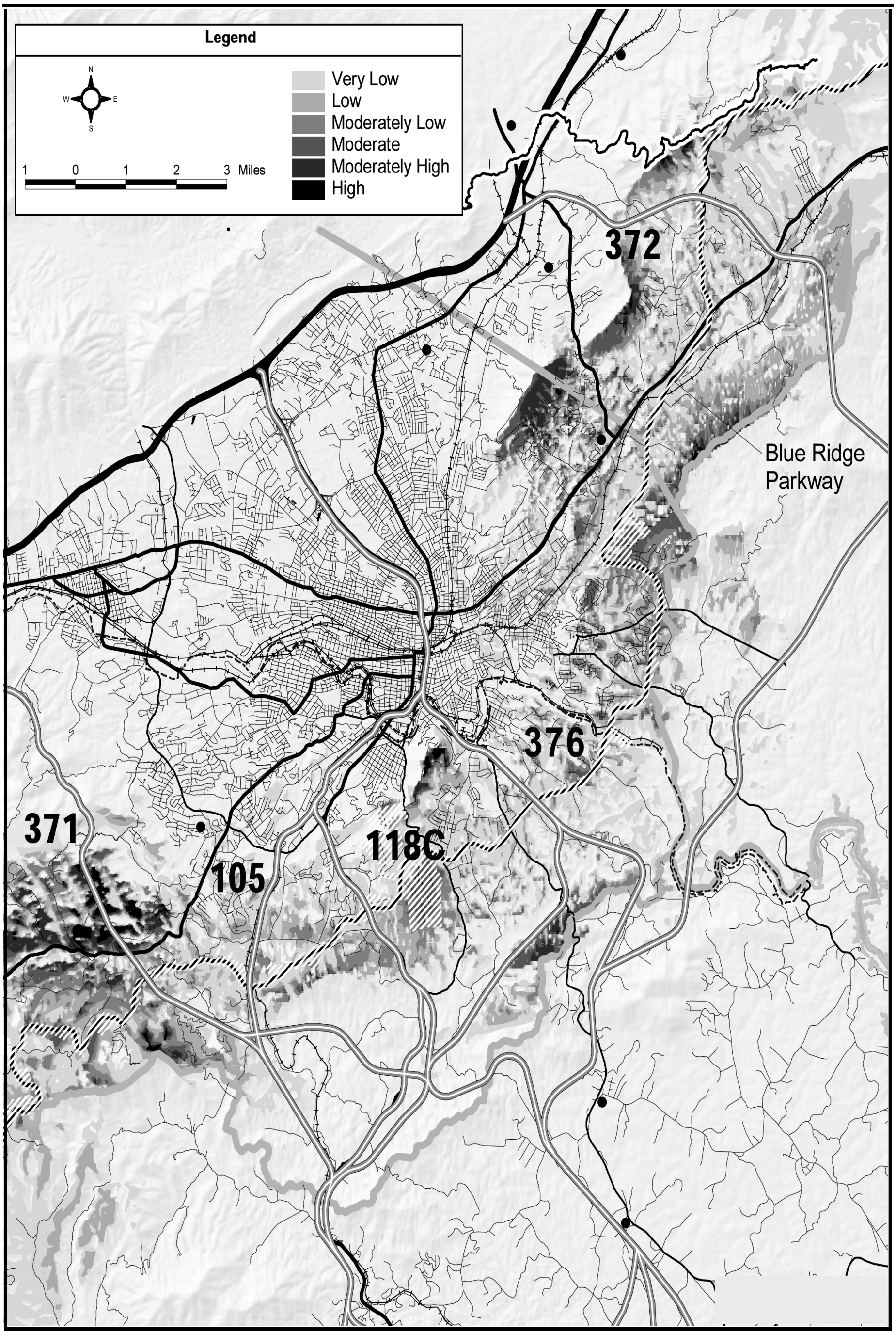


FUTURE 73

I-73 Location Study

FIGURE 4.5-1
VISIBILITY OF ALTERNATIVE CROSSINGS
FROM THE BLUE RIDGE PARKWAY
(SHEET 1 OF 1)

Segment 118C Blue Ridge Parkway Evaluation

Quantitative Analysis: The quantitative analysis of the potential visual impact of segment 118C of Options 2b, 3, 3b, 3c and the ALC on the Blue Ridge Parkway found the following:

- Number of places along the segment that would be seen from the Blue Ridge Parkway: 284
- Minimum view cells: 0
- Maximum view cells: 76
- Mean view cell: 14.02
- Sum of view cells: 3,982
- Variety of view cells: 56

Qualitative Analysis: Segment 118C would cross the Blue Ridge Parkway in an already highly affected area south of milepost 121.4 through the U.S. Route 220 corridor in the Clearbrook area of Roanoke County. Impacts to the foreground would be low, and would include the widening of the U.S. Route 220 corridor. Impacts to the middleground also would be low and similar to those in the foreground. The middleground view would be most pronounced from the bridge looking south on U.S. Route 220. The Clearbrook area vista extends to the end of the middleground, in contrast to a north view of only the foreground. Most of the north view would be relatively protected due to two-thirds Blue Ridge Parkway ownership and viewshed boundary at the top of the hill just 1,000 feet (300 meters) away.

The impact on the cinematic experience would be moderate. The current location of the Blue Ridge Parkway on a bridge over U.S. Route 220 provides only a brief view of the corridor at a 90-degree angle, both east and west of the Park. The approach from the Blue Ridge Parkway north would be more visible than the approach from the Blue Ridge Parkway south. The approach from the north would be through a large and gradual S-curve in open pasture. The highway width would provide a much more visible section in the landscape setting, framed by background pine trees. The approach from the Blue Ridge Parkway south would reveal a sudden approach to the interstate because a pine forest has been carefully managed to create the surprise view of the field beyond. Currently this works exceedingly well because the pasture that is visible just beyond U.S. Route 220 serves as a highlighted forest boundary. The corridor would have its own presence as an event in the choreographed sequence, rather than just an edge between forest and grassland field.

Segment 371 Blue Ridge Parkway Evaluation

Quantitative Analysis: The quantitative analysis of the potential visual impact of segment 371 of Option 4 on the Blue Ridge Parkway found the following:

- Number of places along the segment that would be seen from the Blue Ridge Parkway: 394
- Minimum view cells: 0
- Maximum view cells: 251
- Mean view cell: 66.97
- Sum of view cells: 26,387
- Variety of view cells: 155

Qualitative Analysis: Segment 371 would cross the Blue Ridge Parkway at milepost 126.5. The two segments that would have the maximum potential visual effects on the Blue Ridge Parkway are segments 371 and 372, the two segments at the extreme outside edges of the study area. They vary in the type of exposure to the Blue Ridge Parkway, however. In the south end of the study area, segment 371 would cross the Blue Ridge Parkway near Mason's Knob Overlook. To the south of the Blue Ridge Parkway, the segment would be relatively well hidden in a valley as it approaches. After crossing the Blue Ridge Parkway, however, the segment would move north-northwest into high-visibility areas. These areas, shown in the darkest colors

of Figure 4.4-1, show that they would be highly visible from many places along the Blue Ridge Parkway, including some of the overlooks moving up the Metts Run to Adney Gap section.

The foreground views from the Blue Ridge Parkway would experience relatively high impacts, and would be more dramatically affected by this crossing because the land use on the south side of the Blue Ridge Parkway is currently very well blended with the invisible Blue Ridge Parkway boundary. As the interstate moves toward the Parkland, a more definite boundary would be discernible and the interstate would provide a southern boundary for the Blue Ridge Parkway.

Beyond the Blue Ridge Parkway boundary, the middleground impacts would be high. In particular the northern middleground may be affected because large cuts and fills would be placed into the northern ridges visible from many of the overlooks between Mason's Knob overlook and Adney Gap. Unmitigated middleground views could also be distracting to the south as the interstate cuts between Masons Knob overlook and Masons Knob, providing an interruption in this rural scenery from pasture to interstate highway to the featured covered mountain of the overlook scene.

Segment 371, through its secondary impacts, would also have a high impact on the Blue Ridge Parkway traveler's cinematic experience by extending the suburban reach of Roanoke County and its views another five miles (eight kilometers) past where it currently is perceived by the viewer. Approaching from Blue Ridge Parkway south, the secondary impact of expanded commercial and suburban development would be viewed early along the sequence of vistas and overlooks coming from Adney Gap down into the Back Creek drainage basin.

Segment 372 Blue Ridge Parkway Evaluation

Quantitative Analysis: The quantitative analysis of the potential visual impact of segment 372 of Options 1 and 1a on the Blue Ridge Parkway found the following:

- Number of places along the segment that would be seen from the Blue Ridge Parkway: 940
- Minimum view cells: 0
- Maximum view cells: 86
- Mean view cell: 13.84
- Sum of view cells: 13,005
- Variety of view cells: 81

Qualitative Analysis: Segment 372 would cross the Blue Ridge Parkway at milepost 103.6, in corridor section 1L, center lined at station 310. Segment 372 in the north end of the study area would have the highest effects of the five segments that would cross the Blue Ridge Parkway from a quantitative perspective. Although it would not share the high visibility of segment 371, it would be seen from across a broader land area, indicating that it would be seen in more places from the Blue Ridge Parkway. It would not be the subject of a focused view, but a more extended occasional view over and over again along the Blue Ridge Parkway experience.

This most northern of Blue Ridge Parkway crossings would have a relatively high impact on the foreground of the Park. If unmitigated, it would remove canopy vegetation in a forested segment of the Blue Ridge Parkway. In the foreground scene, cut slopes would occupy the majority of the view. In the foreground scene, cut slopes would occupy the majority of the view. The middleground views would be moderately affected, and would be exposed outside of Blue Ridge Parkway limits and in the presence of the interstate with open views to suburban areas on the east side of the Blue Ridge Parkway and rural residential areas on the west side. The same impacts of the visible roadway corridor section would apply to the middleground landscape. The interstate would open up scenes of currently hidden suburban development.

Segment 372 would also have a relatively high impact on the cinematic experience of the Blue Ridge Parkway albeit a brief impact relative to the overall length of the Blue Ridge Parkway. Approaching from Blue Ridge Parkway north, the visitor has been in a forested environment since the James River Basin,

approximately 53.6 miles (86.3 kilometers). Although open fields currently occur for the Blue Ridge Parkway visitor in another 1.5 miles (2.4 kilometers), the movement of open space onto the steeper slopes of the choreographed roadway gently descending into the Roanoke Valley would be a discordant placement with regard to the Blue Ridge Parkway traveler's experience. The movement of the open spaces off the valley floor would be a significant impact on this choreographed sequence. A secondary impact from this would include the addition of off-site development moving out of the Roanoke Valley another two miles (three kilometers) to the north. From the perception of the Blue Ridge Parkway visitor, the experience would be much more sudden than the currently gradually revealed city at a distance with housing in the middleground.

Segment 376 Blue Ridge Parkway Evaluation

Quantitative Analysis: The quantitative analysis of the potential visual impact of segment 376 of Options 2, 2a, and 2c on the Blue Ridge Parkway found the following:

- Number of places along the segment that would be seen from the Blue Ridge Parkway: 260
- Minimum view cells: 0
- Maximum view cells: 135
- Mean view cell: 6.72
- Sum of view cells: 1,749
- Variety of view cells: 39

Segment 376 would result in the lowest visual impact on the Blue Ridge Parkway of any of the proposed crossings. This segment would be concealed along drainageways both south and north of the Blue Ridge Parkway.

Quantitative Analysis: Segment 376 would cross the Blue Ridge Parkway at milepost 116.9. The foreground impacts would be moderate. This crossing would affect the foreground views of the Blue Ridge Parkway with pavement, guardrail, concrete structures, and cuts and fills.

Middleground impacts would also be moderate. The middleground views would be opened both north and south by the interstate crossing. This would create more vistas into residential areas, which have previously been screened by topography. To the north a vista of the Roanoke Valley extending to Mill Mountain and to downtown has a potential to change the rural atmosphere in this segment of the Blue Ridge Parkway, although views of distant downtown are available further north.

The impact on the cinematic experience would be relatively low. Approaching this from the north the visitor would have already experienced the residential development and would have seen downtown Roanoke in the distance. The view to the north toward downtown Roanoke would come as no surprise. Views to the south would be opened up more, in concert with the views between U.S. Route 460 and U.S. Route 220. Approaching from Blue Ridge Parkway south, the existing stone arch bridge carrying Route 617 would provide a visual barrier for Blue Ridge Parkway visitors. After crossing through the stone arch, the interstate would be suddenly revealed and then would disappear quickly. The total visitor experience would last approximately 20 seconds.

Option 1 and 1a Blue Ridge Parkway Evaluation

The crossing of the Blue Ridge Parkway for Option 1 and 1a would have the highest effects of the five crossings related to the various options from a quantitative perspective. This most northern of Blue Ridge Parkway crossings would have a relatively high impact on the foreground of the Park. If unmitigated, it would remove canopy vegetation in a forested segment of the Blue Ridge Parkway. In the foreground scene, cut slopes would occupy the majority of the view. The middleground views would be moderately affected, and would be exposed outside of Park limits and in the presence of the interstate with open views to suburban and rural residential areas. The same impacts of the visible roadway corridor section would apply to the middleground landscape. The interstate would open up scenes of currently hidden suburban development.

These option crossings would also have a relatively high impact on the cinematic experience of the Blue Ridge Parkway albeit a brief impact relative to the overall length of the Blue Ridge Parkway.

Option 2, 2a, and 2c Blue Ridge Parkway Evaluation

The crossing related to these options would result in the lowest visual impact on the Blue Ridge Parkway of any of the proposed crossings. This crossing would be concealed along drainageways both south and north of the Blue Ridge Parkway. The foreground impacts would be moderate. This crossing would affect the foreground views of the Blue Ridge Parkway with pavement, guardrail, concrete structures, and cuts and fills. Middleground impacts would also be moderate. The middleground views would be opened both north and south by the interstate crossing. This would create more vistas into residential areas, which have previously been screened by topography. To the north a vista of the Roanoke Valley extending to Mill Mountain and to downtown has a potential to change the rural atmosphere in this segment of the Blue Ridge Parkway, although views of distant downtown are available further north. The impact on the cinematic experience would be relatively low.

Option 2b, 3, 3b, 3c, and the ALC Blue Ridge Parkway Evaluation

The crossing of the Blue Ridge Parkway for these options is in an already highly affected area south of milepost 121 through the U.S. Route 220 corridor in the Clearbrook area of Roanoke County. Impacts to the foreground would be low. Impacts to the middleground also would be low and similar to those in the foreground. The middleground view would be most pronounced from the bridge looking south on U.S. Route 220. The Clearbrook area vista extends to the end of the middleground, in contrast to a north view of only the foreground. Most of the north view would be relatively protected due to two-thirds Park ownership and viewshed boundary at the top of the hill just 1,000 feet (300 meters) away. The impact on the cinematic experience would be moderate.

Option 3a Blue Ridge Parkway Evaluation

Option 3a would cross the Blue Ridge Parkway in the Back Creek area of the Park at milepost 124 in a relatively sharp curve to the right. The potential foreground impacts associated with Option 3a would be moderate. The presence of interstate pavement, barriers, guardrails, and grading in the foreground would be noticed by the travel experience for Blue Ridge Parkway visitors. Effects to the middleground would be high, especially to the north of the Blue Ridge Parkway. Currently screened by Park woods, industrial areas would become visible as the section of the interstate carries the open vista west. Impacts to the middleground include the cut and fill slopes, bridge abutments, pavement, and guardrails, as well as the soundwalls that may be required in this area due to rapid suburban development out in this area of Roanoke County. Option 3a effects on the cinematic experience would be relatively low due to the location of the crossing.

Option 4 Blue Ridge Parkway Evaluation

This option would cross the Blue Ridge Parkway at milepost 126.5. The foreground views from the Blue Ridge Parkway would experience relatively high impacts, and would be more dramatically affected by this crossing because the land use on the south side of the Blue Ridge Parkway is currently very well blended with the invisible Park boundary. As the interstate moves toward the Parkland, a more definite boundary would be discernible and the interstate would provide a southern boundary for the Blue Ridge Parkway. Beyond the Park boundary, the middleground impacts would be high. In particular the northern middleground may be affected because large cuts and fills would be placed into the northern ridges visible from many of the overlooks between Mason's Knob overlook and Adney Gap. Unmitigated middleground views could also be distracting to the south as the interstate cuts between Masons Knob overlook and Masons Knob, providing an interruption in this rural scenery from pasture to interstate highway to the featured covered mountain of the overlook scene. Option 4 would also have a high impact on the Blue Ridge Parkway traveler's cinematic experience.

4.5.7.3 Roanoke Mountain

Managed as an expanded overlook off of the Blue Ridge Parkway at milepost 120.4, the Roanoke Mountain one-way loop road rises to the top of the mountain, overlooking the Garden City area to the north, and surveying the Clearbrook area to the south. Based on the visual quality analysis, the following segments would have potential to affect the middleground scene from the Roanoke Mountain loop road:

- Segment 118 (from Options 2b, 3b, and the ALC), visual quality: low, visual impact: low; and
- Segment 287A (from Options 2a), visual quality: high, visual impact: medium.

4.5.7.4 Mill Mountain

Roanoke City's flagship park, this 542-acre (219-hectare) high-point preserve is discussed more fully in the parklands report for the I-73 Location Study. There are several overlooks placed on the north and northwestern side of the mountain, overlooking the Roanoke Valley. Based on the visual quality analysis, the following segments would be located in the middleground scene of the Mill Mountain overlooks:

- Segment 374 (from Options 2, 2a, 2b, 2c, 3, 3a, 3b, 3c, and the ALC), visual quality: medium, visual impact: low;
- Segment 375 (from Option 2b, 3, 3a, 3b, and 3c), visual quality: medium, visual impact: low; and
- Segment 376 (from Option 2, 2a, and 2c), visual quality: medium, visual impact: medium.

4.5.8 Mitigation Measures

Minimization of the effects for the TSM Alternative and each Build Alternative option has been reviewed and discussed during coordination with the NPS and other agencies. When the ALC was initially identified, FHWA and VDOT approached the NPS to discuss the crossing of the Blue Ridge Parkway by Segment 376 and related design issues. An MOA was initiated that identified the roles and responsibilities that FHWA, VDOT, and the NPS would assume in the development of the crossing and visual simulations were prepared to gain a better understanding of the potential visual impacts of the crossing on the Blue Ridge Parkway and to serve as a tool for mitigation discussions. When the decision was made to pursue the alignment which crossed the Blue Ridge Parkway at Route 220, the NPS's preferred location, an MOA was no longer needed and set aside. Notwithstanding, VDOT has continued to work closely with the NPS on the crossing of the Blue Ridge Parkway at Route 220. Through discussions with the NPS, mitigation strategies have been developed to minimize impacts to the Blue Ridge Parkway and will be refined during final design. Other mitigation measures under consideration to minimize the visual effects of the ALC are as follows:

- Existing vegetation will be preserved wherever practical to avoid disturbing existing views in areas.
- Cut and fill will be minimized to the extent necessary to balance structural stability, appropriate vertical profile and aesthetic features of the roadway and appurtenant features.
- Ground-disturbing activities will be mitigated through seeding, landscaping restoration, and long-term maintenance.
- Lighting within the right-of-way will be minimized to those areas requiring improved visibility for safety (usually confined to higher volume interchanges) and for displaying driver information signage where necessary.
- VDOT cannot prohibit the placement of billboards outside the Right of Way (ROW), however, VDOT's Travel Services Signing Program, which is responsible for the blue service signs, has successfully provided businesses with an alternative to billboards for indicating where travelers can get food, lodging, and fuel. Laws to limit or band billboards outside the ROW can be adopted by local jurisdictions.

4.6 WATER QUALITY AND WATER RESOURCES

The types and concentrations of pollutants in stormwater runoff typically vary among watersheds. These variations can be attributed largely to the land use, topography, soil chemistry, and hydrology of the watershed. Other factors contributing to concentrations of pollutants in runoff include the duration of a storm, the severity of a storm, and the number of dry days preceding a storm.

Recent National Water Quality Inventory reports indicate that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts to rivers and lakes. These reports also indicate that nonpoint source (NPS) pollution is also a major contributor to groundwater contamination and wetlands degradation. Agricultural activities that cause NPS pollution include confined domestic animal facilities, grazing, plowing, pesticide spraying, irrigation, and fertilizing. Primary agricultural NPS pollutants that typically result from these activities include sediment, nutrients, pathogens, pesticides, and salts. Agricultural activities (especially livestock incursions into streams) can also lead to physical damage of habitat and stream channels. Agricultural watersheds often exhibit high concentrations of nutrients from fertilizers and coliform bacteria from livestock. Consistent with these findings, rapid bioassessment surveys conducted as part of this study verified that indicators of poorest water quality occur immediately downstream of regularly grazed pasturelands.

Urbanization may contribute high concentrations of pollutants to a watershed. Primary pollutants typically found in runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, hydrocarbons, pathogenic bacteria, and viruses.

As discussed in the following sections, stormwater runoff from highways and associated rights-of-way typically contains a specific suite of pollutants which can occur in widely varying concentrations. As illustrated in table 4.6-1, pollutants of concern associated with highway construction and use include a variety of substances from common organic materials to toxic metals. Some pollutants, such as herbicides, road salts, and fertilizers, are intentionally placed in the environment to promote safety or roadside vegetation. Other pollutants, such as the incidental release of small amounts of petroleum products and metals from trucks and cars, are the indirect effect of roadway utilization. A major factor contributing to concentrations of pollutants in highway stormwater runoff is the volume of traffic carried by a particular segment of roadway.

4.6.1 Primary Sources of Highway Runoff Pollutants

The most common contaminants in highway runoff consist of heavy metals, inorganic salts, aromatic hydrocarbons, and suspended solids (EPA, 1995; USDOT, FHWA, 1998). Deicing operations (salting and sanding), may leave measurable concentrations of chloride, sodium, and calcium on road surfaces. Salt levels in highway runoff will vary according to the amount of deicing chemicals applied and the intensity of subsequent precipitation events. Oil, grease, other hydrocarbons, rust, rubber particles, and metals resulting from normal vehicle operation are deposited on roadways. Normal wear of brakes, tires, and other vehicle parts can result in relatively higher concentrations of cadmium, chromium, copper, iron, lead, nickel, and zinc in highway runoff. Typical highway runoff pollutants and their primary sources are summarized in Table 4.6-1.

Table 4.6-1
HIGHWAY RUNOFF POLLUTANTS AND THEIR PRIMARY SOURCES

Pollutant	Primary Sources
Sediment	Pavement wear, vehicles, atmospheric deposition, maintenance, sand application (for deicing)
Nutrients (N, P)	Atmosphere, roadside fertilizer application
Lead*	Leaded gasoline, auto exhaust*, tire wear
Zinc	Tire wear, motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures, moving engine parts

Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Tire wear, insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline exhaust, lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anti-cake compound in deicing salts
Sodium, Calcium, Chloride	Deicing salts
Sulfate	Roadway beds, fuel, deicing salts
Petroleum	Motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

* Lead pollution has been greatly reduced since the introduction of unleaded gasoline (Source: U.S. EPA, 1993).

4.6.2 Potential Effects of Highway Runoff Pollutants

Heavy metals are reported to be the most prevalent priority pollutant contained in highway runoff (Hathhorn and Younge, 1996). Most heavy metals are associated with the particulate matter in highway runoff (Gupta, et al, 1981). Toxicity is largely dependent on the physical and chemical forms of the metals, their availability to aquatic organisms, and existing conditions of the receiving waters. Heavy metals in highway runoff are usually not a problem with respect to acute toxicity (FHWA, 1998). Depending on the degree of vegetation management within a corridor, pesticides, herbicides, and nutrients (primarily nitrogen and phosphorus) can contribute in a minor way to water quality degradation (FHWA, 1996). Along with fecal coliform of small mammal and bird origin (Gupta, et al, 1981), these contaminants are commonly washed off roadway surfaces as minor constituents of stormwater runoff during rain or snow events.

Some factors that influence the extent and degree of pollutant loading include the type and size of the receiving water body, the potential for dispersion, the size of the catchment area, and the biological diversity of the receiving water ecosystem. Bioassay analyses of organisms from stream and lakes receiving highway runoff generally have not demonstrated acute toxicity, and concentrations of pollutants in water columns of receiving waters generally exhibit only minor changes due to highway runoff (Barrett, et al, 1993). A major factor that determines concentrations of pollutants in highway stormwater runoff is the volume of traffic carried by a particular segment of roadway. As shown in Table 4.6-2, concentrations of pollutants can vary according to the volume of traffic being carried.

Table 4.6-2
TYPICAL RANGES OF POLLUTANT CONCENTRATIONS IN HIGHWAY RUNOFF

Pollutant	Fewer than 30,000 vehicles per day [1]	More than 30,000 vehicles per day [1]	Monitoring results from Route 17 Bypass (Warrenton VA) [2] vehicle volume not provided
TSS	41	142	89
TOC	8	25	Not measured
COD	49	114	70.5
NO_x	0.46	0.76	0.627
TKN	0.87	1.83	Not measured
PO_4^{-2}	0.16	0.40	1.77
Copper	0.022	0.054	0.23
Lead	0.080	0.400	<0.005
Zinc	0.080	0.329	0.153

[1] Event mean concentrations for the 50% median site, in mg/l

[2] Event mean concentrations, in mg/l

[3] Estimated from graph provided in Yu and Langan, 1999.

Source: Adapted from Driscoll et al.,1990 and Yu and Langan,1999.

FHWA Guidelines (Lorant, 1992) indicate that highway runoff is unlikely to have adverse effects on receiving waters when:

- the receiving waters are not associated with a public water supply,
- the highway conveys less than 30,000 vehicles on an average daily basis,
- highway runoff is conveyed by overland flow within an unlined or grassed channel for at least 197 feet (60 meters) prior to discharge to the receiving stream, or
- the dilution ratio of highway runoff to the receiving stream is at least 100 to one.

4.6.3 Surface Water Resources of the Project Area

Stormwater runoff pollution loadings for the TSM Alternative and the Build Alternative Options are presented in Table 4.6-3 and Table 4.6-4. For purposes of comparison, the severity of potential effects with respect to water quality is expressed in terms of percent increase over 1997 base year conditions. Effects of pollutant loadings will, naturally, vary along the corridor of any selected alternative. Primary factors that will influence the extent and degree of highway runoff pollutant loading within any particular surface water body include the type and size of the receiving water body, the potential for dispersion, the size of the catchment area, the biological diversity of the receiving water body, and relative effectiveness of proposed mitigation measures.

Surface water resources of particular concern consist of those critical to public drinking water supplies and/or special aquatic habitat. Surface water resources of the study area having a public water supply withdrawal within one-quarter mile of the ALC are listed in Table 4.6-5 and are shown in Figures 4.6-1 through 4.6-3. Figures showing surface water supplies affected by previously considered alternatives are provided in the DEIS and the Water Quality Technical Report (VDOT, 2000). Barring implementation of effective mitigation measures, potential environmental consequences associated with increases in pollutant loading (presented in Table 4.6-3 and Table 4.6-4) are also listed in Table 4.6-5. Mitigation measures designed to avoid or minimize adverse water quality effects are discussed in following sections.

4.6.3.1 TSM Alternative

The TSM Alternative would include the use of U.S. Route 220 as the major north-south arterial through the region. U.S. Route 220 currently traverses three watersheds that are used for public water supplies: the upper Roanoke River, the Blackwater River, and the Smith River. U.S. Route 220 also traverses the Pigg River watershed, which drains into water supply districts along Smith Mountain Lake. U.S. Route 220 is currently heavily urbanized, including a large volume of commercial traffic, and this trend would continue under the TSM Alternative. Failure to relieve U.S. Route 220 of its present traffic volumes and failure to make it safer by improving levels of service would continue to expose the public water supplies to an increasing probability of contamination from traffic accident-related spills. In addition, the TSM Alternative would include roadway construction such as grade and curve adjustments, in close proximity to crossings of Marrowbone Creek, the Blackwater River, the Pigg River, and the Smith River.

For construction of components near public surface water supply withdrawals, special mitigation measures would be required, both during and following construction. Such measure would include pollution prevention plans implemented during critical phases of construction and design of stormwater drainage systems to provide additional protective measures. Measures developed to protect nearby surface water supplies would include stormwater management facilities developed during later design phases and development of Spill Prevention and Countermeasure Control (SPCC) plans. With implementation of appropriate mitigation measures and best management practices (BMPs), the TSM Alternative would not result in a loss of water-related recreational opportunities or aquatic habitat values due to degradation of water quality.

Table 4.6-3
STORMWATER RUNOFF POLLUTION LOADINGS

Pollutant	Daily Production Rate of Pollutant (mg/vehicle mile)[1]	Annual Pollutant Loadings (kg)							
		1997 - Base Year	No Build /TSM	2020 Build					
				Options 1 & 1a		Options 2, 2a, 2b & 2c		Options 3, 3a, 3b & 3c	
				Loading at 2020	Build/No Build Difference	Loading at 2020	Build/No Build Difference	Loading at 2020	Build/No Build Difference
Chemical Oxygen Demand	63.5000	102,444.55	117,973.48	152,044.40	34,070.93	131,648.20	13,674.73	135,356.60	17,383.13
Suspended Solids	120.0000	193,596.00	222,942.00	287,328.00	64,386.00	248,784.00	25,842.00	255,792.00	32,850.00
Floatable Solids	3.9300	6,340.27	7,301.35	9,409.99	2,108.64	8,147.68	846.33	8,377.19	1,075.84
Settleable Solids	43.5000	70,178.55	80,816.48	104,156.40	23,339.93	90,184.20	9,367.73	92,724.60	11,908.13
Oil	9.6700	15,600.61	17,965.41	23,153.85	5,188.44	20,047.84	2,082.43	20,612.57	2,647.16
Chromium	0.0077	12.42	14.31	18.44	4.13	15.96	1.66	16.41	2.11
Copper	0.0696	112.29	129.31	166.65	37.34	144.29	14.99	148.36	19.05
Zinc	0.7350	1,185.78	1,365.52	1,759.88	394.36	1,523.80	158.28	1,566.73	201.21
Lead	1.8200	2,936.21	3,381.29	4,357.81	976.52	3,773.22	391.94	3,879.51	498.23
Nickel	0.0620	100.02	115.19	148.45	33.27	128.54	13.35	132.16	16.97
Total Phosphorus	0.0970	156.49	180.21	232.26	52.05	201.10	20.89	206.77	26.55
Total Nitrogen	3.4000	5,485.22	6,316.69	8,140.96	1,824.27	7,048.88	732.19	7,247.44	930.75
TOTAL	-----	398,148.40	458,501.22	590,917.09	132,415.87	511,647.72	53,146.51	526,060.34	67,559.12
% Increase Compared to No Build	-----	-----	-----	-----	28.9	-----	11.6	-----	14.7
Vehicle Miles Traveled (millions of vehicles per day)		4,420,000	5,090,000	6,560,000		5,680,000		5,840,000	

[1] Reference: Sylvester and DeWalle, December 1972.

Table 4.6-4
STORMWATER RUNOFF POLLUTION LOADINGS

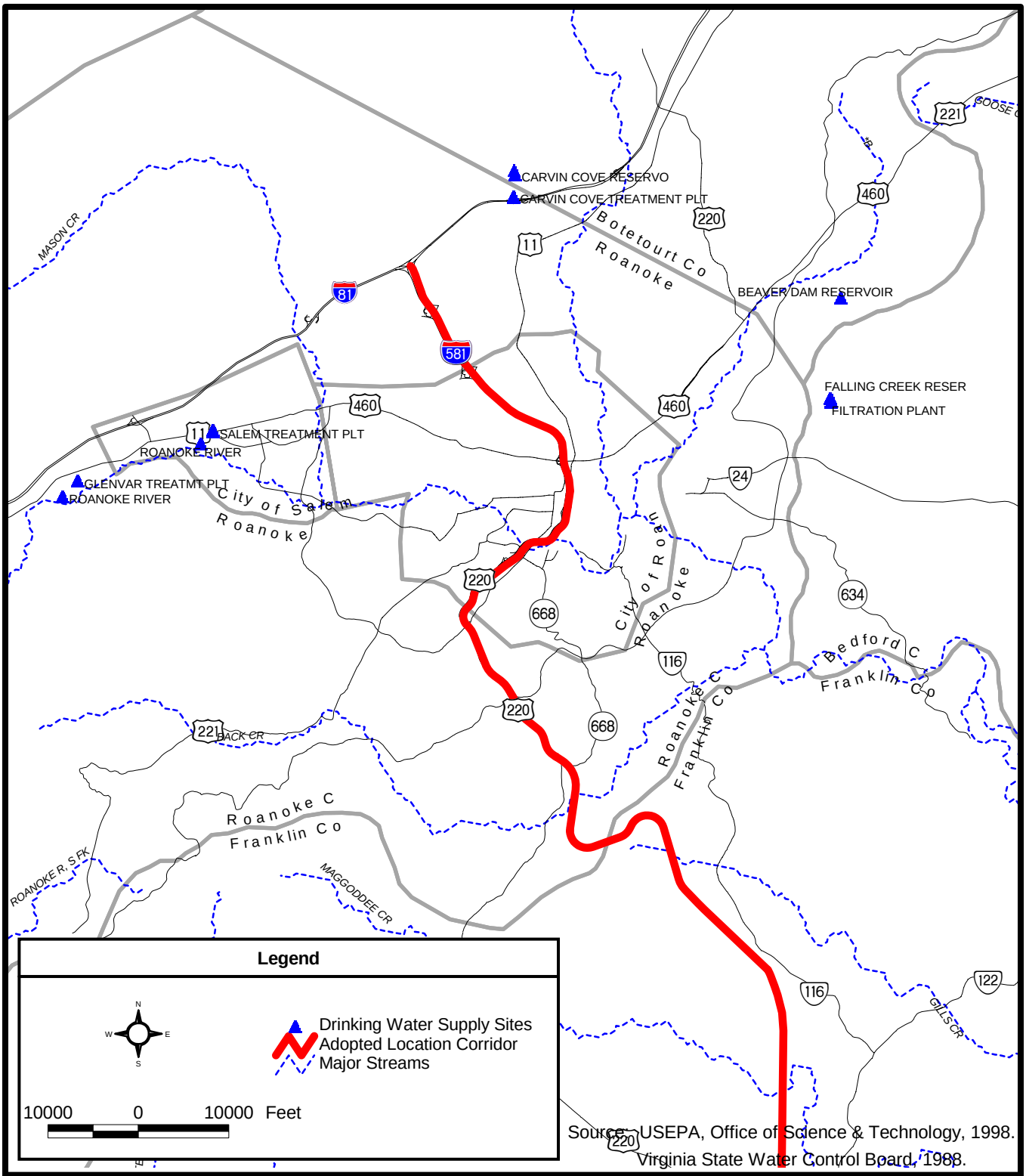
Pollutant	Daily Production Rate of Pollutant (mg/vehicle mile) [1]	Annual Pollutant Loadings (kg)				
		No Build /TSM	2020 Build			
			Option 4		ALC	
			Loading at 2020	Build/No Build Difference	Loading at 2020	Build/No Build Difference
Chemical Oxygen Demand	63.5000	117,973.48	161,778.95	43,805.48	126,113.71	8,140.24
Suspended Solids	120.0000	222,942.00	305,724.00	82,782.00	238,325.13	15,383.13
Floatable Solids	3.9300	7,301.35	10,012.46	2,711.11	7,805.15	503.80
Settleable Solids	43.5000	80,816.48	110,824.95	30,008.48	86,392.86	5,576.38
Oil	9.6700	17,965.41	24,636.26	6,670.85	19,205.03	1,239.62
Chromium	0.0077	14.31	19.62	5.31	15.29	0.99
Copper	0.0696	129.31	177.32	48.01	138.23	8.92
Zinc	0.7350	1,365.52	1,872.56	507.04	1,459.74	94.22
Lead	1.8200	3,381.29	4,636.81	1,255.53	3,614.60	233.31
Nickel	0.0620	115.19	157.96	42.77	123.13	7.95
Total Phosphorus	0.0970	180.21	247.13	66.92	192.65	12.43
Total Nitrogen	3.4000	6,316.69	8,662.18	2,345.49	6,752.55	435.86
TOTAL	-----	458,501.22	628,750.20	170,248.98	490,138.07	31,636.85
% Increase (Compared to No Build)	-----	-----	-----	37.1	-----	6.9
Vehicle Miles Traveled (millions of vehicles per day)		5,090,000	6,980,000		5,441,213	

[1] Reference: Sylvester and DeWalle, December 1972.

Table 4.6-5
POTENTIALLY AFFECTED PUBLIC SURFACE WATER SUPPLIES

Alternative		Public Surface Water Supply Withdrawals Within ¼ Mile	Environmental Consequences
TSM		Blackwater River near U.S. Route 220	Varies with implementation of each component. Generally speaking, includes increased risk of spills during and following construction, and potential increase in turbidity during construction. All other water quality effects minimized with implementation of BMPs.
		Pigg River at U.S. Route 220 near Rocky Mount[1]	
		Smith River at U.S. Route 220	
		Marrowbone Creek at U.S. Route 220	
Build Alternative Option	1	None	None
	1a	None	None
	2	Marrowbone Creek near U.S. Route 220	Increased risk of spills during and following construction; potential increase in turbidity during construction; all other water quality effects minimized with implementation of BMPs and stormwater management plan.
	2a	Marrowbone Creek near U.S. Route 220	
	2b	Marrowbone Creek near U.S. Route 220	
	2c	Marrowbone Creek near U.S. Route 220	
	3	Blackwater River near U.S. Route 220	
		Smith River near Fieldale	
		Marrowbone Creek near U.S. Route 220	
	3a	Blackwater River near U.S. Route 220	
		Smith River near Fieldale	
		Marrowbone Creek near U.S. Route 220	
	3b	Blackwater River near U.S. Route 220	
		Smith River near Fieldale	
		Marrowbone Creek near U.S. Route 220	
	3c	Blackwater River near U.S. Route 220	
		Smith River near Fieldale	
		Marrowbone Creek near U.S. Route 220	
	4	Roanoke River near Glenvar	
		Smith River near Fieldale	
		Marrowbone Creek near U.S. Route 220	
	ALC	Blackwater River near U.S. Route 220	Negligible to none (Proposed alignment located approx. 1,000 feet downstream of intake).

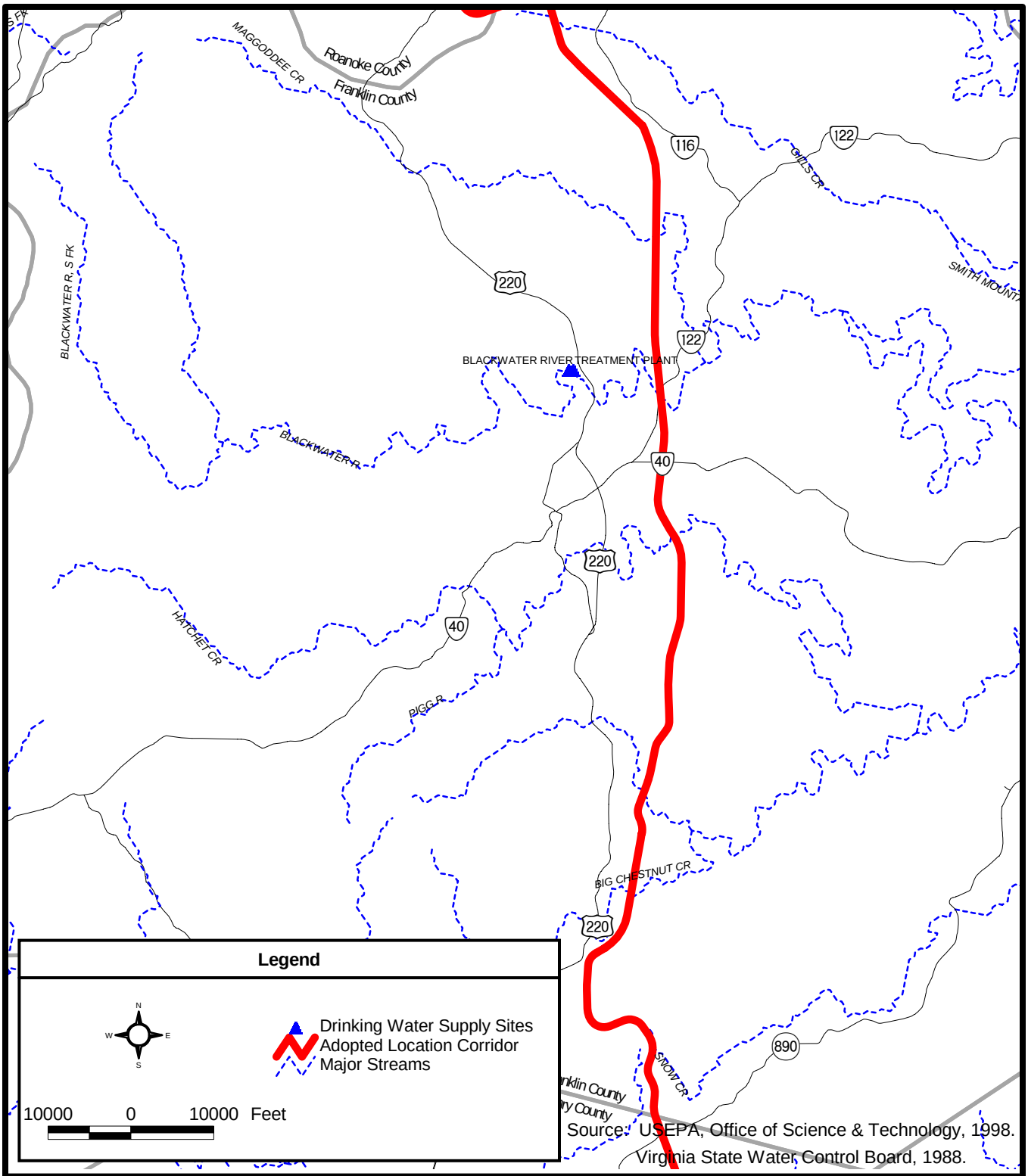
[1] Not directly used as water supply in project vicinity since 1983, however, drains to Smith Mountain Lake public water supply.



FUTURE 73

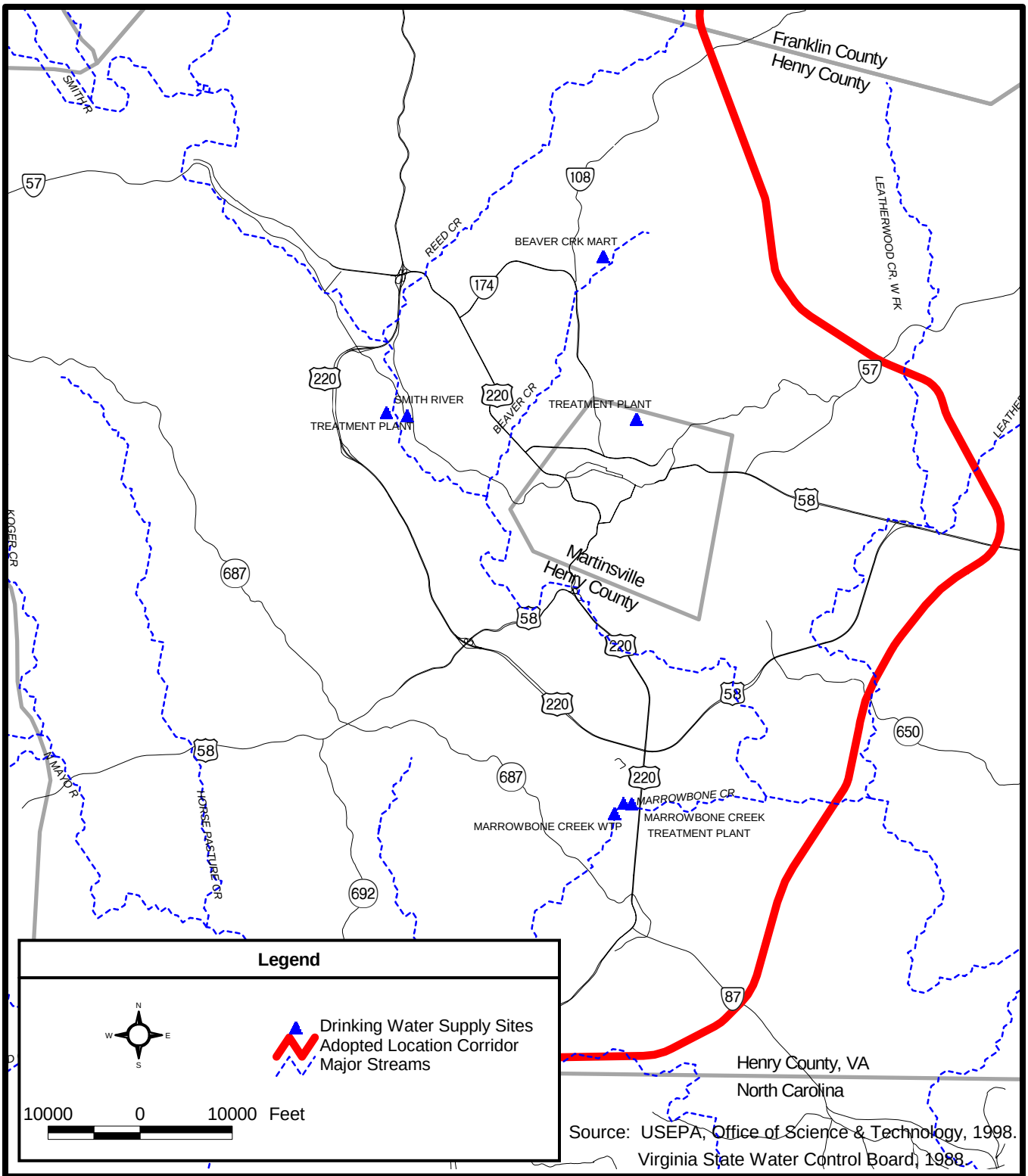
I-73 Location Study

FIGURE 4.6-1
PUBLIC SURFACE WATER SUPPLIES
ROANOKE COUNTY AND CITY OF ROANOKE



I-73 Location Study

FIGURE 4.6-2
PUBLIC SURFACE WATER SUPPLIES
FRANKLIN COUNTY



I-73 Location Study

FIGURE 4.6-3
PUBLIC SURFACE WATER SUPPLIES
HENRY COUNTY

4.6.3.2 Build Alternative

All of the Build Alternative options would traverse three watersheds containing public water supplies - the upper Roanoke River, the Blackwater River, and the Smith River. Although the Pigg River has not been directly utilized as a public water supply since 1983, it ultimately drains into Smith Mountain Lake, which serves as a public water supply for both Franklin County and Bedford County.

Surface water supply withdrawals located in the vicinity of each of the Build Alternative options are listed in Table 4.6-4. Options 1 and 1a would not be located in the vicinity of any public surface water withdrawals. Options 2, 2a, 2b, and 2c would be located in the vicinity of two existing public water supply withdrawals. Options 3, 3a, 3b, 3c, and 4 would be located in the vicinity of three existing public water supply withdrawals.

Short-Term (Construction) Impacts

Clearing and grubbing, earth moving and grading, and other construction-related activities can lead to erosion of soils. If unchecked, these erosional processes can lead to the deposition of eroded sediments within nearby waterways and water bodies. Without implementation of appropriate mitigation measures, impacts to public surface water supplies during construction would include (1) a temporary increase in turbidity and sedimentation during and immediately following nearby land disturbances and (2) an increase risk of contamination associated with the presence of heavy equipment fluids (fuels, lubricants, etc.) and construction-related chemicals (paints, concrete additives, etc.). As discussed below, all Build Alternative options will require a general VPDES permit for construction activities affecting greater than five acres and an approved erosion and sediment control plan. With implementation of appropriate mitigation measures and BMPs, construction activities associated with the Build Alternative options will not result in adverse impacts to public water supplies, water-related recreational opportunities, or aquatic habitat values due to degradation of water quality.

Long-Term Impacts

Roadway projects result in an increase in impervious surfaces within drainage areas. If not addressed through appropriate stormwater management, this situation can lead to drainage and flooding problems (an increase in roadway runoff and an increase in peaks rates of discharge). Roadway projects also result in the potential introduction of pollutants normally associated with vehicular traffic. If not addressed through appropriate stormwater management, this situation can lead to water quality problems (an increase in nonpoint pollutant loading). If unabated, roadway runoff and other nonpoint source pollution can adversely impact water quality of nearby receiving streams and associated wildlife habitat.

Stormwater runoff pollutant loadings for the Build Alternative are provided in Table 4.6-3A and Table 4.6-3B. Compared to 1997 baseline conditions, the ALC would result in the smallest percent increase of stormwater runoff pollutant loading (at 6.9 percent). Compared to 1997 baseline conditions, Build Alternative Option 4 would result in the greatest percent increase of stormwater runoff pollutant loading (at 37.2 percent). Only Build Alternative Options 1 and 1a would avoid stream crossings or major construction within one-quarter of a mile from a public surface water supply withdrawal.

On a long-term basis, construction of a new interstate in the vicinity of a public water supply would increase the probability of contamination should pollutants be released as a result of traffic accidents or should pollutants typically carried as constituents of highway stormwater runoff be introduced via runoff. As discussed in Section 4.6.3.3, stormwater management systems will be designed to avoid or minimize these impacts to the fullest degree practicable. With implementation of appropriate mitigation measures and BMPs, the long-term operation and maintenance of the Build Alternative options will not result in adverse impacts to public water supplies, water-related recreational opportunities, or aquatic habitat values due to degradation of water quality.

4.6.3.3 Review of Available Mitigation Measures

Congress established the Non-Point Source Management Program under section 319 of the Clean Water Act in 1987 to assist the states in addressing non-point source or runoff pollution. Key management measures identified under section 319 of the Clean Water Act include protecting areas that provide critical water quality benefits or are particularly susceptible to erosion or sediment loss; limiting land surface disturbances to reduce erosion and sediment loss; limiting disturbance of natural drainage features and vegetation; placing bridge structures so that sensitive and valuable aquatic ecosystems are protected; preparing and implementing approved erosion control plans; ensuring proper storage and disposal of toxic materials; incorporating pollution prevention plans into operation and maintenance procedures to reduce pollutant loading to surface waters, and; developing and implementing runoff pollution controls for existing road systems to reduce pollutant concentrations and volumes (EPA, 1995). Also, construction sites that would disturb one or more acres are considered point sources of pollution requiring an NPDES stormwater permit under section 402 of the Clean Water Act.

In the absence of appropriate mitigation in the form of water pollution controls, highway construction can lead to measurably adverse effects on the water quality of surface water resources in the area; however, because highway pollutant loads are generated during wet weather events and because the right-of-way to total watershed ratios are usually low, considerable dilution capacity is available for mitigation of water quality effects (Dupius, et al, 1985). General guidelines for management of highway runoff pollutants include elimination of curbs, control of litter, management of pesticide/herbicide use, reduction of direct discharges, reduction of runoff velocities, use of grassed channels, maximized use of overland flow, and establishment and maintenance of right-of-way vegetation.

By preventing or minimizing the entry of pollutants into waterways, water pollution controls can serve as effective means for mitigating the effects of highway stormwater runoff. A number of methods are available to control or contain highway stormwater pollutants at their sources and along the pathways they travel. Water pollution controls typically used to mitigate highway stormwater runoff fall into the broad categories of (1) erosion and sediment controls, (2) best management practices (BMPs) for controlling surface runoff and its contaminants, and (3) prevention and remediation of hazardous material spills. Once introduced into a drinking water supply, sediments and other contaminants can be removed by various treatment methods; however, the primary goal of an effective stormwater management program is to preclude or minimize the possibility of such an event. As discussed in following sections, BMPs that can further reduce highway runoff pollutant loadings include vegetative controls, wet detention basins, infiltration basins, and manmade wetland treatment systems (Maestri, Burch, and Johnson, 1985).

4.6.3.3.1 Erosion and Sediment (E&S) Controls

Erosion is the process of detachment and transport of soil particles by precipitation or overland flow. These soil particles (or sediment) are ultimately deposited at some point downstream or downgradient, depending on how long the sediment remains in suspension (a function of grain size and velocity of flows). A variety of biological and mechanical means (such as vegetative stabilization, turf reinforcement, check dams, turbidity curtains, and stormwater detention basins/ponds) have been demonstrated to be effective in reducing erosion rates and containing resulting sediment deposits. All of the E&S controls discussed below target the removal of total suspended solids (TSS). The performance of E&S controls varies depending on the extent that the removal measures are practiced (standard, enhanced, or maximum). Overall, the removal efficiencies for the E&S controls discussed below range from 68 to 99 percent (FHWA, 1996).

Vegetative Stabilization. One of the most effective ways to prevent erosion and sedimentation is to preserve existing vegetation to the fullest extent practicable. If land surface disturbances cannot be avoided, disturbed land surfaces can be effectively stabilized through the establishment of new vegetation cover. Such vegetative covers serve to protect the soil surface from the impact of falling raindrops and can also provide dust control, increased infiltration, sediment trapping, and soil anchoring. Vegetative covers can be either temporary or permanent. Specific practices include applying sod to a site or temporarily or permanently seeding the site. Sod is a strip of permanent grass cover placed over a disturbed area to provide an immediate and permanent turf that both stabilizes the soil surface and eliminates sediment loss. Temporary

seeding consists of planting grass or other herbaceous plant seed immediately following rough grading to provide soil protection until a final cover is established. Permanent seeding establishes perennial vegetation in disturbed areas. Seed selection is based on the geographic region of the project and site-specific concerns. Qualitatively, vegetative covers are effective in controlling dust and erosion when properly implemented. The amount of runoff generated from vegetated areas is considerably reduced and of better quality than runoff from unvegetated areas. The performance of vegetation in removing sediment and other pollutants depends on site-specific hydrologic conditions as well as the underlying soil types, the type of vegetation, the height and density of growth, and proper installation.

Turf Reinforcement Mats (TRMs). Turf Reinforcement Mats or TRMs combine vegetative growth and synthetic materials to form a high-strength mat that helps to prevent soil erosion in drainage areas and on steep slopes. TRMs enhance the natural ability of vegetation to permanently protect soil from erosion. They are composed of interwoven layers of non-degradable geosynthetic materials such as polypropylene, nylon, and polyvinyl chloride (PVC) netting, stitched together to form a three-dimensional matrix. Unlike temporary erosion control products, TRMs are designed to remain in place permanently to protect seeds and soils and to improve germination. The installation area may be seeded before or after the TRM is installed, depending on the matting construction and manufacturer's recommendations. TRMs can incorporate natural fiber materials to assist in establishing vegetation; however, the permanent reinforcement structure of TRMs is composed of entirely non-degradable synthetic materials. TRMs are thick and porous enough to allow for soil filling and retention. In addition to providing scour protection, the mesh netting of TRMs is designed to enhance vegetative root and stem development. By protecting the soil from scouring and by enhancing vegetative growth, TRMs can raise the threshold of natural vegetation to withstand higher hydraulic forces on slopes, streambanks, and channels. In addition to reducing flow velocities, the use of natural vegetation provides particulate contaminant removal through sedimentation and soil infiltration and improves the aesthetics of a site. The performance of the TRM-lined conveyance system depends on the duration of the runoff event to which it is subjected. For short-term events, TRMs are typically effective at flow velocities of up to 5 meters per second (15 feet per second) and shear stresses of up to 380 Newtons per square meter (8 pounds per square foot) (EPA 832-F-99-002, 1999). However, specific high-performance TRMs may be effective under more severe hydraulic conditions.

Check Dams. Check dams are small temporary or permanent barriers constructed across open channels, swales, or drainageways. They reduce erosion and promote sedimentation by slowing flow velocities and filtering concentrated flows. They are used to reduce or prevent excessive bank and bed erosion by reducing the gradient or runoff velocity. Check dams often are used in natural or constructed channels or swales where adequate vegetation cannot be established promptly. They are used below small drainage structures but may be used below large structures if a diversion ditch cannot be used. Check dams are typically used in conjunction with swales in order to achieve the greatest removal efficiency. Sediment removal ranges between 70 to 80 percent for check dams when used in combination with swales.

Turbidity Curtains. A turbidity curtain is a geotextile material suspended from the water surface by floats. The curtain provides a screen that blocks sediment transport from disturbed areas from reaching certain receiving bodies of water or they can prevent further migration of silt within the receiving waters. The curtains can also help retard the migration of petroleum products or other pollutants, particularly if equipped with a boom across the water surface. The turbidity curtain is designed to deflect and contain sediment within a limited area and provide enough residence time so that soil particles will fall out of suspension and not travel to other areas. It provides sedimentation protection for a watercourse from up-slope land disturbance or from dredging or filling within the watercourse. Turbidity curtains are used most often in non-tidal and tidal watercourses where intrusion into the watercourse by construction activities and subsequent sediment movement is unavoidable. Turbidity curtains are designed and installed to trap sediment, not to halt the movement of the water itself. They are not designed to act as water impoundment dams and cannot be expected to stop the flow of a significant volume of water. Turbidity curtains are most commonly employed as a temporary measure during project construction. Under most circumstances, turbidity curtains have been demonstrated to effectively deflect sediment and keep it out of the waterway by prohibiting it from passing through the curtain. Turbidity curtains provide high containment and deflection when they are used in optimal conditions.

Catch Basins. Catch basins are chambers or sumps, usually built at the curb-line, which allow surface water runoff to enter the stormwater conveyance system. Many catch basins have a low area below the invert of the outlet pipe intended to retain coarse sediment. By trapping sediment, catch basins prevent most solids from entering stormwater drainage systems and from being washed into receiving waters. Catch basins must be cleaned periodically to maintain their ability to trap sediment, and consequently their ability to prevent flooding. The removal of sediment, decaying debris, and highly polluted water from catch basins has aesthetic and water quality benefits, including reducing foul odors, reducing suspended solids, and reducing the load of oxygen-demanding substances that reach receiving waters. Catch basins generally combine wet storage with detention storage. The removal efficiency of catch basins ranges from 70 to 90 percent. The removal efficiency is increased when they have some "wet" storage. This permanent pool of water aids in the removal of sediment by slowing the runoff velocity and allowing more sediment to settle out.

4.6.3.3.2 Best Management Practices (BMPs)

During rain events, that portion of the precipitation which does not infiltrate ground surfaces flows along ground surfaces first as sheet flow which ultimately assembles as channelized flow. As stormwater runoff flows downstream, this channelized flow cumulates into progressively greater volumes conveyed in progressively larger channels. Stormwater runoff conveys suspended materials (such as sediment) and various other pollutants that may have been washed off land surfaces or may have adhered to sediment particles. As a result, stormwater can contain a variety of organic and inorganic materials, such as nutrients, heavy metals, bacteria, and pesticides. One effective means for reducing concentrations of these pollutants involves retaining/detaining runoff for sufficient periods of time under conditions that can allow pollutants to be removed or significantly reduced prior to reaching waterways or water bodies. These means (generally referred to as best management practices or BMPs) include construction of extended wet detention basins, vegetated swales, and bioretention facilities.

Wet Detention Ponds. Wet detention ponds are stormwater management structures capable of providing both detention and treatment of contaminated stormwater runoff. Such ponds typically consist of a permanent pool of water into which stormwater runoff is directed. Runoff from each rain event is detained and treated in the pond until it is displaced by runoff from the next storm. By capturing and retaining runoff during storm events, wet detention ponds control both stormwater quantity and quality. The physical, biological, and chemical processes of the pond then work to remove pollutants. Sedimentation processes remove particulates, organic matter, and metals; while dissolved metals and nutrients are removed through biological uptake. In general, a higher level of nutrient removal and better stormwater quantity control can be achieved in wet ponds than can be achieved with other BMPs such as dry ponds, infiltration trenches, or sand filters. Several common modifications can be made to increase a pond's pollutant removal effectiveness. The first is to increase the settling area for sediments through the addition of a sediment forebay. Heavier sediments will drop out of suspension as runoff passes through the sediment forebay; lighter sediments will settle out as the runoff is retained in the permanent pool. A second common modification is the construction of shallow ledges along the edge of the permanent pool. These shallow peripheral ledges can be used to establish aquatic plants that can impede flow and trap pollutants as they enter the pond. The plants also increase biological uptake of nutrients. In addition to their function as aquatic plant habitat, the ledges can act as a safety feature to prevent accidental drowning, and provide easy access to the permanent pool to aid in maintenance. Finally, perimeter wetland areas also can be created around the pond to aid in pollutant removal.

Space-limited BMPs. Space-limited BMPs such as hydrodynamic separators are widely used in stormwater treatment. Hydrodynamic separators are flow-through structures with a settling or separation unit equipped to remove sediments and other pollutants. No outside power source is required, because the energy of the flowing water allows the sediments to efficiently separate. Depending on the type of unit, this separation may be by means of swirl action or indirect filtration. Hydrodynamic separators are most effective when the materials to be removed are heavy particulates (which can be settled) or floatables (which can be captured) rather than solids with poor settleability or dissolved pollutants. In addition to the standard units, some manufacturers offer supplemental features to reduce the velocity of the flow entering the system. This increases the efficiency of the unit by allowing more sediment to settle out.

Water Qualify Inlets (WQls). Also referred to as oil/grit separators or oil/water separators, water quality inlets (WQIs) consist of a series of chambers that promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil) from stormwater. Most WQls also contain screens to help retain larger or floating debris, and many of the newer designs also include a coalescing unit that helps to promote oil/water separation. WQls typically capture only the first portion of runoff for treatment and are generally used for pretreatment before discharging to other BMPs. A typical WQI consists of a sedimentation chamber, an oil separation chamber, and a discharge chamber. The basic WQI design often is modified to improve performance. Possible modifications include an additional orifice and chamber that replace the inverted pipe elbow; the extension of the second chamber wall up to the top of the structure; or the addition of a diffusion device at the inlet. The diffusion device is intended to dissipate the velocity head and turbulence and distribute the flow more evenly over the entire cross-sectional area of the sedimentation chamber (EPA 832-F-99-029, 1999). The addition of a coalescing unit to the WQI can dramatically increase its effectiveness in oil/water separation while also greatly reducing the size of the required unit. Coalescing units are made from oil-attracting materials, such as polypropylene or other materials. These units attract small oil droplets, which begin to concentrate until they are large enough to float to the surface and separate from the stormwater. Without these units, the oil and grease particles must concentrate and separate naturally. This requires a much larger surface area; therefore, units that do not use the coalescing process must be larger than units utilizing a coalescing unit.

Vegetated Swales. A vegetated swale is a broad, shallow channel with dense vegetation covering the side slopes and bottom. Swales can be natural or manmade and are designed to trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters, and storm sewer systems. Swales are best suited for residential, industrial, and commercial areas with low flow and smaller populations.

Bioretention Facilities. Bioretention facilities utilize organic soils and a combination of woody and herbaceous plants to remove pollutants from stormwater runoff. Runoff is conveyed as sheet flow to the treatment area, which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. Runoff first passes over or through a sand bed, which slows the velocity of runoff and distributes flows evenly along the length of a ponding area, The ponding area consists of a surface organic layer and/or ground cover and the underlying planting soil.

Constructed Wetland Systems. Wetlands are areas that are inundated or saturated with surface water or groundwater for sufficient periods of time to support plants adapted to saturated soil conditions. Wetlands support physical, chemical, and biological processes that break-down certain compounds (such as nitrogen-containing compounds) and filter others (EPA 832-F-99-025, 1999). Two types of constructed wetlands have been used successfully for wastewater treatment: the subsurface flow (SF) constructed wetland and the free water surface (FWS) constructed wetland. The SF wetland basin is lined with a pre-designed amount of rock or gravel, through which the runoff is conveyed. The water level in an SF wetland remains below the top of the rock or gravel bed. Studies have indicated that the SF wetland is well-suited for the diurnal flow pattern of wastewater; however, the peak flows from stormwater may be several orders of magnitude higher than the base flow. In the FWS wetland, runoff flows through the soil-lined basin at shallow depths. The wetland consists of a shallow pool planted with emergent vegetation. The four basic designs of FWS constructed wetlands consist of (1) shallow marsh, (2) extended detention wetland, (3) pond/wetland system, and (4) pocket wetland. These wetlands store runoff in a shallow basin vegetated with wetland plants. The selection of one design over another depends on various factors, including land availability, level and reliability of pollutant removal, and size of the contributing drainage area. The shallow marsh design requires the most land and a sufficient baseflow to maintain water within the wetlands. The basic shallow marsh design can be modified into an extended detention wetland to store extra water above the normal pool elevation, thereby attenuating flows and relieving downstream flooding. The pond/wetland system has two separate cells: a wet pond and a shallow marsh. The wet pond traps sediments and reduces runoff velocities prior to entry into the wetland. Less land is required for a pond/wetland system than for the shallow marsh system. Still less land is required for a pocket wetland. Pocket wetlands should be designed with contributing drainage areas of 1 to 10 acres (0.4 to 4 hectares) and usually require excavation to the water table for a reliable water source.

Unreliable water sources and fluctuating water levels result in low plant diversity and poor wildlife habitat value (EPA 832-F-99-025, 1999).

Performance Data: The percent pollutant removal for BMPs are listed in Table 4.6-6.

Table 4.6-6
EXPECTED POLLUTANT REMOVAL EFFICIENCY FOR STRUCTURAL BMPs

BMP Type	Typical Pollutant Removal (%)				
	Sediments	Nitrogen	Phosphorus	COD/BOD	Metals
Wet Ponds	90	48	65	30/*	*
Water Quality Inlets	20 - 40	< 10	< 10	< 10/< 10	< 10
Constructed Wetlands	50 - 80	< 30	15 – 45	*/*	50 - 80
Bioretention Facilities	90	68 – 80	70 – 83	*/*	93 - 98
Grassed Swales	70	25	30	25/*	50- 90
Extended Detention Ponds	68 - 90	28 -40	42 – 50	42 - 50/*	42 - 90
Infiltration Trenches	75 – 99	45 – 70	50 – 75	*/70 – 90	75 - 99
Hydrodynamic Separators	50 – 90	*	*	*/*	*
Infiltration Basins	75 – 99	45 – 70	50 – 70	*/70 – 90	50 - 90
Porous Pavement	82 – 95	80 – 85	65	*	*

* Insufficient data
Source: FHWA, 1996.

4.6.3.3.3 Prevention and Remediation of Hazardous Material Spills

Hazardous materials include a wide range of products that are toxic, flammable, reactive, or explosive. Examples include pesticides, petroleum products, acids, and compressed gases. Because of their potential threat to human health and safety, such materials are subjected to comprehensive regulations for manufacture, transport, handling, and disposal under a number of state and federal laws. Control methods for accidental spills generally involve containment with subsequent recapture or cleanup. The containment and cleanup often involve specially trained emergency response teams and specially designed sorbent materials.

Spill containment and disposal are critical components of a local emergency response plan. Methods to be used for containment and clean-up also should include:

- Containment and mitigation actions,
- Clean up methods, and
- Restoration of the surrounding environment.

Typically, local responders will emphasize the containment and stabilization of a spill. State and federal regulatory agencies focus on the details of site cleanup; however, it is the releaser's legal and financial responsibility to clean up and minimize the risks to the health of the general public and the workers involved. Under local programs, a clear and concise list of containment and cleanup countermeasures should be prepared for each hazardous material present in the community in significant quantities. Planners should concentrate also on the techniques that are applicable to the hazardous materials and terrain of their particular jurisdiction.

4.6.3.4 Proposed Mitigation Measures

Certain components of the TSM Alternative would be located near enough to public surface water supply withdrawals as to require special mitigation measures, both during and following construction. Such measures would include pollution prevention plans implemented during critical phases of construction and the design of stormwater drainage systems to provide additional protective measures. Measures developed to protect nearby surface water supplies will include stormwater management facilities developed during later design phases and development of SPCC plans. Stormwater management basins located near public water

supplies would be designed with adequate detention time to allow contaminants to settle out before they can enter the water supply. To mitigate temporary construction impacts, an erosion and sediment control plan developed in accordance with the Virginia Sediment and Erosion Handbook would also be implemented.

On a long-term basis, construction of a new interstate in the vicinity of a public water supply could increase the probability of contamination should pollutants be released as a result of traffic accidents or should pollutants typically carried as constituents of highway stormwater runoff be introduced via runoff. With implementation of appropriate mitigation measures and BMPs, as discussed below, the long-term operation and maintenance of the ALC will not result in significantly adverse impacts to public water supplies, water-related recreational opportunities, or aquatic habitat values due to degradation of water quality.

Erosion and Sediment Control

During construction, erosion and sediment controls would consist of but not limited to, temporary filter barriers, temporary silt fences, temporary sediment traps, jute mesh and EC-3 mat erosion control ditches, Type II rock check dams, culvert inlet protections, diversion dikes, block and gravel sediment filter curb inlet protection, block and gravel sediment filter drop inlet protection, stone outlet protection, and Type II turbidity curtains. Rock check dams would be used in all the fill ditches of the proposed roadway within proximity to environmentally sensitive waters. This would increase the travel time for runoff to reach the resource and would improve the sediment removal capability of the ditches. Turbidity curtains would be used during construction at proposed stream crossings, thereby helping to reduce the amount of sediment that reaches the main body of the water course. Erosion and Sediment Control Inspectors certified by the Virginia Department of Conservation and Recreation would be assigned to the project during construction as needed. Runoff leaving the construction site would be treated in sediment basins. Implementing these erosion and sediment control measures would minimize sedimentation during the construction phase of the project. The magnitude of this reduction depends on the types of erosion and sediment controls used at the site, as well as the magnitude of changes in the grade and slope of the construction site (steeper constructed grades and slopes typically result in higher sedimentation loads).

Highway Runoff Control.

The ALC would incorporate multiple features to reduce the effects of highway runoff. Detention ponds would be designed to function as temporary basins for sediment and erosion control during the construction of the ALC. After construction is complete, the ponds would be restored to their original depth and converted into permanent stormwater retention basins. The primary stormwater management facilities would be multi-chambered stormwater retention ponds that would consist of an initial dry sump area, a sediment forebay, and a wet detention pond area. All facilities would be constructed and maintained according to details and specifications developed during appropriate phases of design. Basic design features of proposed ponds would likely include:

- Extended wet retention capabilities to increase pollutant removal efficiency and improve water quality;
- A shape using a 3:1 length-to-width ratio (this ratio is professionally accepted as maximizing the pollutant removal efficiency of the system);
- An outlet wider than the inlet;
- 3:1 side slopes for easy maintenance access;
- A shallow safety ledge around the perimeter;
- Fencing around the perimeter;
- A shallow sediment forebay at the entrance to the pond, with rock riprap protection sized for a volume equal to ten percent of the total pond volume;
- Perimeter vegetation in the wet ponds to increase biological uptake;
- The use of the pond as a temporary sediment control basin during construction.

Runoff entering proposed ponds would be routed from the inlet pipe to a dry sump area sized to capture the volume of a tanker truck (1,100 cubic feet) in the event of a spill. Inflow would then be detained in a sediment forebay before it would be allowed to overflow into the permanent wet pond. The design would also include a berm separating the sediment forebay from the permanent wet pond. The stormwater management ponds would comply with design specifications in Section 3.14 of the Virginia Erosion and Sediment Control Handbook (1992). The Handbook states that the purpose of sediment ponds is "to detain sediment-laden runoff from disturbed areas in 'wet' and 'dry' storage long enough for the majority of sediment to settle out." By retaining runoff, the ponds would control water quantity while also enabling natural processes that improve runoff quality.

The use of retention ponds to improve stormwater quality is widespread, and the pollutant removal mechanisms of these types of ponds are well documented. Runoff from each rain event would be retained and treated in a pond until it is displaced by runoff from the next storm. While runoff is being retained in the pond, physical, biological, and chemical processes inherent to the pond design would work to remove pollutants. The primary pollutant removal mechanism in a wet detention pond is sedimentation. Substantial loads of suspended pollutants, such as metals, nutrients, sediments, and organics, would be removed through sedimentation. Other pollutant removal mechanisms include algal uptake, wetland plant uptake, and bacterial decomposition (Schueler, 1992). Studies indicate that dissolved pollutant removal would also occur as a result of biological and chemical processes (NVPDC, 1992). In general, a higher level of nutrient removal and better stormwater quantity control could be achieved through optimal use of wet detention ponds (as compared with other BMPs such as dry ponds, infiltration trenches, or sand filters). As summarized in Table 4.6-6, numerous studies have shown wet detention ponds to be effective in removing TSS, nutrients, metals, and BOD/COD from stormwater.

Hazardous Material Spill Control

Drainage from roadway surfaces and rights-of-way would be directed through stormwater management facilities. Although a spill consisting of the entire contents of a tanker truck would be highly unlikely, retention/detention basins constructed in the vicinity of surface waters critical to public water supply or the Roanoke logperch would be equipped with dry sumps designed to store the spill volume of a typical tanker truck (1,300 cubic feet, or approximately 10,000 gallons). In dry weather, any spill that was not contained on the roadway would first be contained in this dry sump area. During wet weather, this dry sump would be filled with runoff in addition to the spill material; therefore, the mixture of rainwater and spill material may overflow to the sediment forebay and the wet pond. This could lead to hazardous materials flowing through the pond and contaminants exiting the outfall. To prevent this type of situation, the wet portion of stormwater management ponds could be provided with additional storage depth that is not used by the normal pool. If additional outlet controls (gate valves) are installed in the ponds, this additional capacity could provide containment of a spill and would minimize the possibility of an overflow of the pond.

In the event of a spill, local spill response personnel would initiate a Level II response to contain the spill and prevent its spread through the use of absorbent booms and pads. This method is effective for containing petroleum-based spills (by far, the most common type of spill); however, this method may not be as effective for non-petroleum spills. If there is a requirement for response to other types or more severe spills, responsibility is transferred to the regional Department of Emergency Services. Regional Level ll hazmat response teams are based in Roanoke.

Additional Mitigation Measures for Critical Surface Water Resources

Multiple measures (such as silt basins, silt traps, rock check dams, silt fences, a phased plan to limit the amount of exposed soil, and oversight by a full-time erosion and sediment control inspector) would be implemented in the vicinity of surface waters critical to public water supplies or special aquatic habitat. Curbing could be installed along portions of the ALC draining to portions of the Pigg River watershed critical to habitat for the Roanoke logperch to capture 100 percent of roadway runoff. Potential additional mitigation measures to control hazardous materials spills include pre-treatment devices (such as space-limited BMPs) placed in the drainage system immediately upstream of the stormwater management ponds and modifications to the ponds to better contain the spill within the pond. Another type of BMP that may be effective in

mitigating potential spills along critical portions of the ALC are BMPs containing sorbent materials. Sorbent materials could provide another layer of protection from very small spills and typical oil runoff from roadways. Stormwater management ponds could be equipped with inverted orifices and sluice gates. These controls would help to contain potential spills that have passed through the drainage system and entered the ponds. These devices would allow operators to control the release of water from pond outlets and would thereby allow them to trap any spill within the pond. Hazardous pollutants could then be removed from the stormwater, before the stormwater was released back into receiving waters. In the vicinity of environmentally sensitive surface waters, modification of stormwater management ponds could also include the addition of a membrane lining of the forebay or dry sump, which would provide an additional layer of protection for limiting the fate and transport of spill material into ground and surface waters.

Heavy trucks, such as those carrying hazardous materials, need longer highway stopping sight distances, particularly on crest vertical curves and horizontal curves. Enhanced design along critical portions of the ALC could include shoulders on horizontal curves, both on the roadway and on ramps, which are common sites of accidents. Geometric design in environmentally sensitive areas could be based on higher-than-minimum standards to enhance truck safety, thereby further reducing the probability of a truck running off the road.

These mitigation measures will be given further consideration during final design as hydrological and runoff analysis is conducted and specific stormwater measures designed.

4.6.4 Groundwater Resources of the Project Area

Highway runoff can have a measurable effect on groundwater, including changes in water quality within the vadose zone and the saturated zone. Highway runoff effects on groundwater are often spatially limited, however, due to local hydrological conditions as well as pollutant sorption processes within and above the aquifer (Barrett, et al, 1993). For example, studies have demonstrated that the impact of deicing on the surrounding soil is limited to a distance of approximately 50 feet (15 meters) from the edge of pavement (California Department of Transportation, 1992). For public groundwater resources within the study area, environmental consequences associated with alternatives under consideration are provided in Table 4.6-7.

Table 4.6-7
POTENTIALLY AFFECTED PUBLIC GROUNDWATER SUPPLIES

Alternative		Public Groundwater Supply Wells Within ¼ Mile	Effects
TSM		7	Potentially measurable increase in dissolved metals and chloride; increased risk of spills during construction
Build Alternative Option	1	2	Potentially measurable increase in dissolved metals and chloride; increased risk of spills during construction. BMPs required in wellhead protection zones and aquifer recharge areas.
	1a	2	
	2	4	
	2a	4	
	2b	4	
	2c	4	
	3	7	
	3a	7	
	3b	7	
	3c	7	
	4	7	
	ALC	2	Potentially measurable increase in dissolved metals and chloride; increased risk of spills during construction. BMPs required in wellhead protection zones and aquifer recharge areas.

No sole source aquifers, as defined under Section 1424(e) of the Safe Drinking Water Act, have been designated in Virginia (EPA, 1999). The Commonwealth of Virginia currently has no approved wellhead protection program (EPA, 1999).

4.6.4.1 TSM Alternative

Following the implementation of a number of improvements along U.S. Route 220, the TSM Alternative would maintain the use of U.S. Route 220 as the major north-south arterial through the region. U.S. Route 220 and areas of proposed improvements are located upgradient of and in close proximity to a number of groundwater supply wells owned and maintained by the Henry County Public Service Authority. U.S. Route 220 is currently heavily urbanized, including a large volume of commercial traffic, and this trend would continue under the TSM Alternative. Failure to relieve U.S. Route 220 of its present traffic volumes and failure to make it safer by improving levels of service would continue to expose the groundwater recharge area to an increasing probability of contamination from traffic accident-related spills.

4.6.4.2 Build Alternative

Roadway projects result in the introduction of pollutants normally associated with vehicular traffic. If not addressed through appropriate stormwater management, this situation can lead to water quality problems (an increase in nonpoint pollutant loading). If unabated, roadway runoff and other nonpoint source pollution can adversely impact water quality of nearby water supply wells or groundwater recharge areas. Infiltration could introduce contaminants typically carried in stormwater runoff (primarily salts and heavy metals) unless adequate BMPs are employed. Similar to the situation with surface water supplies, construction of a new interstate in the vicinity of a public groundwater supply well would increase the probability of contamination should contaminants be suddenly released as a result of a traffic accident.

The number of groundwater supply wells located in the vicinity of each of the Build Alternative options is listed in Table 4.6-3. Options 1 and 1a would be located in the vicinity of two public groundwater supply wells. Options 2, 2a, 2b, and 2c would be located in the vicinity of four public groundwater supply wells. Options 3, 3a, 3b, 3c, and 4 would be located in the vicinity of seven public groundwater supply wells. The ALC would be located in the vicinity of two public groundwater supply wells.

4.6.4.3 Mitigation

Certain components of the TSM Alternative and the ALC would be located within the currently non-regulatory 1,000-foot (305-meter) wellhead protection radius recommended in the Virginia model ordinance (Virginia Ground Water Protection Steering Committee, 1998) and could be located within the 100-foot (30.5-meter) wellhead setback zone specified in Virginia Waterworks Regulations (VR 355-18-000) for public groundwater supply wells. In these cases, special mitigation measures, both during and following construction would be required. Such measures would include pollution prevention plans implemented during critical phases of construction and design of stormwater drainage systems to prevent the infiltration of liquid contaminants or contaminated runoff.

Measures developed to protect nearby groundwater supply wells would include routing of runoff laden with deicing agents away from well recharge zones, stormwater management facilities developed during later design phases to optimize fee ion retention (through use of organic soil linings, etc.), and development of SPCC plans. Plans will be developed in accordance with Virginia Waterworks Regulations and any wellhead protection ordinances subsequently developed by local governments and service authorities. The stormwater management system would be designed to intercept and retain spilled materials before they can reach a water supply well aquifer (through use of detention/ retention basins and stormwater conveyance routes which avoid direct infiltration to aquifer recharge areas and wellhead protection zones). Stormwater facilities will be designed with adequate detention times to allow recovery of spilled contaminants before such contaminants can reach a critical groundwater supply area. To mitigate temporary construction impacts, an erosion and sediment control plan developed in accordance with the Virginia Sediment and Erosion Handbook will also be implemented.