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VEGETATION AND WILDLIFE HABITAT TECHNICAL REPORT

Alignment Selection SDEIS

APPALACHIAN CORRIDOR H

Elkins to Interstate 81

West Virginia Department of Transportation

Baker

Michael Baker Jr., Inc.

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I. INTRODUCTION

This is the Vegetation and Wildlife Habitat Technical Report of the *1994 Alignment Selection Supplemental Draft Environmental Impact Statement* (SDEIS) prepared for the construction of Appalachian Corridor H from Elkins, West Virginia, to Interstate 81 in Virginia. The SDEIS has been prepared in accordance with a two-step study process explained in the preface of the SDEIS. Other documents related to the SDEIS include the *Executive Summary*, the *Alignment and Resource Location Plans*, the *Cultural Resources Technical Report*, the *Secondary and Cumulative Impacts Technical Report*, the *Socioeconomics Technical Report*, the *Wetlands Technical Report*, the *Streams Technical Report*, the *Air, Noise and Energy Technical Report*, the October 21, 1992 *Corridor Selection SDEIS* and associated Technical Reports, and the July 26, 1993 *Decision Document.*

Appalachian Corridor H is one of the economic growth highways designated by Congress to serve the Appalachian Region. There are three alternatives under study: the No-Build Alternative, the Improved Roadway Alternative, and the Build Alternative. The No-Build Alternative means that Corridor H would not be constructed in any fashion. The Improved Roadway Alternative consists of a proposed two-lane highway which would utilize existing roads as much as possible. The Build Alternative is a proposed four-lane highway which would be constructed entirely on new location. Please refer to the SDEIS, Section II, for more information on the design criteria and design elements of these alternatives.

The purpose of the Vegetation and Wildlife Habitat Technical Report is to document the existing conditions of wildlife habitat and the impacts resulting from the construction of the proposed Corridor H project. The Vegetation and Wildlife Habitat assessment follows the guidance of Federal Highway Administration (FHWA) Technical Advisory T6640.8A (US Department of Transportation, 1987) and the Environmental Protection Agency's *Evaluation of Ecological Impacts from Highway Development* (Southerland, 1993).

This report consists of four major sections. The Vegetation and Wildlife Habitat section describes the procedures used to estimate habitat value before and after highway construction for nineteen evaluation species for each of the proposed alternatives. The Rare, Threatened and Endangered Species section describes procedures used to identify potential impacts certain species by the proposed alternatives and avoidance, minimization, and mitigation measures. The Forest Fragmentation and Biodiversity section reviews scientific literature on this topic and describes the procedures used to estimate the impacts of the proposed alternatives on the existing forested landscape. The Wildlife Mortality section reviews scientific literature that presents information on wildlife/highway interactions and discusses potential impacts of the proposed alternatives on several groups of wildlife species.

II. VEGETATION AND WILDLIFE HABITAT

The wildlife habitat value of existing land use/land cover types within each watershed was assessed using the US Fish and Wildlife Service's (USFWS) Habitat Evaluation Procedure (HEP) (USFWS, 1980). HEP was developed to rate the quality and quantity of wildlife habitat in order to quantify the impacts which result from land and water development projects. HEP is based on the fundamental assumption that the quantity and quality of a habitat can be numerically documented and reasonably predicted for future conditions. Generally, HEP provides information to evaluate the relative value of different habitat types at the same point in time, and the relative value of the same habitat area at future points in time. The overall objective of this analysis was to determine the wildlife habitat value before, during and after highway construction for each of the proposed alignments.

A. METHODOLOGY

Habitat quality for selected evaluation species is documented with a non-dimensional index, the Habitat Suitability Index (HSI). This value is calculated by collecting information on key habitat characteristics (e.g., % tree canopy cover, % herbaceous canopy cover, density of woody stems) that are integral components of a species life requisites (breeding and feeding). The HSI index for each species is determined by comparing existing habitat conditions to optimal habitat conditions. Optimal conditions are those associated with the highest potential densities of a species within a defined area and thus the HSI value is an index of carrying capacity for that species. This index is a number that ranges from 0.0, representing no habitat suitability, to 1.0 representing optimum suitability. When calculating the HSI for species that utilize more than one habitat type, the HSI value is weighted by the area of available habitat to produce a weighted mean HSI. This prevents underestimating the suitability of a species total habitat.

Habitat quantity is any measure of area (e.g., acres, hectares, square miles, or sections) which is relevant to the project study area. Land use in this study is expressed in hectares (ha) and acres (ac).

The Habitat Unit (HU) is the principle unit of comparison in the HEP system. Habitat Units (HUs) are calculated for each evaluation species by multiplying the computed HSI value by the area of available habitat (e.g., 0.5 (HSI) x 120 (Area) = 60 HUs. The overall objective of this analysis was to determine the wildlife habitat value before, during and after highway construction for each of the proposed alignments. HUs were used to quantify gains and losses in wildlife habitat value resulting from project-related activities.

A land use and land cover map was produced through the interpretation of 1" = 1,000' scale aerial photography and selected groundtruthing. This photography encompassed an area approximately 3.2 km (2 miles) wide and 192 km (120 miles) in length. Existing land use was classified to Anderson Level II (Table 1). The land use and land cover types within the construction limits of the alignments were further classified according to the USFWS cover type classification system (USFWS, 1981) (Table 2) to accommodate data entry into the HSI computer program (USFWS, Micro-HSI Version 2.1). Each cover type was assumed to be homogenous throughout the study area. Due to definitional differences between the Anderson and USFWS land classification systems, field verification of existing vegetation within certain cover types (Anderson 21, 31, 33, 43, 76) was necessary to allow these to be converted to the USFWS system.

1. SPECIES SELECTION

Based on the broad spectrum of habitats within each watershed, a "guild" approach was employed to select HEP evaluation species. Guilds offer a way of evaluating large groups of animals by selecting several individual indicator species. A guild is a group of species that exploit a resource in a similar fashion (Root 1967). Thus, if the impact of environmental change is determined for one species from the guild, the remaining species should be similarly affected. The guild-indicator concept is a cost and time-effective approach because monitoring populations of a few guild-indicator species can enable one to estimate population levels of many birds, mammals, reptiles and amphibians (Block *et al.*, 1986).

The selection of evaluation species involved categorizing vertebrate species according to their feeding and reproductive habitat requirements. This information was collected through an extensive literature review on a number of terrestrial vertebrate species. DeGraaf and Rudis (1986) and individual *Habitat Suitability Index Models* (see references) provided the most comprehensive collection of information on species habitat requirements. The selection of evaluation species was predicated on several factors: the species had to be found within the study area, either as a permanent resident or as a migratory species that potentially breeds within the study area; the species had to represent a group of animals that exploits the same resources within particular cover types; and the species had to have an existing USFWS documented model for use with the HSI computer program.

Nineteen evaluation species were selected to evaluate eleven USFWS habitat types within the study area (Table 3). In conjunction with HEP, the HSI program developed a list of habitat variables for each species and generated a data collection form for each cover type. The habitat variables for each species are defined in Appendix A.

TABLE 1
ANDERSON LEVEL II LAND USE AND COVER TYPE CLASSIFICATIONS

LEVEL NUMBER	LAND USE AND COVER TYPE
11	Residential
12	Commercial
13	Industrial
14	Transportation, Communications, Utilities
16	Mixed Urban or Built-up Land
17	Other Urban or Built-up Land
21	Cropland and Pasture
22	Orchards
24	Other Agricultural Land
31	Herbaceous Rangeland
32	Shrub and Brush Rangeland
33	Mixed Rangeland
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Streams and Canals
53	Reservoirs
61	Forested Wetlands
62	Non-forested Wetlands
73	Sandy Areas Other Than Beaches
74	Bare Exposed Rock
75	Strip Mines, Quarries, Gravel Pits
76	Transitional Areas

Source: Anderson et al. 1976.

TABLE 2
USFWS LAND USE AND COVER TYPE CLASSIFICATIONS

CLASSIFICATION	LAND USE AND COVER TYPE
AC	Cropland
AO	Orchard
AP	Pasture or Hayland
PEM	Palustrine Emergent Wetland
PFO	Palustrine Forested Wetland
PSS	Palustrine Scrub/Shrub Wetland
UF	Forbland
UFOD	Deciduous Forest
UFOE	Evergreen Forest
UG	Grassland
USHD	Deciduous Shrubland

Source: USFWS 1981

TABLE 3
COVER TYPE USE BY EVALUATION SPECIES

US FISH & WILDLIFE SERVICE LAND USE/LAND COVER TYPE	EVALUATION SPECIES																		
	American Woodcock	Barred Owl	Black-capped Chickadee	Brown Thrasher	Downy Woodpecker	Eastern Cottontail	Eastern Meadowlark	Eastern Wild Turkey	Gray Squirrel	Hairy Woodpecker	Mink	Muskrat	Pileated Woodpecker	Pine Warbler	Red-winged Blackbird	Ruffed Grouse	Veery	White-tailed Deer	Yellow Warbler
Cropland								✓										✓	
Orchards				✓		✓												✓	
Pasture/Hayland				✓		✓	✓	✓										✓	
Forbland				✓		✓	✓	✓										✓	
Deciduous Forest	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓		✓		✓	
Evergreen Forest	✓	✓	✓	✓	✓	✓		✓					✓	✓		✓		✓	
Grassland				✓		✓	✓	✓										✓	
Deciduous Shrubland				✓		✓		✓								✓		✓	✓
Palustrine Emergent Wetland												✓			✓			✓	
Palustrine Forested Wetland	✓	✓	✓		✓			✓	✓	✓	✓		✓				✓	✓	
Palustrine Scrub/Shrub Wetland											✓	✓					✓	✓	✓

2. DATA COLLECTION

Data collection techniques included both physical measurement and visual estimation procedures (Hays *et al.,* 1981, Brower and Zar, 1984) to measure quantitatively the various wildlife habitat variables produced by the HSI program. A pilot study was conducted to assess the variability of habitat variables within each cover type. Reasonable reliability standards for most HEP analyses are 25% relative precision with a 90% confidence level (USFWS, 1980). Based on the pilot study, arithmetic mean and standard deviation values of each habitat variable and an estimate of the sample size required to meet the above reliability standards for each habitat cover type was calculated (USFWS, 1980). Due to the large number of cover types and habitat variables involved, consideration was also given to allocating sample sites in proportion to cover type size; i.e., larger cover type areas (deciduous forest) were allocated more sample plots. A stratified random sampling approach was used to assess habitat variables within each cover type. This method of sampling allowed the entire project area to be divided into homogeneous subareas based on existing vegetative cover types.

HEP sampling transects were randomly located in each cover type across the project area. Transects were located within or adjacent to the construction limits of the proposed alignments whenever possible. Circular 0.01 hectare (0.02 acre) sample plots were systematically established along each transect and habitat variable information was recorded at each site (See Appendix B for HEP data sheets). The values recorded for each habitat variable were averaged for each cover type. Eighty-five percent of the habitat variables sampled during the HEP study were within the USFWS recommended reliability standards. These averaged values were entered into the HSI program to allow prediction of the habitat suitability of each cover type for each evaluation species. These values represent the current or baseline conditions that exist within each cover type before implementation of any project-related activities.

An attempt was also made to locate transects at least 100 m from existing roadways to minimize edge/invasive vegetative species biases in HEP data collection. This was a particular concern when sampling in the deciduous forest cover type. Species such as staghorn sumac (*Rhus typhina*), black locust (*Robinia pseudoacacia*), pokeweed (*Phytolacca americana*) and crown vetch (*Coronilla varia*) are plants associated with roadside right-of-ways that may penetrate the adjacent native vegetative community, thereby altering their vegetative composition. A study was initiated to investigate the extent of edge plant species invasion into a hardwood, deciduous forest. Four vegetation sampling transects were established along Interstate 68 in Garrett County, Maryland. Transects were established at the forest/edge interface perpendicular to the existing roadway. Vegetation sampling plots were located along each transect at 25 meter intervals. Data were collected on three strata of vegetation: herbaceous and woody seedlings (percent cover by species), subcanopy (trees > 2.5 cm [1"] and < 10 cm [4"] dbh, percent cover by species), and canopy (trees > 10 cm [4"] dbh, basal area measured with a 10x prism). The results of this field investigation show the preponderance of edge/invasive species, both in average number of individuals and in average percent cover, to occur at the forest/edge interface (Table 4). The majority of edge/invasive species were no longer observed more than 75 meters from the forest edge. While this is a relatively small sample size conducted within one cover type (deciduous forest), the results indicate that vegetative edge species within the deciduous forest do not become well established greater than 75 meters from an open edge. Additionally, other investigators of edge effect have found that this phenomenon becomes minimal between 100-200 m from the forest edge (Michael, 1975, Temple, 1986, Temple and Cary, 1988).

An impact assessment of wildlife habitat within each alignment's construction limits was performed using the HEP accounting program (USFWS HEP Accounting Software for Microcomputers, 1985). HUs were calculated for three target years; present or baseline conditions, during or immediately following construction and 5 years after construction. During or immediately following highway construction it is assumed that no meaningful habitat would exist within the highway construction limits. Construction activities would have either removed existing vegetation or would result in disturbances sufficient to render remaining habitat unusable at this time. Bridged areas were also included as wildlife habitat impacts. HU calculation five years after construction represents predicted conditions of unpaved areas within the original construction limits based on standard WVDOT and VDOT right-of-way and roadside development practices. Numerous studies have shown that constructed right-of-way habitat is utilized by many wildlife species (Oetting and Cassel, 1971, Adams and Geis, 1982, Michael, 1975, Getz *et al.*, 1978, Burke and Sherburne, 1982, Michael and Kosten, 1981).

B. EXISTING ENVIRONMENT AND IMPACTS

To facilitate more detailed analyses and discussion of the existing environment and impacts, the proposed project area was divided into six watersheds based on regional drainage patterns. This information, as well as an overview of the entire project area, is presented below.

1. EXISTING ENVIRONMENT

The proposed project lies within two distinct physiographic provinces of the Appalachian Mountains; the Allegheny Mountain Section of the Appalachian Plateau Province and the Middle Section of the Ridge and Valley Province. A major divide, known as the Allegheny Front, generally runs northeast to southwest along the western borders of Pendleton and Grant counties in West Virginia. This high ridge of the Alleghenies separates the Appalachian Plateau Province to the west from the Ridge and Valley Province to the east.

TABLE 4
EDGE SPECIES STUDY: AVERAGE NUMBER AND AVERAGE PERCENT COVER OF PLANT SPECIES PER PLOT

	AVERAGE NUMBER OF INDIVIDUAL PLANT SPECIES PER PLOT					
	HERBACEOUS		SUBCANOPY		CANOPY	
Distance from Edge (m)	Edge Spp.	Forest Spp.	Edge Spp.	Forest Spp.	Edge Spp.	Forest Spp.
0	2.75	2	0.75	4	0.5	2.25
25	1.25	6.5	0	1.75	0	4.75
50	0.25	4.25	0	2.25	0.25	3.75
75	0	3.75	0	2	0.25	3.25
100	0	6	0	3.5	0	2.5
	AVERAGE PERCENT COVER OF INDIVIDUAL PLANT SPECIES PER PLOT					
	HERBACEOUS		SUBCANOPY		CANOPY	
Distance from Edge (m)	Edge Spp.	Forest Spp.	Edge Spp.	Forest Spp.	Edge Spp.	Forest Spp.
0	54.25	29.25	21.25	40	5	48.75
25	4.5	53	0	18	0	97.5
50	0.5	48	0	25.75	3.75	61.25
75	0	47.5	0	20.5	5	73.75
100	0	46	0	32.5	0	72.5

Source: Michael Baker, Jr., Inc.

Upland forest is the dominant vegetation type within the project area. Little is known about the original upland forest vegetation of West Virginia. Quantitative data on the composition of these forests does not exist and even historic firsthand descriptions are few (Stephenson, 1993). Some of the first records of tree species present in the original forests of the Allegheny Mountains include red spruce (*Picea rubens*), beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*) birch (*Betula alleghaniensis*), cherry (*Prunus serotina*) and pine (pitch pine, *Pinus rigida*, and white pine *Pinus strobus*). During the half century between 1870 and 1920, the upland forests of West Virginia were subjected to such intensive logging that by the end of this period the original forests had been essentially eliminated (Clarkson, 1968). Extensive forest fires, fueled by large amounts of logging slash, also destroyed large areas of virgin timber. As a result of the extensive logging and frequent fires that occurred throughout the upland forest region during this period, the present day forest vegetation is mostly a mosaic of second and third-growth forest communities (Stephenson, 1993).

The portion of the proposed project west of the Allegheny Front is drained by the Tygart and Cheat River watersheds. Major rivers in this Province include Shavers Fork, the Blackwater River, the Cheat River and the Tygart River. Elevations west of the Allegheny Front range from 440 m (1,450 feet) to 1,450 m (4,760 feet). Elevation differences between valley, plateau and the higher mountain locations create a diversity of climatic conditions, which result in varying temperatures and precipitation amounts. Generally, the higher elevations yield lower temperatures and higher precipitation when compared to areas of lower elevations.

The present forest vegetation community west of the Allegheny Front is composed primarily of two forest types, the northern hardwood forest and the Appalachian mixed hardwood forest. Northern hardwood forests generally occur at elevations above 915 m (3,000 feet), but can extend down slope as low as 750 m (2,460 feet) in rich moist loamy soils (Stephenson, 1993). The three dominant tree species are sugar maple, beech and yellow birch. Other common associates include basswood (*Tilia americana*), hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), white ash (*Fraxinus americana*), black cherry, sweet birch (*Betula lenta*), cucumber tree (*Magnolia acuminata*), yellow poplar (*Liriodendron tulipifera*), red oak (*Quercus rubra*) and chestnut oak (*Quercus prinus*). Common shrub species include hobblebush (*Viburnum alnifolium*), witch hazel (*Hamamelis virginiana*), big laurel (*Rhododendron maximum*), mountain laurel (*Kalmia latifolia*), mountain holly (*Ilex montana*), and red elderberry (*Sambucus pubens*). Herbaceous plants found in this forest community include spinulose wood fern (*Dryopteris spinulosa*), shining club moss (*Lycopodium lucidulum*), white wood sorrel (*Oxalis montana*), painted trillium (*Trillium undulatum*), Canada mayflower (*Maianthemum canadense*), and several species of violets (*Viola* spp.).

The Appalachian mixed hardwood forests generally occur below 750 m (2,460 feet) and are characterized by a great diversity in species composition. Overstory composition may range from nearly pure stands of red oak or yellow poplar to mixtures of twenty or more commercially valuable species. Common important species include yellow poplar, red oak, chestnut oak, black cherry, white oak, basswood, white ash, sugar maple, red maple, hickories (*Carya* spp.), beech, sweet birch, and black locust (*Robinia pseudoacacia*). Over 2,000 species of shrubs and herbaceous plants are found within this forest type (USDA, FEIS George Washington National Forest, 1993). Species composition varies from site to site and is dependent on site aspect and elevation, soil composition, and moisture regime.

The portion of the proposed project east of the Allegheny Front lies in the Middle Section of the Ridge and Valley Province. This area is drained by the North and South Branch of the Potomac River, the Cacapon River, and the Shenandoah River. Elevations east of the Allegheny Front range from 230 m (550 feet) to 1,220 m (2,900 feet). Elevation differences between the parallel valleys and ridges create a variety of local climates and microclimates. Generally, the temperatures and precipitation levels are aligned parallel to the direction of the valleys and ridges, with the highest precipitation on the ridges and the highest average temperatures in the valleys.

The present forest vegetation community within the Middle Section of the Ridge and Valley Province is composed primarily of northern and Appalachian mixed hardwood forests. However, the species composition of the northern hardwood forest is somewhat different due to lower precipitation levels. This area receives markedly less rainfall than the project area west of the Allegheny Front. Most major air masses move across the Allegheny Mountains from west to east, depositing most of their moisture on the higher ridges west of the Allegheny Front. The resulting tree species are those tolerant of more xeric conditions. Several species of oak including chestnut, red, white, scarlet (*Quercus coccinea*), scrub (*Quercus ilicifolia*), and black (*Quercus velutina*) typically occur in association with various species of pine (Virginia pine, *Pinus virginiana*, pitch pine, *P. rigida*, and Table Mountain pine, *P. pungens*).

The USFWS's Habitat Evaluation Procedure (HEP) was used to determine wildlife habitat value before, during and after highway construction for each of the proposed alignments. Anderson Level II land use within the construction limits of each alignment and within each proposed option area are found in Tables 5 and 6. These values were converted to USFWS cover type definitions to facilitate the HEP analysis (Tables 7 and 8).

TABLE 5

WEST VIRGINIA AND VIRGINIA ANDERSON LEVEL II LAND USE/LAND COVER IMPACTS

	IRA						BUILD - LINE A					
	WV		VA		TOTAL		WV		VA		TOTAL	
LAND USE AND COVER TYPE	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
11 - Residential	6.93	17.12	0.00	0.00	6.93	17.12	2.98	7.36	0.00	0.00	2.98	7.36
12 - Commercial	1.13	2.79	0.00	0.00	1.13	2.79	0.00	0.00	0.00	0.00	0.00	0.00
13 - Industrial	1.67	4.13	0.00	0.00	1.67	4.13	0.63	1.56	0.00	0.00	0.63	1.56
14 - Transportation, Communications, Utilities	15.87	39.21	13.43	33.19	29.30	72.40	4.70	11.61	0.94	2.32	5.64	13.94
17 - Other Urban or Built-up Land	0.00	0.00	0.52	1.28	0.52	1.28	0.15	0.37	1.54	3.81	1.69	4.18
21 - Cropland and Pasture	127.38	314.76	7.00	17.30	134.38	332.05	218.09	538.90	17.05	42.13	235.14	581.03
22 - Orchards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	6.99	2.83	6.99
24 - Other Agricultural Land	5.31	13.12	7.28	17.99	12.59	31.11	9.10	22.49	3.06	7.56	12.16	30.05
31 - Herbaceous Rangeland	15.67	38.72	1.64	4.05	17.31	42.77	46.93	115.96	4.25	10.50	51.18	126.47
32 - Shrub and Brush Rangeland	2.88	7.12	0.01	0.02	2.89	7.14	4.44	10.97	0.00	0.00	4.44	10.97
33 - Mixed Rangeland	2.74	6.77	0.50	1.24	3.24	8.01	26.20	64.74	1.03	2.55	27.23	67.29
41 - Deciduous Forest	469.96	1,161.27	35.00	86.49	504.96	1,247.76	994.78	2,458.10	140.82	347.97	1,135.60	2,806.07
42 - Evergreen Forest	5.57	13.76	0.00	0.00	5.57	13.76	18.75	46.33	0.00	0.00	18.75	46.33
43 - Mixed Forest	42.71	105.54	0.00	0.00	42.71	105.54	46.47	114.83	0.00	0.00	46.47	114.83
51 - Streams and Canals	0.20	0.49	0.01	0.02	0.21	0.52	1.30	3.21	0.05	0.12	1.35	3.34
52 - Lakes	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.72	0.00	0.00	0.29	0.72
53 - Reservoirs	0.00	0.00	0.00	0.00	0.00	0.00	1.16	2.87	0.10	0.25	1.26	3.11
61 - Forested Wetlands	1.22	3.01	0.07	0.17	1.29	3.19	0.28	0.69	0.11	0.27	0.39	0.96
62 - Non-forested Wetlands	6.57	16.23	0.40	0.99	6.97	17.22	13.60	33.61	0.12	0.30	13.72	33.90
75 - Strip Mines, Quarries, Gravel Pits	4.36	10.77	0.00	0.00	4.36	10.77	6.38	15.76	0.00	0.00	6.38	15.76
76 - Transitional Areas	2.88	7.12	0.00	0.00	2.88	7.12	18.61	45.99	0.00	0.00	18.61	45.99
TOTAL	***713.05***	***1,761.95***	***65.86***	***162.74***	***778.91***	***1,924.69***	***1,414.84***	***3,496.07***	***171.90***	***424.76***	***1,586.74***	***3,920.83***

TABLE 6
ANDERSON LEVEL II LAND USE/LAND COVER IMPACTS
(HECTARES)

		OPTION AREA COMPARISONS IN WV											
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK	
LAND USE/ LAND COVER	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A
11 - Residential	2.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12 - Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00
13 - Industrial	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14 - Transportation, Communications, Utilities	5.64	0.13	0.83	0.00	0.00	0.00	0.00	0.04	0.02	0.05	0.00	0.02	0.02
16 - Mixed Urban or Built-up Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17 - Other Urban or Built-up Land	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21 - Cropland and Pasture	235.14	3.78	8.88	0.02	0.02	15.73	14.92	15.79	24.14	9.28	0.52	0.00	0.00
22 - Orchards	2.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24 - Other Agricultural Land	12.16	0.00	0.00	0.00	0.01	0.77	0.00	0.00	0.42	0.19	0.00	0.00	0.28
31 - Herbaceous Rangeland	51.18	0.03	0.20	0.33	2.23	3.08	1.28	8.06	9.25	1.66	0.52	0.05	1.50
32 - Shrub and Brush Rangeland	4.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33 - Mixed Rangeland	27.23	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41 - Deciduous Forest	1,135.60	16.10	11.30	50.13	39.83	47.29	34.24	23.51	22.61	33.42	25.75	26.09	27.37
42 - Evergreen Forest	18.75	0.00	0.03	0.00	0.00	1.26	1.22	0.09	0.08	0.00	0.00	0.00	0.00
43 - Mixed Forest	46.47	0.00	0.00	0.00	0.00	0.42	7.83	1.46	1.46	0.00	0.00	0.00	0.00
51 - Streams and Canals	1.35	0.10	0.07	0.00	0.47	0.00	0.00	0.00	0.00	0.11	0.00	0.09	0.12
52 - Lakes	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53 - Reservoirs	1.26	0.00	0.00	0.00	0.00	0.04	0.01	0.02	0.03	0.03	0.03	0.00	0.00
61 - Forested Wetlands	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
62 - Non-forested Wetlands	13.72	0.05	0.11	0.02	0.03	0.99	0.65	1.43	1.28	0.12	0.00	0.00	0.00
75 - Strip Mines, Quarries, Gravel Pits	6.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76 - Transitional Areas	18.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	***1,586.74***	***20.19***	***21.42***	***50.50***	***42.65***	***69.58***	***60.15***	***50.42***	***59.31***	***45.10***	***26.82***	***26.25***	***29.29***
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON			

TABLE 6 (CONTINUED)
ANDERSON LEVEL II LAND USE/LAND COVER IMPACTS
(ACRES)

		OPTION AREA COMPARISONS IN WV											
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK	
LAND USE/ LAND COVER	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A
11 - Residential	7.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12 - Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00
13 - Industrial	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14 - Transportation, Communications, Utilities	13.94	0.32	2.05	0.00	0.00	0.00	0.00	0.10	0.05	0.12	0.00	0.05	0.05
16 - Mixed Urban or Built-up Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17 - Other Urban or Built-up Land	4.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21 - Cropland and Pasture	581.03	9.34	21.94	0.05	0.05	38.87	36.87	39.02	59.65	22.93	1.28	0.00	0.00
22 - Orchards	6.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24 - Other Agricultural Land	30.05	0.00	0.00	0.00	0.02	1.90	0.00	0.00	1.04	0.47	0.00	0.00	0.69
31 - Herbaceous Rangeland	126.47	0.07	0.49	0.82	5.51	7.61	3.16	19.92	22.86	4.10	1.28	0.12	3.71
32 - Shrub and Brush Rangeland	10.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33 - Mixed Rangeland	67.29	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41 - Deciduous Forest	2,806.07	39.78	27.92	123.87	98.42	116.85	84.61	58.09	55.87	82.58	63.63	64.47	67.63
42 - Evergreen Forest	46.33	0.00	0.07	0.00	0.00	3.11	3.01	0.22	0.20	0.00	0.00	0.00	0.00
43 - Mixed Forest	114.83	0.00	0.00	0.00	0.00	1.04	19.35	3.61	3.61	0.00	0.00	0.00	0.00
51 - Streams and Canals	3.34	0.25	0.17	0.00	1.16	0.00	0.00	0.00	0.00	0.27	0.00	0.22	0.30
52 - Lakes	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53 - Reservoirs	3.11	0.00	0.00	0.00	0.00	0.10	0.02	0.05	0.07	0.07	0.07	0.00	0.00
61 - Forested Wetlands	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00
62 - Non-forested Wetlands	33.90	0.12	0.27	0.05	0.07	2.45	1.61	3.53	3.16	0.30	0.00	0.00	0.00
75 - Strip Mines, Quarries, Gravel Pits	15.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76 - Transitional Areas	45.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	***3,920.83***	***49.89***	***52.93***	***124.79***	***105.39***	***171.93***	***148.63***	***124.59***	***146.56***	***111.44***	***66.27***	***64.86***	***72.38***
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON			

TABLE 6 (CONTINUED)
ANDERSON LEVEL II LAND USE/LAND COVER IMPACTS
(HECTARES)

	OPTION AREA COMPARISONS IN VA				
	DUCK RUN			LEBANON CHURCH	
LAND USE/ LAND COVER	Line D1	Line D2	Line A	Line L	Line A
11 - Residential	0.00	0.00	0.00	0.00	0.00
12 - Commercial	0.00	0.00	0.00	0.00	0.00
13 - Industrial	0.00	0.00	0.00	0.00	0.00
14 - Transportation, Communications, Utilities	0.40	0.14	0.14	0.26	1.01
16 - Mixed Urban or Built-up Land	0.00	0.00	0.00	0.00	0.00
17 - Other Urban or Built-up Land	0.00	0.00	0.00	0.00	1.54
21 - Cropland and Pasture	1.32	0.48	0.72	17.18	16.65
22 - Orchards	0.00	0.00	0.00	2.99	2.83
24 - Other Agricultural Land	1.61	0.00	0.00	1.68	1.35
31 - Herbaceous Rangeland	0.00	0.00	0.00	7.31	4.32
32 - Shrub and Brush Rangeland	0.78	0.00	0.00	0.00	0.00
33 - Mixed Rangeland	0.35	0.79	0.79	2.18	0.31
41 - Deciduous Forest	75.15	87.60	81.82	14.37	22.89
42 - Evergreen Forest	0.00	0.00	0.00	1.14	0.00
43 - Mixed Forest	0.00	0.00	0.00	0.00	0.00
51 - Streams and Canals	0.00	0.00	0.00	0.00	0.00
52 - Lakes	0.00	0.00	0.00	0.00	0.00
53 - Reservoirs	0.10	0.00	0.10	0.03	0.00
61 - Forested Wetlands	0.00	0.11	0.11	0.00	0.00
62 - Non-forested Wetlands	0.05	0.00	0.00	0.33	0.11
75 - Strip Mines, Quarries, Gravel Pits	0.00	0.00	0.00	0.00	0.00
76 - Transitional Areas	0.00	0.00	0.00	0.00	0.00
TOTALS	***79.76***	***89.12***	***83.68***	***47.47***	***51.01***
PROJECT WATERSHEDS:	SHENANDOAH				

TABLE 6 (CONTINUED)
ANDERSON LEVEL II LAND USE/LAND COVER IMPACTS
(ACRES)

	OPTION AREA COMPARISONS IN VA				
	DUCK RUN			LEBANON CHURCH	
LAND USE/ LAND COVER	Line D1	Line D2	Line A	Line L	Line A
11 - Residential	0.00	0.00	0.00	0.00	0.00
12 - Commercial	0.00	0.00	0.00	0.00	0.00
13 - Industrial	0.00	0.00	0.00	0.00	0.00
14 - Transportation, Communications, Utilities	0.99	0.35	0.35	0.64	2.50
16 - Mixed Urban or Built-up Land	0.00	0.00	0.00	0.00	0.00
17 - Other Urban or Built-up Land	0.00	0.00	0.00	0.00	3.81
21 - Cropland and Pasture	3.26	1.19	1.78	42.45	41.14
22 - Orchards	0.00	0.00	0.00	7.39	6.99
24 - Other Agricultural Land	3.98	0.00	0.00	4.15	3.34
31 - Herbaceous Rangeland	0.00	0.00	0.00	18.06	10.67
32 - Shrub and Brush Rangeland	1.93	0.00	0.00	0.00	0.00
33 - Mixed Rangeland	0.86	1.95	1.95	5.39	0.77
41 - Deciduous Forest	185.70	216.46	202.18	35.51	56.56
42 - Evergreen Forest	0.00	0.00	0.00	2.82	0.00
43 - Mixed Forest	0.00	0.00	0.00	0.00	0.00
51 - Streams and Canals	0.00	0.00	0.00	0.00	0.00
52 - Lakes	0.00	0.00	0.00	0.00	0.00
53 - Reservoirs	0.25	0.00	0.25	0.07	0.00
61 - Forested Wetlands	0.00	0.27	0.27	0.00	0.00
62 - Non-forested Wetlands	0.12	0.00	0.00	0.82	0.27
75 - Strip Mines, Quarries, Gravel Pits	0.00	0.00	0.00	0.00	0.00
76 - Transitional Areas	0.00	0.00	0.00	0.00	0.00
TOTALS	***197.09***	***220.22***	***206.77***	***117.30***	***126.05***
PROJECT WATERSHED	SHENANDOAH				

TABLE 7
WEST VIRGINIA AND VIRGINIA USFWS COVER TYPE IMPACTS

	IRA						BUILD - LINE A					
	WV		VA		TOTAL		WV		VA		TOTAL	
COVER TYPE	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
AC - Cropland	12.74	31.48	0.70	1.73	13.44	33.21	21.81	53.89	1.71	4.21	(23.51)	58.10
AO - Orchard	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	6.99	(2.83)	6.99
AP - Pasture or Hayland	114.64	283.28	6.30	15.57	120.94	298.85	196.28	485.01	15.35	37.92	(211.63)	522.93
PEM - Palustrine Emergent Wetland	6.00	14.83	0.15	0.37	6.15	15.20	12.41	30.67	0.12	0.30	(12.53)	30.96
PFO - Palustrine Forested Wetland	1.22	3.01	0.07	0.17	1.29	3.19	0.28	0.69	0.11	0.27	(0.39)	0.96
PSS - Palustrine Scrub/Shrub Wetland	0.57	1.41	0.25	0.62	0.82	2.03	1.19	2.94	0.00	0.00	(1.19)	2.94
UF - Forbland	3.92	9.68	0.41	1.01	4.33	10.69	11.73	28.99	1.06	2.63	(12.80)	31.62
UFOD - Deciduous Forest	512.67	1,266.81	35.00	86.49	547.67	1,353.29	1,041.25	2,572.93	140.82	347.97	(1,182.07)	2,920.89
UFOE - Evergreen Forest	5.57	13.76	0.00	0.00	5.57	13.76	18.75	46.33	0.00	0.00	(18.75)	46.33
UG - Grassland	11.75	29.04	1.23	3.04	12.98	32.08	35.20	86.97	3.19	7.88	(38.39)	94.85
USHD - Deciduous Shrubland	5.62	13.89	0.51	1.26	6.13	15.15	30.64	75.71	1.03	2.55	(31.67)	78.26
TOTALS	***674.70***	***1,667.18***	***44.62***	***110.26***	***719.32***	***1,777.44***	***1,369.54***	***3,384.13***	***166.21***	***410.70***	***(1,535.75)***	***3,794.84***

TABLE 8
U.S. FISH & WILDLIFE SERVICE COVER TYPE IMPACTS
(HECTARES)

		OPTION AREA COMPARISONS IN WV											
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK	
COVER TYPE	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A
AC - Cropland	23.51	0.38	0.89	0.00	0.00	1.57	1.49	1.58	2.41	0.93	0.05	0.00	0.00
AO - Orchard	2.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AP - Pasture or Hayland	211.63	3.40	7.99	0.02	0.02	14.16	13.43	14.21	21.73	8.35	0.47	0.00	0.00
PEM - Palustrine Emergent Wetland	12.49	0.03	0.11	0.02	0.02	0.99	0.78	1.43	1.28	0.00	0.12	0.00	0.00
PFO - Palustrine Forested Wetland	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
PSS - Palustrine Scrub/Shrub Wetland	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UF - Forbland	12.80	0.01	0.05	0.08	0.56	0.77	0.32	2.02	2.31	0.42	0.13	0.01	0.38
UFOD - Deciduous Forest	1,182.07	16.10	11.30	50.13	39.83	47.71	42.07	24.97	24.07	33.42	25.75	26.09	27.37
UFOE - Evergreen Forest	18.75	0.00	0.03	0.00	0.00	1.26	1.22	0.09	0.08	0.00	0.00	0.00	0.00
UG - Grassland	38.39	0.02	0.15	0.25	1.67	2.31	0.96	6.05	6.94	1.25	0.39	0.04	1.13
USHD - Deciduous Shrubland	31.67	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	*1,535.91*	*19.94*	*20.52*	*50.50*	*42.16*	*68.77*	*60.27*	*50.36*	*58.84*	*44.36*	*26.91*	*26.14*	*28.87*
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON			

	OPTION AREA COMPARISONS IN VA				
	DUCK RUN			LEBANON CHURCH	
COVER TYPE	Line D1	Line D2	Line A	Line L	Line A
AC - Cropland	0.13	0.05	0.07	1.72	1.67
AO - Orchard	0.00	0.00	0.00	2.99	2.83
AP - Pasture or Hayland	1.19	0.43	0.65	15.46	14.99
PEM - Palustrine Emergent Wetland	0.00	0.00	0.00	0.32	0.11
PFO - Palustrine Forested Wetland	0.15	0.11	0.11	0.00	0.00
PSS - Palustrine Scrub/Shrub Wetland	0.00	0.00	0.00	0.00	0.00
UF - Forbland	0.00	0.00	0.00	1.83	1.08
UFOD - Deciduous Forest	75.15	87.60	81.82	14.37	22.89
UFOE - Evergreen Forest	0.00	0.00	0.00	1.14	0.00
UG - Grassland	0.00	0.00	0.00	5.48	3.24
USHD - Deciduous Shrubland	1.13	0.79	0.79	2.18	0.31
TOTAL	*77.75*	*88.98*	*83.44*	*45.49*	*47.11*
PROJECT WATERSHEDS:	SHENANDOAH				

TABLE 8 (CONTINUED)
U.S. FISH & WILDLIFE SERVICE COVER TYPE IMPACTS
(ACRES)

		OPTION AREA COMPARISONS IN WV											
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK	
COVER TYPE	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A
AC - Cropland	58.10	0.93	2.19	0.00	0.00	3.89	3.69	3.90	5.96	2.29	0.13	0.00	0.00
AO - Orchard	6.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AP - Pasture or Hayland	522.93	8.41	19.75	0.04	0.04	34.98	33.18	35.12	53.68	20.64	1.16	0.00	0.00
PEM - Palustrine Emergent Wetland	30.86	0.07	0.27	0.05	0.05	2.45	1.93	3.53	3.16	0.00	0.30	0.00	0.00
PFO - Palustrine Forested Wetland	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00
PSS - Palustrine Scrub/Shrub Wetland	3.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UF - Forbland	31.62	0.02	0.12	0.20	1.38	1.90	0.79	4.98	5.71	1.03	0.32	0.03	0.93
UFOD - Deciduous Forest	2,920.89	39.78	27.92	123.87	98.42	117.89	103.95	61.70	59.48	82.58	63.63	64.47	67.63
UFOE - Evergreen Forest	46.33	0.00	0.07	0.00	0.00	3.11	3.01	0.22	0.20	0.00	0.00	0.00	0.00
UG - Grassland	94.85	0.06	0.37	0.61	4.13	5.71	2.37	14.94	17.14	3.08	0.96	0.09	2.78
USHD - Deciduous Shrubland	78.26	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	***3,795.23***	***49.27***	***50.70***	***124.79***	***104.18***	***169.93***	***148.93***	***124.44***	***145.39***	***109.61***	***66.49***	***64.59***	***71.34***
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON			

	OPTION AREA COMPARISONS IN VA				
	DUCK RUN			LEBANON CHURCH	
COVER TYPE	Line D1	Line D2	Line A	Line L	Line A
AC - Cropland	0.33	0.12	0.18	4.25	4.11
AO - Orchard	0.00	0.00	0.00	7.39	6.99
AP - Pasture or Hayland	2.94	1.07	1.60	38.21	37.03
PEM - Palustrine Emergent Wetland	0.00	0.00	0.00	0.79	0.27
PFO - Palustrine Forested Wetland	0.37	0.27	0.27	0.00	0.00
PSS - Palustrine Scrub/Shrub Wetland	0.00	0.00	0.00	0.00	0.00
UF - Forbland	0.00	0.00	0.00	4.52	2.67
UFOD - Deciduous Forest	185.70	216.46	202.18	35.51	56.56
UFOE - Evergreen Forest	0.00	0.00	0.00	2.82	0.00
UG - Grassland	0.00	0.00	0.00	13.55	8.01
USHD - Deciduous Shrubland	2.79	1.95	1.95	5.39	0.77
TOTAL	***192.12***	***219.87***	***206.18***	***112.41***	***116.41***
PROJECT WATERSHEDS:	SHENANDOAH				

Baseline habitat suitability indices (HSI's) were determined for each evaluation species for the Improved Roadway Alternative (IRA) and Line A (Table 9). These values represent the habitat suitability for the evaluation species prior to project construction. The HSI values are an estimate of the habitat quality found within the proposed alignments for each evaluation species. The majority of the evaluation species produced HSI's that were commensurate with the expected value of the existing available habitat. HSI values varied little between the two alternatives indicating that similar proportions of individual cover types occur within the impact areas. HSI values ranged from highs of 1.0 and 0.97 for the black-capped chickadee and white-tailed deer respectively, to a lows of 0.00 for the ruffed grouse. The pine warbler and red-winged blackbird also received low HSI values (0.01). The high HSI values were attributed to the adaptable nature of the above two species, the available cover types and their ability to coexist with man. The ruffed grouse did not produce an HSI value for the IRA or the Build Alternative. Further analyses of the documented model for this species (Cade and Sousa 1985) revealed that optimum habitat for ruffed grouse is provided by the interspersion of several forest age classes. In addition, stem density and the presence of mature aspen trees are also important habitat components of the model. The habitat types sampled within the project area do not provide these specific habitat components in the quantities necessary to yield a measurable HSI value as defined by the documented model. Hall (1983) reported that much of the forest in West Virginia has matured beyond the state that provides optimum grouse habitat, and it is probable that grouse populations are less than they were in the past. The greatest difference in HSI values was observed for the mink and veery. These species utilize both palustrine forested and palustrine scrub/shrub wetlands. The observed differences in HSI values are the result of differing proportions of these two wetland cover types within the alternatives.

Baseline habitat units (HUs) were calculated by multiplying the HSI values by the area of each cover type used by the evaluation species within the construction limits of each alignment (Tables 9 and 10). For example, in the HSI model for the black-capped chickadee, this species utilizes deciduous forests, palustrine forested wetlands and coniferous forests. The areas of these cover types were added together and multiplied by the species HSI value to produce HUs. These numbers represent the wildlife habitat value within each alignment prior to project construction. As stated previously, the evaluation species were chosen to represent larger groups, or guilds of species that utilize similar habitat components within the different cover types. As such, any potential habitat value calculated for a particular evaluation species would be representative of the habitat value to the entire guild. For example, the brown thrasher (*Toxostoma rufum*), represents other bird species that utilize shrubby edge habitat such as catbirds (*Dumetella carolinensis*), rufous-sided towhees (*Pipilo erythrophthalmus*), indigo buntings (*Passerina cyanea*), and northern cardinals (*Cardinalis cardinalis*).

TABLE 9
BASELINE HSI VALUES BY ALTERNATIVE

EVALUATION SPECIES	ALTERNATIVES	
	IRA	BUILD
American Woodcock	0.60	0.60
Barred Owl	0.69	0.66
Black-capped Chickadee	1.00	1.00
Brown Thrasher	0.12	0.13
Downy Woodpecker	0.50	0.50
Eastern Cottontail	0.74	0.74
Eastern Meadowlark	0.46	0.49
Eastern Wild Turkey	0.59	0.55
Gray Squirrel	0.52	0.52
Hairy Woodpecker	0.74	0.73
Mink	0.46	0.69
Muskrat	0.18	0.21
Pileated Woodpecker	0.38	0.38
Pine Warbler	0.01	0.01
Red-winged Blackbird	0.01	0.01
Ruffed Grouse	0.00	0.00
Veery	0.28	0.41
White-tailed Deer	0.97	0.97
Yellow Warbler	0.38	0.33

Of the alternatives, the Improved Roadway Alternative (IRA) generated a total of 4,246 HUs, 3,979 in West Virginia and 267 in Virginia while Line A produced a total of 9,041 HUs, 8,018 HUs within West Virginia and 1,023 HUs in Virginia (Table 10). The amount of wildlife habitat currently along the IRA is less than that along Line A for several reasons. First, a large portion of the IRA follows existing roads (minimal wildlife habitat). Second, areas adjacent to the existing roads where the IRA would be constructed are somewhat developed, thereby providing less productive wildlife habitat. Third, the area to be occupied by the IRA (predominantly two lanes) would be less than the area to be occupied by Line A (four lanes). Species that utilized deciduous forest habitat (black-capped chickadee, barred owl, woodpeckers) and generalist species (white-tailed deer, cottontail rabbit) produced the most HUs. A comparison of the various option area alignments to Line A revealed the greatest differences within the Baker and Duck Run Option Areas. Line B would generate an additional 79 HUs within the Baker Option Area, while Line D1 would yield 42 fewer HUs within the Duck Run Option Area (Table 11).

2. IMPACTS

Wildlife habitat within the construction limits of each alignment would be altered due to highway construction. As stated previously, the HEP process assumes that during and immediately following highway construction, no meaningful wildlife habitat would exist within the construction limits. The area component of potential wildlife habitat is assigned a "0" for all cover types. When a "0" is multiplied by any HSI value, all HUs become "0". Therefore, it is assumed that during this time no habitat units or potential wildlife habitat is available within the construction limits of each alternative.

For this analysis, future habitat conditions within the construction limits of each alignment alternative were predicted 5 years after the completion of the project. It was assumed that the roadway had consistent pavement, median, and shoulder dimensions within each state. With the exception of the shoulders and pavement, the existing vegetative habitat would primarily be replaced with plantings designed for bank stabilization for erosion and sediment control purposes. Using West Virginia DOT right-of-way and roadside development guidelines, habitat variable values were estimated to allow the development of a habitat suitability index for this "new" habitat. The general land cover type associated with these plantings is the USFWS's grassland habitat. At this time it is assumed that this habitat will be composed of 70% grassland, 10% shrub cover and 5% tree cover. The individual habitat variable values were estimated for the grassland habitat 5 years after construction and using these values (Table 12), future habitat suitability indices (HSI's) were determined for each evaluation species for each alternative (Table 13). Future habitat units (HUs) for each evaluation species were then calculated (Tables 14 and 15).

TABLE 10
ALTERNATIVE COMPARISON OF BASELINE HABITAT UNITS (HUs)
BY EVALUATION SPECIES

	IRA						BUILD - LINE A					
	WV		VA		TOTAL		WV		VA		TOTAL	
EVALUATION SPECIES	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
American Woodcock	311.68	770.15	21.04	51.99	332.72	822.15	630.87	1,558.87	83.85	207.20	714.72	1,766.07
Barred Owl	358.43	885.67	24.20	59.79	382.63	945.47	704.03	1,739.65	93.58	231.23	797.60	1,970.88
Black-capped Chickadee	519.46	1,283.59	35.07	86.66	554.53	1,370.24	1,058.16	2,614.71	140.65	347.54	1,198.81	2,962.25
Brown Thrasher	78.50	193.98	5.21	12.88	83.71	206.86	169.40	418.59	20.86	51.55	190.26	470.14
Downy Woodpecker	259.73	641.79	17.54	43.33	277.27	685.12	530.14	1,309.98	70.47	174.12	600.61	1,484.09
Eastern Cottontail	484.09	1,196.18	32.15	79.45	516.24	1,275.63	989.72	2,445.59	121.89	301.20	1,111.61	2,746.79
Eastern Meadowlark	59.94	148.12	3.65	9.03	63.60	157.15	118.20	292.07	9.52	23.53	127.72	315.61
Eastern Wild Turkey	394.20	974.06	26.09	64.47	420.29	1,038.53	747.12	1,846.14	89.96	222.28	837.08	2,068.42
Gray Squirrel	267.22	660.31	18.24	45.06	285.46	705.37	541.60	1,338.28	73.28	181.08	614.88	1,519.37
Hairy Woodpecker	384.40	949.85	25.95	64.13	410.35	1,013.98	775.06	1,915.18	103.02	254.56	878.08	2,169.75
Mink	0.82	2.03	0.15	0.36	0.97	2.40	1.01	2.50	0.08	0.19	1.09	2.69
Muskrat	1.18	2.92	0.07	0.18	1.25	3.10	2.88	7.12	0.03	0.06	2.91	7.19
Pileated Woodpecker	197.39	487.76	13.33	32.93	210.72	520.69	400.79	990.34	53.27	131.63	454.06	1,121.98
Pine Warbler	5.18	12.81	0.35	0.86	5.53	13.67	9.54	23.57	1.27	3.13	10.81	26.71
Red-winged Blackbird	0.06	0.15	0.00	0.00	0.06	0.15	0.11	0.28	0.01	0.02	0.12	0.30
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.50	1.24	0.09	0.22	0.59	1.46	0.60	1.47	0.04	0.11	0.64	1.59
White-tailed Deer	654.46	1,617.17	43.28	106.95	697.74	1,724.12	1,328.45	3,282.61	161.22	398.38	1,489.68	3,680.99
Yellow Warbler	2.35	5.81	0.29	0.71	2.64	6.53	10.41	25.72	0.34	0.83	10.75	26.55
TOTALS	***3,979.60***	***9,833.59***	***266.70***	***659.02***	***4,246.30***	***10,492.61***	***8,018.08***	***(19,812.68)***	***1,023.34***	***(2,528.67)***	***9,041.42***	***22,341.35***

TABLE 11
OPTION AREA COMPARISON OF BASELINE HABITAT UNITS (HUs) BY EVALUATION SPECIES

		OPTION AREA COMPARISONS IN WV												OPTION AREA COMPARISONS IN VA				
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK		DUCK RUN			LEBANON CHURCH	
EVALUATION SPECIES	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A	Line D1	Line D2	Line A	Line L	Line A
American Woodcock	714.72	9.58	6.74	29.83	23.70	29.14	25.76	14.92	14.38	19.88	15.32	15.52	16.29	44.80	52.19	48.75	9.23	13.62
Barred Owl	797.60	10.69	7.52	33.29	26.45	32.52	28.74	16.65	16.05	22.19	17.10	17.32	18.17	50.00	58.24	54.40	10.30	15.20
Black-capped Chickadee	1,198.81	16.07	11.31	50.03	39.75	48.87	43.20	25.03	24.12	33.35	25.70	26.04	27.32	75.15	87.53	81.77	15.48	22.84
Brown Thrasher	190.26	2.48	2.48	6.41	5.35	8.41	7.37	6.01	7.00	5.52	3.40	3.32	3.67	9.84	11.28	10.57	5.52	5.76
Downy Woodpecker	600.61	8.05	5.67	25.07	19.92	24.49	21.65	12.54	12.09	16.71	12.88	13.05	13.69	37.65	43.86	40.97	7.76	11.45
Eastern Cottontail	1,111.61	14.49	14.49	37.45	31.27	49.13	43.03	35.12	40.90	32.23	19.84	19.40	21.42	57.48	65.91	61.78	32.24	33.64
Eastern Meadowlark	127.72	1.67	3.98	0.17	1.09	8.38	7.15	10.82	15.05	4.87	0.48	0.02	0.73	0.58	0.21	0.31	11.07	9.38
Eastern Wild Turkey	837.08	10.97	11.25	27.81	23.22	37.35	32.78	26.96	31.72	24.44	14.76	14.40	15.91	42.84	49.03	45.98	23.24	24.34
Gray Squirrel	614.88	8.37	5.88	26.07	20.71	24.81	21.88	12.99	12.53	17.38	13.39	13.57	14.23	39.16	45.61	42.60	7.47	11.90
Hairy Woodpecker	878.08	11.77	8.28	36.65	29.12	35.80	31.64	18.33	17.67	24.43	18.82	19.07	20.01	55.04	64.12	59.89	11.34	16.73
Mink	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.10	0.08	0.08	0.00	0.00
Muskrat	2.91	0.01	0.02	0.00	0.00	0.21	0.17	0.30	0.27	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.07	0.02
Pileated Woodpecker	454.06	6.09	4.28	18.95	15.06	18.51	16.36	9.48	9.14	12.63	9.73	9.86	10.35	28.46	33.15	30.97	5.86	8.65
Pine Warbler	10.81	0.14	0.10	0.45	0.36	0.44	0.39	0.23	0.22	0.30	0.23	0.23	0.25	0.68	0.79	0.74	0.14	0.21
Red-winged Blackbird	0.11	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.04	0.04	0.00	0.00
White-tailed Deer	1,489.68	19.34	19.90	48.99	40.90	66.71	58.46	48.85	57.07	43.03	26.10	25.36	28.00	75.42	86.31	80.94	44.13	45.70
Yellow Warbler	10.75	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.26	0.26	0.71	0.10
TOTALS	***9,041.41***	***119.72***	***101.90***	***341.16***	***276.90***	***384.75***	***338.59***	***238.28***	***258.24***	***256.96***	***177.78***	***177.16***	***190.02***	***517.63***	***598.60***	***560.04***	***184.55***	***219.54***
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON				SHENANDOAH				

TABLE 12
PREDICTED FUTURE GRASSLAND
HABITAT VARIABLE VALUES

HEP HABITAT VARIABLES	PREDICTED VALUE
Mean distance to forest cover type (m)	50
Mean distance to a perch site (m)	50
% canopy cover of herbs	70
% canopy cover of persistent herbs	30
% of ground surface bare or with litter < 5cm deep	90
% of ground surface covered by litter > 1 cm deep	75
% canopy cover of shrubs	10
% canopy cover of trees	5
Density of woody stems >1 m tall (#/ha)	10
Mean height of herbaceous canopy (cm)	25
Mean ht. of herbaceous canopy during spring (cm)	15
% of herbaceous canopy cover that is grasses	70
Average dry matter yield of suitable forage (0-8)	3
# stems/ha of mast spp. fall-winter	0
Diversity Index (0-2)	0.5

TABLE 13
PREDICTED FUTURE HSI VALUES

EVALUATION SPECIES	BUILD AND IRA FUTURE HSI VALUES
American Woodcock	0.00
Barred Owl	0.00
Black-capped Chickadee	0.00
Brown Thrasher	0.05
Downy Woodpecker	0.00
Eastern Cottontail	0.62
Eastern Meadowlark	0.44
Eastern Wild Turkey	0.00
Gray Squirrel	0.00
Hairy Woodpecker	0.00
Mink	0.00
Muskrat	0.00
Pileated Woodpecker	0.00
Pine Warbler	0.00
Red-winged Blackbird	0.00
Ruffed Grouse	0.00
Veery	0.00
White-tailed Deer	0.50
Yellow Warbler	0.00

TABLE 14
ALTERNATIVE COMPARISON OF PREDICTED FUTURE HABITAT UNITS (HUs)
BY EVALUATION SPECIES

	IRA						BUILD - LINE A					
	WV		VA		TOTAL		WV		VA		TOTAL	
EVALUATION SPECIES	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
American Woodcock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barred Owl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black-capped Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brown Thrasher	29.35	72.52	3.20	7.91	32.55	80.43	52.80	130.47	6.10	15.07	58.90	145.54
Downy Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eastern Cottontail	363.94	899.30	39.68	98.05	403.62	997.35	654.72	1,617.81	75.64	186.91	730.36	1,804.72
Eastern Meadowlark	258.28	638.21	28.16	69.58	286.44	707.79	464.64	1,148.13	53.68	132.64	518.32	1,280.77
Eastern Wild Turkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gray Squirrel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mink	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Muskrat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White-tailed Deer	293.50	725.24	32.00	79.07	325.50	804.31	528.00	1,304.69	61.00	150.73	589.00	1,455.42
Yellow Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	***945.07***	***2,335.27***	***103.04***	***254.61***	***1,048.11***	***2,589.88***	***1,700.16***	***4,201.10***	***196.42***	***485.35***	***1,896.58***	***4,686.45***

TABLE 15
OPTION AREA COMPARISON OF FUTURE HABITAT UNITS (HUs)
BY EVALUATION SPECIES

		OPTION AREA COMPARISONS IN WV											
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK	
EVALUATION SPECIES	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A
American Woodcock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barred Owl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black-capped Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brown Thrasher	58.90	0.91	0.96	2.17	1.78	2.90	2.48	2.09	2.60	1.83	0.90	1.14	1.26
Downy Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eastern Cottontail	730.36	11.22	11.90	26.85	22.07	35.96	30.69	25.85	32.18	22.63	11.16	14.14	15.62
Eastern Meadowlark	518.32	7.96	8.45	15.66	19.05	25.52	21.78	18.35	22.84	16.06	7.92	10.03	11.09
Eastern Wild Turkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gray Squirrel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mink	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Muskrat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White-tailed Deer	589.00	9.05	9.60	17.80	21.65	29.00	24.75	20.85	25.95	18.25	9.00	11.40	12.60
Yellow Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	***1,896.58***	***29.14***	***30.91***	***62.48***	***64.55***	***93.38***	***79.70***	***67.14***	***83.56***	***58.77***	***28.98***	***36.71***	***40.57***
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON			

TABLE 15 (CONTINUED)
OPTION AREA COMPARISON OF FUTURE HABITAT UNITS (HUs)
BY EVALUATION SPECIES

	OPTION AREA COMPARISONS IN VA				
	DUCK RUN			LEBANON CHURCH	
EVALUATION SPECIES	Line D1	Line D2	Line A	Line L	Line A
American Woodcock	0.00	0.00	0.00	0.00	0.00
Barred Owl	0.00	0.00	0.00	0.00	0.00
Black-capped Chickadee	0.00	0.00		0.00	
Brown Thrasher	3.23	3.67	3.45	1.62	1.70
Downy Woodpecker	0.00	0.00	0.00	0.00	0.00
Eastern Cottontail	39.99	45.45	42.78	20.09	21.08
Eastern Meadowlark	28.38	32.25	30.36	14.26	14.96
Eastern Wild Turkey	0.00	0.00	0.00	0.00	0.00
Gray Squirrel	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker	0.00	0.00	0.00	0.00	0.00
Mink	0.00	0.00	0.00	0.00	0.00
Muskrat	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker	0.00	0.00	0.00	0.00	0.00
Pine Warbler	0.00	0.00	0.00	0.00	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00
Veery	0.00	0.00	0.00	0.00	0.00
White-tailed Deer	32.25	36.65	34.50	16.20	17.00
Yellow Warbler	0.00	0.00	0.00	0.00	0.00
TOTALS	***103.85***	***118.01***	***111.09***	***52.16***	***54.74***
PROJECT WATERSHEDS:	SHENANDOAH				

These numbers represent the estimated wildlife habitat value within each alignment 5 years after project construction. Only evaluation species that utilize grassland habitat produced future habitat units. Species such as the eastern cottontail, meadowlark, and white-tailed deer are able to utilize these planted areas, while species dependent on forest habitats (black-capped chickadee, woodpeckers) produced no future habitat units. Of the alternatives, the IRA generated a total of 1,048 HUs, 945 in West Virginia and 103 in Virginia. Line A produced a total of 1,896 future HUs, 1,700 HUs in West Virginia and 196 HUs in Virginia (Table 14). A comparison of the predicted future HUs within the various option areas revealed the greatest differences within the Baker and Forman Areas. Line B would generate an additional 30 HUs compared to Line A within the Baker Option Area, while Line F would yield 17 fewer HUs than Line A within the Forman Option Area (Table 15).

Table 16 presents the net gain/loss in habitat units by alternative within each state for each evaluation species. Each alternative would result in a projected net loss of HUs. As expected, species that utilize deciduous forest (the largest impacted cover type) would lose the greatest number of HUs. Again, HUs are a prediction of the wildlife habitat value and are the product of a species HSI value and the total amount of available habitat. Species that produced low baseline HSI values (red-winged blackbird, pine warbler, ruffed grouse) or species that had limited amounts of available habitat (mink, muskrat, veery) subsequently produced and would potentially lose few HUs. Line A would result in a total net loss of 7,145 HUs, 6,318 in West Virginia and 827 in Virginia. The IRA would lose a total of 3,199 HUs, 3,035 in West Virginia and 164 in Virginia. Table 17 presents the net gain/loss in habitat units within each of the proposed option areas. A comparison of the various option areas to Line A revealed the greatest differences within the Shavers Fork and Baker Option Areas. Compared to Line A, Line S would result in a predicted net loss of 66 additional HUs within the Shavers Fork Option Area and Line B would result in an additional loss of 49 HUs within the Baker Option Area. Within the Duck Run Option Area, Line D2 would result in an additional loss of 67 HUs compared to Line D1, and an additional loss of 32 HUs compared with Line A.

The projected loss of habitat units for each alignment is based on the assumption that all wildlife habitat within the construction limits would be altered due to highway construction. Final design for the highway may not necessarily impact this entire area. Bifurcations in the roadway may leave portions of existing habitat intact, thereby reducing the net loss of wildlife habitat units. The proposed alignments also cross several areas of abandoned strip mines along WV 93 east of Davis, West Virginia. Theses areas are sparsely vegetated and presently provide little wildlife habitat. Right of way development, in conjunction with highway construction within these stripped sites, could provide additional habitat for wildlife utilization.

TABLE 16
ALTERNATIVE COMPARISON OF NET GAIN/(LOSS) OF HABITAT UNITS (HUs)
BY EVALUATION SPECIES

	IRA						BUILD - LINE A					
	WV		VA		TOTALS		WV		VA		TOTALS	
EVALUATION SPECIES	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
American Woodcock	(311.68)	(770.15)	(21.04)	(51.99)	(332.72)	(822.15)	(630.87)	(1,558.87)	(83.85)	(207.20)	(714.72)	(1,766.07)
Barred Owl	(358.43)	(885.67)	(24.20)	(59.79)	(382.63)	(945.47)	(704.03)	(1,739.65)	(93.58)	(231.23)	(797.60)	(1,970.88)
Black-capped Chickadee	(519.46)	(1,283.59)	(35.07)	(86.66)	(554.53)	(1,370.24)	(1,058.16)	(2,614.71)	(140.65)	(347.54)	(1,198.81)	(2,962.25)
Brown Thrasher	(49.15)	(121.45)	(2.01)	(4.98)	(51.16)	(126.43)	(116.60)	(288.12)	(14.76)	(36.48)	(131.36)	(324.60)
Downy Woodpecker	(259.73)	(641.79)	(17.54)	(43.33)	(277.27)	(685.12)	(530.14)	(1,309.98)	(70.47)	(174.12)	(600.61)	(1,484.09)
Eastern Cottontail	(120.15)	(296.88)	-(7.53)	-(18.60)	(112.62)	(278.28)	(335.00)	(827.78)	(46.25)	(114.29)	(381.25)	(942.07)
Eastern Meadowlark	198.34	490.09	24.51	60.56	222.84	550.65	346.44	856.05	44.16	109.11	390.60	965.16
Eastern Wild Turkey	(394.20)	(974.06)	(26.09)	(64.47)	(420.29)	(1,038.53)	(747.12)	(1,846.14)	(89.96)	(222.28)	(837.08)	(2,068.42)
Gray Squirrel	(267.22)	(660.31)	(18.24)	(45.06)	(285.46)	(705.37)	(541.60)	(1,338.28)	(73.28)	(181.08)	(614.88)	(1,519.37)
Hairy Woodpecker	(384.40)	(949.85)	(25.95)	(64.13)	(410.35)	(1,013.98)	(775.06)	(1,915.18)	(103.02)	(254.56)	(878.08)	(2,169.75)
Mink	(0.82)	(2.03)	(0.15)	(0.36)	(0.97)	(2.40)	(1.01)	(2.50)	(0.08)	(0.19)	(1.09)	(2.69)
Muskrat	(1.18)	(2.92)	(0.07)	(0.18)	(1.25)	(3.10)	(2.88)	(7.12)	(0.03)	(0.06)	(2.91)	(7.19)
Pileated Woodpecker	(197.39)	(487.76)	(13.33)	(32.93)	(210.72)	(520.69)	(400.79)	(990.34)	(53.27)	(131.63)	(454.06)	(1,121.98)
Pine Warbler	(5.18)	(12.81)	(0.35)	(0.86)	(5.53)	(13.67)	(9.54)	(23.57)	(1.27)	(3.13)	(10.81)	(26.71)
Red-winged Blackbird	(0.06)	(0.15)	0.00	0.00	(0.06)	(0.15)	(0.11)	(0.28)	(0.01)	(0.02)	(0.12)	(0.30)
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	(0.50)	(1.24)	(0.09)	(0.22)	(0.59)	(1.46)	(0.60)	(1.47)	(0.04)	(0.11)	(0.64)	(1.59)
White-tailed Deer	(360.96)	(891.93)	(11.73)	(28.98)	(372.69)	(920.91)	(800.45)	(1,977.92)	(100.22)	(247.65)	(900.68)	(2,225.57)
Yellow Warbler	(2.35)	(5.81)	(0.29)	(0.71)	(2.64)	(6.53)	(10.41)	(25.72)	(0.34)	(0.83)	(10.75)	(26.55)
TOTALS	***(3,034.53)***	***(7,498.32)***	***(164.11)***	***(405.51)***	***(3,198.64)***	***(7,903.84)***	***(6,317.92)***	***(15,611.59)***	***(826.92)***	***(2,043.31)***	***(7,144.84)***	***(17,654.90)***

TABLE 17
OPTION AREA COMPARISON OF NET GAIN/(LOSS) OF HABITAT UNITS (HUs)
BY EVALUATION SPECIES

		OPTION AREA COMPARISONS IN WV											
		INTERCHANGE		SHAVERS FORK		PATTERSON CREEK		FORMAN		BAKER		HANGING ROCK	
EVALUATION SPECIES	Line A	Line I	Line A	Line S	Line A	Line P	Line A	Line F	Line A	Line B	Line A	Line R	Line A
American Woodcock	(714.72)	(9.58)	(6.74)	(29.83)	(23.70)	(29.14)	(25.76)	(14.92)	(14.38)	(19.88)	(15.32)	(15.52)	(16.29)
Barred Owl	(797.60)	(10.69)	(7.52)	(33.29)	(26.45)	(32.52)	(28.74)	(16.65)	(16.05)	(22.19)	(17.10)	(17.32)	(18.17)
Black-capped Chickadee	(1,198.81)	(16.07)	(11.31)	(50.03)	(39.75)	(48.87)	(43.20)	(25.03)	(24.12)	(33.35)	(25.70)	(26.04)	(27.32)
Brown Thrasher	(131.36)	(1.58)	(1.52)	(4.25)	(3.57)	(5.51)	(4.89)	(3.93)	(4.41)	(3.69)	(2.50)	(2.18)	(2.41)
Downy Woodpecker	(600.61)	(8.05)	(5.67)	(25.07)	(19.92)	(24.49)	(21.65)	(12.54)	(12.09)	(16.71)	(12.88)	(13.05)	(13.69)
Eastern Cottontail	(381.25)	(3.27)	(2.58)	(10.61)	(9.19)	(13.17)	(12.34)	(9.27)	(8.73)	(9.60)	(8.68)	(5.26)	(5.80)
Eastern Meadowlark	(390.60)	6.30	4.47	15.49	17.96	17.14	14.63	7.52	7.78	11.19	7.44	10.01	10.36
Eastern Wild Turkey	(837.08)	(10.97)	(11.25)	(27.81)	(23.22)	(37.35)	(32.78)	(26.96)	(31.72)	(24.44)	(14.76)	(14.40)	(15.91)
Gray Squirrel	(614.88)	(8.37)	(5.88)	(26.07)	(20.71)	(24.81)	(21.88)	(12.99)	(12.53)	(17.38)	(13.39)	(13.57)	(14.23)
Hairy Woodpecker	(878.08)	(11.77)	(8.28)	(36.65)	(29.12)	(35.80)	(31.64)	(18.33)	(17.67)	(24.43)	(18.82)	(19.07)	(20.01)
Mink	(1.09)	0.00	0.00	0.00	0.00	0.00	0.00	(0.01)	(0.01)	0.00	0.00	0.00	0.00
Muskrat	(2.91)	(0.01)	(0.02)	0.00	0.00	(0.21)	(0.17)	(0.30)	(0.27)	0.00	(0.03)	0.00	0.00
Pileated Woodpecker	(454.06)	(6.09)	(4.28)	(18.95)	(15.06)	(18.51)	(16.36)	(9.48)	(9.14)	(12.63)	(9.73)	(9.86)	(10.35)
Pine Warbler	(10.81)	(0.14)	(0.10)	(0.45)	(0.36)	(0.44)	(0.39)	(0.23)	(0.22)	(0.30)	(0.23)	(0.23)	(0.25)
Red-winged Blackbird	(0.11)	0.00	0.00	0.00	0.00	(0.01)	(0.01)	(0.01)	(0.01)	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	(0.64)	0.00	0.00	0.00	0.00	0.00	0.00	(0.01)	(0.01)	0.00	0.00	0.00	0.00
White-tailed Deer	(900.68)	(10.29)	(10.30)	(31.19)	(19.25)	(37.71)	(33.71)	(28.00)	(31.12)	(24.78)	(17.10)	(13.96)	(15.40)
Yellow Warbler	(10.75)	0.00	0.00	0.00	(0.02)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	***(7,144.83)***	***(90.58)***	***(70.99)***	***(278.68)***	***(212.35)***	***(291.37)***	***(258.89)***	***(171.14)***	***(174.68)***	***(198.20)***	***(148.80)***	***(140.46)***	***(149.45)***
PROJECT WATERSHEDS:		TYGART VALLEY		CHEAT		N. BRANCH POTOMAC				CACAPON			

TABLE 17 (CONTINUED)
OPTION AREA COMPARISON OF NET GAIN/(LOSS) OF HABITAT UNITS (HUs)
BY EVALUATION SPECIES

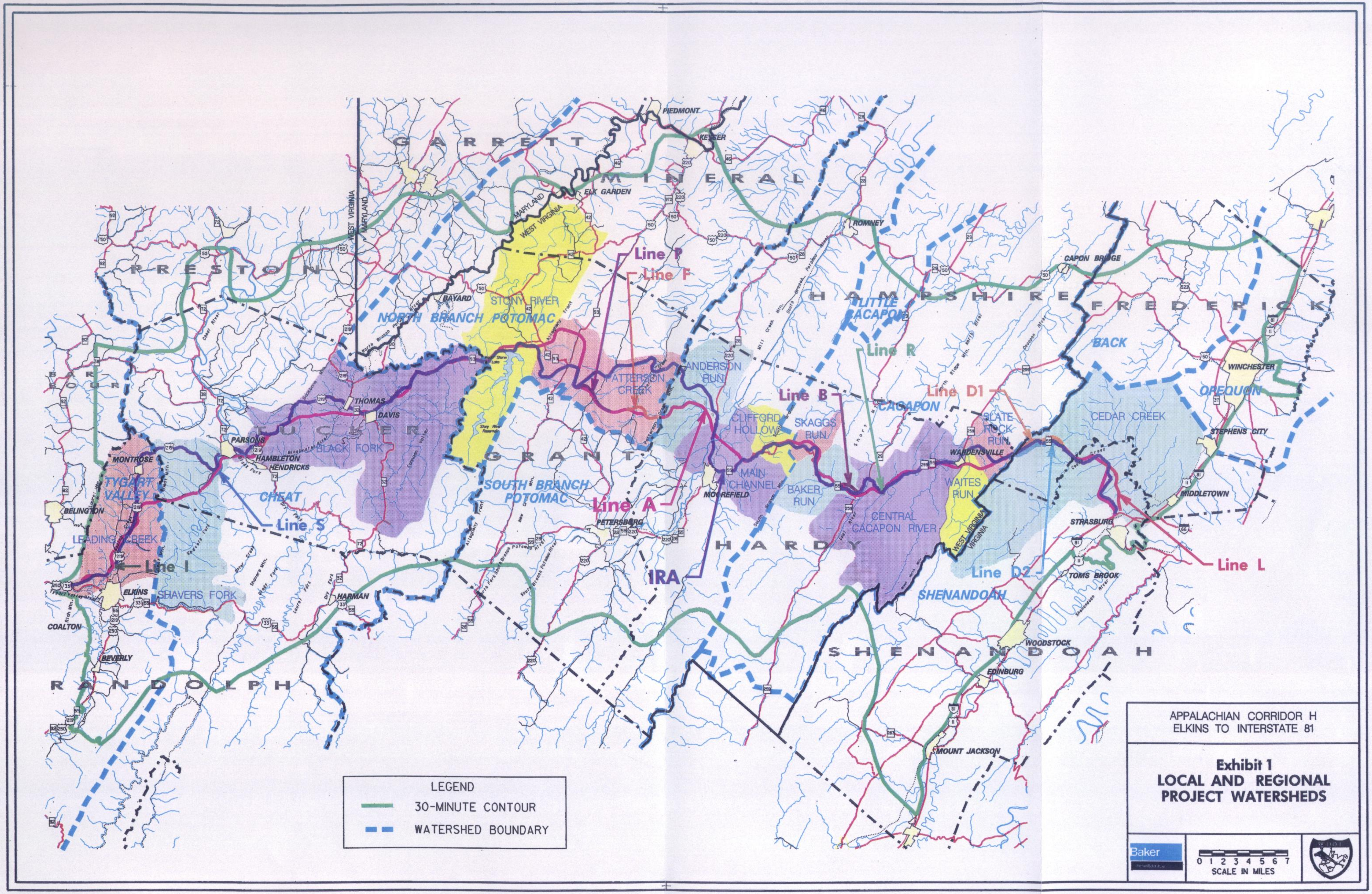
	OPTION AREA COMPARISONS IN VA				
	DUCK RUN			LEBANON CHURCH	
EVALUATION SPECIES	Line D1	Line D2	Line A	Line L	Line A
American Woodcock	(44.80)	(52.19)	(48.75)	(9.23)	(13.62)
Barred Owl	(50.00)	(58.24)	(54.40)	(10.30)	(15.20)
Black-capped Chickadee	(75.15)	(87.53)	(81.77)	(15.48)	(22.84)
Brown Thrasher	(6.61)	(7.62)	(7.12)	(3.90)	(4.06)
Downy Woodpecker	(37.65)	(43.86)	(40.97)	(7.76)	(11.45)
Eastern Cottontail	(17.49)	(20.46)	(19.00)	(12.15)	(12.56)
Eastern Meadowlark	27.80	32.04	30.05	3.19	5.58
Eastern Wild Turkey	(42.84)	(49.03)	(45.98)	(23.24)	(24.34)
Gray Squirrel	(39.16)	(45.61)	(42.60)	(7.47)	(11.90)
Hairy Woodpecker	(55.04)	(64.12)	(59.89)	(11.34)	(16.73)
Mink	(0.10)	(0.08)	(0.08)	0.00	0.00
Muskrat	0.00	0.00	(0.00)	(0.07)	(0.02)
Pileated Woodpecker	(28.46)	(33.15)	(30.97)	(5.86)	(8.65)
Pine Warbler	(0.68)	(0.79)	(0.74)	(0.14)	(0.21)
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00
Veery	(0.06)	(0.04)	(0.04)	0.00	0.00
White-tailed Deer	(43.17)	(49.66)	(46.44)	(27.93)	(28.70)
Yellow Warbler	(0.37)	(0.26)	(0.26)	(0.71)	(0.10)
TOTALS	*(413.79)*	*(480.58)*	*(448.95)*	*(132.39)*	*(164.80)*
PROJECT WATERSHEDS:	SHENANDOAH				

3. WATERSHED ANALYSIS

To allow a more refined evaluation of the HEP analysis, the proposed project area was divided into six watersheds, Exhibit 1 (See SDEIS, Section III for watershed descriptions). The methodology and calculations presented for each watershed are identical to those employed in the previous analysis. Anderson Level II land use within the construction limits of each alignment for each watershed were determined and converted to USFWS cover type definitions to facilitate the HEP analysis (Tables 18 and 19). The dominant land use type across all watersheds is deciduous forest. Wetland acreage is a small percentage of the total land cover in all watersheds (see *Wetlands Technical Report* for detailed information). The Cacapon and Cheat River watersheds have the largest component of deciduous forest and include portions of the George Washington and Monongahela National Forests respectively. Deciduous forest in these watersheds is primarily Appalachian hardwoods with Northern hardwood vegetation occurring in the mountainous areas near the Virginia/West Virginia border. Within Line A, the Cheat River watershed would have the greatest amount of total land converted (432 ha, 1,069 ac), while the Tygart Valley and Shenandoah watersheds would have the least (166 ha, 411 ac and 172 ha, 425 ac, respectively). Within the IRA, the North Branch of the Potomac River watershed would have the greatest amount of total land converted (206 ha, 510 ac), while the Shenandoah River watershed would have the least (66 ha, 163 ac). Forested habitat would be the major cover types converted across all watersheds for both the Improved Roadway and Build Alternatives.

Within each watershed, baseline habitat suitability indices (HSI's) were determined for each evaluation species for each alternative (Table 20). HSI values were similar for most evaluation species across all watersheds for both the Improved Roadway and Build Alternatives. Overall, these values differed only slightly from the project wide values due to varying amounts of individual cover types found within each watershed.

Baseline habitat units (HUs) were determined for each evaluation species within each watershed for each alternative (Table 21). These numbers represent the wildlife habitat value within each watershed for each alternative prior to project construction. Within Line A, HUs varied from 2,367 (Cheat River watershed) to 996 (Tygart Valley River watershed). Within the IRA, HUs varied from 1,145 (N. Branch Potomac River watershed) to 267 (Shenandoah River watershed).



APPALACHIAN CORRIDOR H
ELKINS TO INTERSTATE 81

Exhibit 1
LOCAL AND REGIONAL PROJECT WATERSHEDS

TABLE 18
ANDERSON LEVEL II LAND USE/LAND COVER IMPACTS BY WATERSHED

	TYGART VALLEY RIVER				CHEAT RIVER				N. BRANCH POTOMAC RIVER				S. BRANCH POTOMAC RIVER				CACAPON RIVER				SHENANDOAH RIVER			
	IRA		Line A		IRA		Line A		IRA		Line A		IRA		Line A		IRA		Line A		IRA		Line A	
LAND USE AND COVER TYPE	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
11 - Residential	0.00	0.00	0.00	0.00	4.62	11.42	2.98	7.36	0.00	0.00	0.00	0.00	1.83	4.52	0.00	0.00	0.48	1.19	0.00	0.00	0.00	0.00	0.00	0.00
12 - Commercial	0.00	0.00	0.00	0.00	0.93	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.49	0.00	0.00	0.00	0.00	0.00	0.00
13 - Industrial	0.00	0.00	0.00	0.00	0.19	0.47	0.00	0.00	1.30	3.21	0.03	0.08	0.00	0.00	0.00	0.00	0.16	0.40	0.59	1.47	0.00	0.00	0.00	0.00
14 - Transp., Commun., Utilities	2.50	6.18	1.18	2.93	5.85	14.46	2.77	6.84	0.52	1.28	0.43	1.07	1.47	3.63	0.12	0.31	5.53	13.66	0.19	0.46	13.43	33.19	0.94	2.32
17 - Other Urban or Built-up Land	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	1.28	1.54	3.80
21 - Cropland and Pasture	21.43	52.95	27.89	68.92	6.51	16.09	31.75	78.45	50.20	124.04	57.03	140.93	34.09	84.24	65.39	161.57	15.15	37.44	36.03	89.03	7.01	17.32	17.05	42.12
22 - Orchards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	7.00
24 - Other Agricultural Land	0.02	0.05	0.00	0.00	0.58	1.43	3.23	7.98	0.43	1.06	0.42	1.04	1.02	2.52	1.87	4.62	3.26	8.06	3.58	8.85	7.28	17.99	3.06	7.57
31 - Herbaceous Rangeland	1.95	4.82	2.25	5.56	4.17	10.30	10.68	26.39	2.81	6.94	25.63	63.34	3.12	7.71	1.86	4.59	3.61	8.92	6.51	16.08	1.64	4.05	4.25	10.51
32 - Shrub and Brush Rangeland	0.22	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.66	6.57	3.25	8.04	0.00	0.00	1.19	2.93	0.01	0.02	0.00	0.00
33 - Mixed Rangeland	0.00	0.00	0.00	0.00	0.55	1.36	16.78	41.47	0.00	0.00	0.59	1.47	0.82	2.03	7.33	18.11	1.36	3.36	1.50	3.70	0.50	1.24	1.03	2.54
41 - Deciduous Forest	59.74	147.62	130.14	321.57	94.18	232.72	318.89	787.97	138.37	341.91	186.44	460.69	76.94	190.12	89.81	221.93	100.74	248.93	269.51	665.95	35.00	86.49	140.82	347.96
42 - Evergreen Forest	0.00	0.00	1.85	4.57	1.29	3.19	8.89	21.96	4.28	10.58	4.72	11.66	0.00	0.00	3.29	8.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43 - Mixed Forest	0.00	0.00	0.00	0.00	24.63	60.86	7.76	19.16	4.66	11.51	12.02	29.71	11.30	27.92	26.69	65.95	2.10	5.19	0.00	0.00	0.00	0.00	0.00	0.00
51 - Streams and Canals	0.18	0.44	0.11	0.27	0.00	0.00	0.75	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.51	0.03	0.07	0.23	0.57	0.00	0.00	0.05	0.13
52 - Lakes	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00
53 - Reservoirs	0.02	0.05	0.11	0.26	0.02	0.05	0.53	1.32	0.23	0.57	0.23	0.56	0.00	0.00	0.03	0.09	0.08	0.20	0.26	0.65	0.00	0.00	0.10	0.24
61 - Forested Wetlands	0.11	0.27	0.00	0.00	1.02	2.52	0.12	0.30	0.10	0.25	0.06	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.07	0.17	0.11	0.27
62 - Non-forested Wetlands	0.90	2.22	1.90	4.69	3.54	8.75	7.19	17.77	1.58	3.90	3.07	7.59	0.56	1.38	0.78	1.93	0.00	0.00	0.67	1.66	0.40	0.99	0.12	0.30
75 - Strip Mines, Quarries, Gravel Pits	0.00	0.00	0.00	0.00	2.52	6.23	3.31	8.18	1.77	4.37	3.07	7.59	0.00	0.00	0.00	0.00	0.07	0.17	0.00	0.00	0.00	0.00	0.00	0.00
76 - Transitional Areas	0.93	2.30	0.97	2.39	0.00	0.00	16.45	40.66	0.00	0.00	0.11	0.28	0.00	0.00	0.00	0.00	1.95	4.82	1.07	2.65	0.00	0.00	0.00	0.00
TOTALS	***88.00***	***217.45***	***166.40***	***411.17***	***150.60***	***372.13***	***432.53***	***1,068.78***	***206.25***	***509.64***	***293.87***	***726.15***	***133.81***	***330.64***	***200.64***	***495.77***	***134.72***	***332.89***	***321.42***	***794.23***	***65.87***	***162.76***	***171.89***	***424.75***

TABLE 19
USFWS COVER TYPE IMPACTS BY WATERSHED

	TYGART VALLEY RIVER				CHEAT RIVER				N. BRANCH POTOMAC RIVER				S. BRANCH POTOMAC RIVER				CACAPON RIVER				SHENANDOAH RIVER			
	IRA		Line A		IRA		Line A		IRA		Line A		IRA		Line A		IRA		Line A		IRA		Line A	
COVER TYPE	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC	HA	AC
AC - Cropland	2.14	5.30	2.79	6.89	0.65	1.61	3.17	7.85	5.02	12.40	5.70	14.09	3.41	8.42	6.54	16.16	1.52	3.74	3.60	8.90	0.70	1.73	1.70	4.21
AO - Orchard	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	7.00
AP - Pasture or Hayland	19.29	47.66	25.10	62.03	5.86	14.48	28.57	70.61	45.18	111.64	51.33	126.84	30.68	75.81	58.85	145.42	13.64	33.69	32.43	80.12	6.31	15.59	15.34	37.91
PEM - Palustrine Emergent Wetland	0.75	1.85	1.87	4.62	3.11	7.68	6.24	15.42	1.58	3.90	3.07	7.59	0.56	1.38	0.62	1.53	0.00	0.00	0.61	1.51	0.15	0.37	0.15	0.37
PFO - Palustrine Forested Wetland	0.11	0.27	0.00	0.00	1.02	2.52	0.12	0.30	0.10	0.25	0.06	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.07	0.17	0.11	0.27
PSS - Palustrine Scrub/Shrub Wetland	0.15	0.37	0.03	0.07	0.43	1.06	0.95	2.35	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.40	0.00	0.00	0.06	0.15	0.25	0.62	0.00	0.00
UF - Forbland	0.49	1.20	0.56	1.39	1.04	2.58	2.67	6.60	0.70	1.74	6.41	15.84	0.78	1.93	0.46	1.15	0.90	2.23	1.63	4.02	0.41	1.01	1.06	2.63
UFOD - Deciduous Forest	59.74	147.62	130.14	321.57	118.81	293.58	326.64	807.13	143.03	353.43	198.46	490.39	88.24	218.04	116.50	287.87	102.84	254.12	269.51	665.95	35.00	86.49	140.82	347.96
UFOE - Evergreen Forest	0.00	0.00	1.85	4.57	1.29	3.19	8.89	21.96	4.28	10.58	4.72	11.66	0.00	0.00	3.29	8.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UG - Grassland	1.46	3.61	1.69	4.17	3.13	7.73	8.01	19.80	2.11	5.21	19.23	47.51	2.34	5.78	1.39	3.44	2.71	6.69	4.88	12.06	1.23	3.04	3.19	7.88
USHD - Deciduous Shrubland	0.22	0.54	0.00	0.00	0.55	1.36	16.78	41.47	0.00	0.00	0.59	1.47	3.48	8.60	10.58	26.14	1.36	3.36	2.68	6.63	0.51	1.26	1.03	2.54
TOTALS	***84.35***	***208.43***	***164.03***	***405.32***	***135.89***	***335.78***	***402.05***	***993.48***	***202.00***	***499.14***	***289.57***	***715.53***	***129.49***	***319.97***	***198.40***	***490.25***	***122.96***	***303.83***	***315.49***	***779.59***	***44.63***	***110.28***	***166.24***	***410.77***

TABLE 20
BASELINE HSI VALUES BY WATERSHED

	TYGART VALLEY RIVER		CHEAT RIVER		N. BRANCH POTOMAC RIVER		S. BRANCH POTOMAC RIVER		CACAPON RIVER		SHENANDOAH RIVER - VA	
EVALUATION SPECIES	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A
American Woodcock	0.60	0.60	0.60	0.59	0.59	0.59	0.60	0.59	0.60	0.60	0.60	0.60
Barred Owl	0.67	0.66	0.67	0.66	0.66	0.66	0.67	0.66	0.67	0.67	0.67	0.67
Black-capped Chickadee	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Brown Thrasher	0.11	0.12	0.14	0.14	0.12	0.11	0.12	0.11	0.13	0.13	0.12	0.13
Downy Woodpecker	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Eastern Cottontail	0.72	0.74	0.78	0.76	0.72	0.68	0.71	0.72	0.76	0.76	0.75	0.76
Eastern Meadowlark	0.45	0.45	0.56	0.51	0.44	0.43	0.45	0.53	0.49	0.48	0.49	0.49
Eastern Wild Turkey	0.61	0.48	0.33	0.34	0.61	0.50	0.58	0.59	0.45	0.38	0.59	0.39
Gray Squirrel	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Hairy Woodpecker	0.74	0.73	0.74	0.72	0.72	0.72	0.74	0.73	0.74	0.74	0.74	0.74
Mink	0.58	0.82	0.41	0.77	0.22	0.23	0.28	0.84	0.53	0.46	0.66	0.22
Muskrat	0.19	0.22	0.17	0.21	0.21	0.22	0.22	0.21	0.13	0.19	0.15	0.13
Pileated Woodpecker	0.38	0.38	0.38	0.37	0.37	0.37	0.38	0.38	0.38	0.38	0.38	0.38
Pine Warbler	0.00	0.01	0.01	0.02	0.02	0.02	0.00	0.01	0.00	0.00	0.00	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.34	0.48	0.24	0.45	0.14	0.14	0.17	0.49	0.32	0.27	0.39	0.14
White-tailed Deer	0.97	0.97	0.97	0.96	0.96	0.95	0.97	0.97	0.99	0.99	0.98	0.99
Yellow Warbler	0.57	0.95	0.58	0.34	0.91	0.30	0.30	0.44	0.30	0.32	0.52	0.30

TABLE 21
BASELINE HABITAT UNITS (HUs) BY WATERSHED

EVALUATION SPECIES	TYGART VALLEY RIVER		CHEAT RIVER		N. BRANCH POTOMAC RIVER		S. BRANCH POTOMAC RIVER		CACAPON RIVER		SHENANDOAH RIVER - VA	
	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A
American Woodcock	35.91	79.19	72.67	198.03	86.97	119.91	52.94	70.68	61.70	161.76	21.04	84.56
Barred Owl	40.10	87.11	81.15	221.53	97.29	134.14	59.12	79.06	68.90	180.64	24.20	94.42
Black-capped Chickadee	59.85	131.99	121.12	335.65	147.41	203.24	88.24	119.79	102.84	269.61	35.07	140.93
Brown Thrasher	8.93	19.12	18.30	54.82	23.44	30.88	15.06	21.02	15.79	40.45	5.21	21.36
Downy Woodpecker	29.93	65.99	60.56	167.82	73.71	101.62	44.12	59.90	51.42	134.80	17.54	70.46
Eastern Cottontail	58.46	117.91	101.93	297.59	140.62	190.90	89.12	137.58	92.30	236.45	32.15	124.85
Eastern Meadowlark	9.56	12.31	5.62	20.02	21.12	33.09	15.21	32.18	8.45	18.69	3.65	9.60
Eastern Wild Turkey	50.90	77.82	43.68	134.25	122.26	143.25	74.78	116.60	55.33	119.63	26.09	63.67
Gray Squirrel	31.12	67.67	62.31	169.92	74.43	103.23	45.88	60.58	53.48	140.19	18.24	73.28
Hairy Woodpecker	44.29	96.35	89.63	241.67	106.14	146.33	65.30	87.45	76.10	199.51	25.95	104.29
Mink	0.15	0.02	0.59	0.82	0.02	0.01	0.00	0.13	0.00	0.07	0.15	0.02
Muskrat	0.17	0.42	0.60	1.51	0.33	0.68	0.12	0.16	0.00	0.13	0.07	0.02
Pileated Woodpecker	22.74	50.15	46.03	124.19	54.54	75.20	33.53	45.52	39.08	102.45	13.33	53.55
Pine Warbler	0.00	1.32	1.20	6.71	2.95	4.06	0.00	1.20	0.00	0.00	0.35	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.09	0.01	0.35	0.48	0.01	0.01	0.00	0.08	0.00	0.04	0.09	0.02
White-tailed Deer	81.82	159.11	131.81	385.97	193.92	275.09	125.61	192.45	121.73	312.34	43.28	164.57
Yellow Warbler	0.21	0.03	0.57	6.03	0.00	0.18	1.04	4.73	0.41	0.88	0.29	0.31
TOTAL	474.23	966.53	838.11	2,367.02	1,145.14	1,561.83	710.08	1,029.10	747.53	1,917.64	266.70	1,005.89

4. IMPACTS BY WATERSHED

Future habitat conditions within the construction limits of each alignment were predicted 5 years after the completion of the project. Since there is only one predicted future cover type within all watersheds (grassland), the calculated future HSI values for each evaluation species were identical for each watershed and were equal to the overall proposed project values (see Table 13). These numbers represent the estimated wildlife habitat value by watershed within each alignment 5 years after project construction. Table 22 presents the predicted future HUs within each watershed by alternative. Within Line A, future HUs varied from 509 (Cheat River watershed) to 196 (Shenandoah River watershed). Within the IRA, future HUs varied from 277 (N. Branch Potomac River watershed) to 103 (Shenandoah River watershed).

Table 23 presents the net gain/loss in HUs within each watershed by alternative for each evaluation species. Species that produced low baseline HSI values (red-winged blackbird, pine warbler, ruffed grouse) or species that had limited amounts of available habitat (mink, muskrat, veery) subsequently produced and would potentially lose few HUs. The construction area within the IRA would generate the greatest loss of HU's within the North Branch of the Potomac River watershed, while the area within Line A would generate the greatest loss within the Cheat River watershed.

TABLE 22
ALTERNATIVE COMPARISON OF FUTURE HABITAT UNITS (HUs)
BY WATERSHED

	TYGART VALLEY		CHEAT RIVER		N. BRANCH POTOMAC		S. BRANCH POTOMAC		CACAPON RIVER		SHENANDOAH RIVER - VA	
EVALUATION SPECIES	**IRA**	**Line A**	**IRA**	**Line A**	**IRA**	**Line A**	**IRA**	**Line A**	**IRA**	**Line A**	**IRA**	**Line A**
American Woodcock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barred Owl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black-capped Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brown Thrasher	3.45	6.20	6.30	15.80	8.60	11.20	5.50	7.50	5.55	12.00	3.20	6.10
Downy Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eastern Cottontail	42.78	76.88	78.12	195.92	106.64	138.88	68.20	93.00	68.82	148.80	39.68	75.64
Eastern Meadowlark	30.36	54.56	55.44	139.04	75.68	98.56	48.40	66.00	48.84	105.60	28.16	53.68
Eastern Wild Turkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gray Squirrel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mink	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Muskrat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White-tailed Deer	34.50	62.00	63.00	158.00	86.00	112.00	55.00	75.00	55.50	120.00	32.00	61.00
Yellow Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	111.09	199.64	202.86	508.76	276.92	360.64	177.10	241.50	178.71	386.40	103.04	196.42

TABLE 23
ALTERNATIVE COMPARISON OF NET GAIN/(LOSS) OF HUs BY WATERSHED

EVALUATION SPECIES	TYGART VALLEY		CHEAT RIVER		N. BRANCH POTOMAC		S. BRANCH POTOMAC		CACAPON RIVER		SHENANDOAH RIVER - VA	
	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A
American Woodcock	(35.91)	(79.19)	(72.67)	(198.03)	(86.97)	(119.91)	(52.94)	(70.68)	(61.70)	(161.76)	(21.04)	(84.56)
Barred Owl	(40.10)	(87.11)	(81.15)	(221.53)	(97.29)	(134.14)	(59.12)	(79.06)	(68.90)	(180.64)	(24.20)	(94.42)
Black-capped Chickadee	(59.85)	(131.99)	(121.12)	(335.65)	(147.41)	(203.24)	(88.24)	(119.79)	(102.84)	(269.61)	(35.07)	(140.93)
Brown Thrasher	(5.48)	(12.92)	(12.00)	(39.02)	(14.84)	(19.68)	(9.56)	(13.52)	(10.24)	(28.45)	(2.01)	(15.26)
Downy Woodpecker	(29.93)	(65.99)	(60.56)	(167.82)	(73.71)	(101.62)	(44.12)	(59.90)	(51.42)	(134.80)	(17.54)	(70.46)
Eastern Cottontail	(15.68)	(41.03)	(23.81)	(101.67)	(33.98)	(52.02)	(20.92)	(44.58)	(23.48)	(87.65)	7.53	(49.21)
Eastern Meadowlark	20.80	42.25	49.82	119.02	54.56	65.47	33.19	33.82	40.39	86.91	24.51	44.08
Eastern Wild Turkey	(50.90)	(77.82)	(43.68)	(134.25)	(122.26)	(143.25)	(74.78)	(116.60)	(55.33)	(119.63)	(26.09)	(63.67)
Gray Squirrel	(31.12)	(67.67)	(62.31)	(169.92)	(74.43)	(103.23)	(45.88)	(60.58)	(53.48)	(140.19)	(18.24)	(73.28)
Hairy Woodpecker	(44.29)	(96.35)	(89.63)	(241.67)	(106.14)	(146.33)	(65.30)	(87.45)	(76.10)	(199.51)	(25.95)	(104.29)
Mink	(0.15)	(0.02)	(0.59)	(0.82)	(0.02)	(0.01)	0.00	(0.13)	0.00	(0.07)	(0.15)	(0.02)
Muskrat	(0.17)	(0.42)	(0.60)	(1.51)	(0.33)	(0.68)	(0.12)	(0.16)	0.00	(0.13)	(0.07)	(0.02)
Pileated Woodpecker	(22.74)	(50.15)	(46.03)	(124.19)	(54.54)	(75.20)	(33.53)	(45.52)	(39.08)	(102.45)	(13.33)	(53.55)
Pine Warbler	(0.00)	(1.32)	(1.20)	(6.71)	(2.95)	(4.06)	0.00	(1.20)	0.00	0.00	(0.35)	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veery	(0.09)	(0.01)	(0.35)	(0.48)	(0.01)	(0.01)	0.00	(0.08)	0.00	(0.04)	(0.09)	(0.02)
White-tailed Deer	(47.32)	(97.11)	(68.81)	(227.97)	(107.92)	(163.09)	(70.61)	(117.45)	(66.23)	(192.34)	(11.28)	(103.57)
Yellow Warbler	(0.21)	(0.03)	(0.57)	(6.03)	0.00	(0.18)	(1.04)	(4.73)	(0.41)	(0.88)	(0.29)	(0.31)
TOTAL	**(363.14)**	**(766.89)**	**(635.25)**	**(1,858.26)**	**(868.22)**	**(1,201.19)**	**(532.98)**	**(787.60)**	**(568.82)**	**(1,531.24)**	**(178.71)**	**(809.47)**

5. SECONDARY IMPACTS

Secondary impacts to wildlife habitat are assessed in two categories: highway-related and development-related. Highway-related impacts are covered in Sections IV and V of this report which discuss forest fragmentation, biodiversity, and wildlife mortality. Development-related impacts to wildlife habitat, presented below, are based on the induced development predictions for industrial, commercial, residential and service-oriented growth contained in the *Secondary and Cumulative Impacts Technical Report*. This growth has been predicted within the area influenced by Corridor H, defined as the *30-Minute Contour*.

a. Habitat Unit Loss - Improved Roadway Alternative

Development predictions as a result of construction of the IRA involve commercial enterprises at intersections and interchanges. The required land area for this development has been defined as part of the induced development predictions. Based on that estimate, the total number of hectares per land cover type was multiplied by the habitat units calculated for that particular land cover type. Results of those calculations are presented in Table 24.

b. Habitat Unit Loss - Build Alternative

Total hectares required for predicted commercial, residential and service-oriented development were calculated. Following that calculation the total number of hectares per land cover type was multiplied by the habitat units calculated for that particular land cover type. Results of those calculations are presented in Table 25. For this calculation all development-related impacts are presented in the aggregate. That is, commercial, residential and service-oriented development were combined by land cover type to determine the total number of habitat units that could be lost due to land area requirements for predicted development.

TABLE 24
LAND COVER AND HABITAT UNITS (HUs) LOST DUE TO PREDICTED DEVELOPMENT

IMPROVED ROADWAY ALTERNATIVE

Watershed	Land Cover Type	Total Hectares	Total Acres	Total HUs	Hectare Loss	Acre Loss	HUs Loss	% Total Watershed HUs Lost
Tygart Valley River	Forest	29,545	72,977	35,454	28	68	33	0.1
	Farmland	8,643	21,348	2,593	13	32	4	0.1
Cheat River	Forest	148,118	365,852	177,742	19	46	22	0.0
	Farmland	21,670	53,525	6,501	8	20	2	0.0
North Branch Potomac River	Forest	94,878	234,349	113,854	0	0	0	0.0
	Farmland	20,155	49,783	6,047	0	0	0	0.0
South Branch Potomac River	Forest	97,140	239,936	116,568	0	0	0	0.0
	Farmland	34,502	85,219	10,350	0	0	0	0.0
Cacapon River	Forest	98,364	242,960	118,037	2	4	2	0.0
	Farmland	20,393	50,370	6,118	6	14	2	0.0
Shenandoah River	Forest	45,945	113,484	55,134	10	25	12	0.0
	Farmland	35,022	86,504	10,507	14	35	4	0.1
Back Creek	Forest	22,515	55,611	27,017	0	0	0	0.0
	Farmland	10,775	26,614	3,232	0	0	0	0.0
Opequon Creek	Forest	2,097	5,180	2,517	0	0	0	0.0
	Farmland	9,164	22,635	2,749	0	0	0	0.0

1.2 HUs/Forest Hectare

0.3 HUs/Farmland (Pasture) Hectare

TABLE 25
LAND COVER AND HABITAT UNITS (HUs)
LOST DUE TO PREDICTED DEVELOPMENT

BUILD ALTERNATIVE

Watershed	Land Cover Type	Total Hectares	Total Acres	Total HUs	Hectare Loss	Acre Loss	HUs Loss	% Total Watershed HUs Lost
Tygart Valley River	Forest	29,545	72,977	35,454	794	1,960	952	2.7
	Farmland	8,643	21,348	2,593	296	732	89	3.4
Cheat River	Forest	148,118	365,852	177,742	506	1,251	608	0.3
	Farmland	21,670	53,525	6,501	376	929	113	1.7
North Branch Potomac River	Forest	94,878	234,349	113,854	216	533	259	0.2
	Farmland	20,155	49,783	6,047	88	218	26	0.4
South Branch Potomac River	Forest	97,140	239,936	116,568	1,712	4,228	2,054	1.8
	Farmland	34,502	85,219	10,350	963	2,378	289	2.8
Cacapon River	Forest	98,364	242,960	118,037	722	1,784	867	0.7
	Farmland	20,393	50,370	6,118	272	673	82	1.3
Shenandoah River	Forest	45,945	113,484	55,134	1,393	3,440	1,671	3.0
	Farmland	35,022	86,504	10,507	1,574	3,887	472	4.5
Back Creek	Forest	22,515	55,611	27,017	1,617	3,993	1,940	7.2
	Farmland	10,775	26,614	3,232	285	705	86	2.6
Opequon Creek	Forest	2,097	5,180	2,517	260	642	312	12.4
	Farmland	9,164	22,635	2,749	128	316	38	1.4

1.2 HUs/Forest Hectare

0.3 HUs/Farmland (Pasture) Hectare

6. CUMULATIVE IMPACTS

Cumulative impacts for this project have been assessed in three categories: the additive effects of direct impacts, the additive effects of direct and secondary (induced development) impacts, and the effects of other foreseeable future Federal actions. These actions include the Moorefield Floodwall Project, the Stony Run Dam Project, the Canaan Valley Wildlife Refuge, and the Monongahela and George Washington National Forest Plans. Impacts to wildlife habitat for each of these categories is presented below.

a. Additive Direct Impacts

Additive direct impacts to wildlife habitat (as measured by Habitat Units lost) by watershed are summarized in Table 26 for both the Improved Roadway and Build Alternatives. The IRA would cumulatively result in the loss of 2,968 HUs in West Virginia and 164 HUs in Virginia. Line A would cumulatively result in the loss of 6,145 HUs in West Virginia and 809 HUs in Virginia. Habitat Units lost in both alternatives are less than 2% of the HUs found within the regional project watersheds.

b. Additive Direct and Secondary Impacts

The combination of direct and secondary impacts yielded an increase in HUs lost by the evaluation species due to predicted secondary development (Table 27). Predicted secondary development is an aggregate of commercial, residential and service-oriented development. The Shenandoah River watershed would have the greatest cumulative loss of HUs, while the North Branch of the Potomac River watershed would have the least. This calculated loss is based on the total removal of forest and farmland habitat from wildlife use. However, residential development is based on using 2 acre lots. Many of these parcels would not be completely converted from their present land use type and would still provide some benefits for a variety of wildlife species.

c. Foreseeable Future Federal Actions

Cumulative impacts related to the development of foreseeable future projects was limited to known Federal actions that are currently ongoing or are in the formulative stages of study. The five Federal actions considered are listed above. Table 28 summarizes the potential wildlife habitat impacts due to the above-mentioned Federal actions. Two projects predict loss of wildlife habitat. The Moorefield floodwall project would involve impacts to approximately 8.5 ha (21 ac) of cropland and 0.8 ha (2 ac) of bottomland hardwoods. A comprehensive assessment of this wildlife habitat value was performed by the USFWS in conjunction with the US Fish and Wildlife Coordination Act. To compensate for habitat losses, mitigation measures included the proposed acquisition and the planting of 7.6 ha (18.8) acres of high habitat value trees and shrubs to replace 32 HUs lost (COE 1990). The Stony Run water supply dam would result in the loss of 28.3 ha (70 ac) of forested habitat. Based on an approximate value of 2.9 HUs/forested acre (based on SDEIS HEP study), this project would result in the loss of 203 HUs. However, the creation of open water habitat and

TABLE 26
SUMMARY OF HABITAT UNITS (HUs) LOST
BY WATERSHED

	TYGART VALLEY		CHEAT RIVER		N. BRANCH POTOMAC		S. BRANCH POTOMAC		CACAPON RIVER		SHENANDOAH RIVER - VA	
HABITAT UNITS	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A	IRA	Line A
Baseline HUs	474	967	838	2,367	1,145	1,562	710	1,029	748	1,918	267	1,006
Predicted Future HUs	111	200	203	509	277	361	177	242	179	386	103	196
NET LOSS of HUs	*363*	*767*	*635*	*1,858*	*868*	*1,201*	*533*	*788*	*569*	*1,531*	*164*	*809*

TABLE 27
CUMULATIVE HABITAT UNITS (HUs) LOST DUE TO DIRECT HIGHWAY AND PREDICTED SECONDARY DEVELOPMENT IMPACTS

IMPROVED ROADWAY ALTERNATIVE

HABITAT UNITS LOST	Tygart Valley	Cheat	North Branch Potomac	South Branch Potomac	Cacapon	Shenandoah	Back	Opequon
Direct Impacts	363	635	868	533	569	164	0	0
Secondary Impacts	37	24	0	0	4	16	0	0
CUMULATIVE IMPACTS	***400***	***659***	***868***	***533***	***573***	***180***	***0***	***0***

BUILD ALTERNATIVE

HABITAT UNITS LOST	Tygart Valley	Cheat	North Branch Potomac	South Branch Potomac	Cacapon	Shenandoah	Back	Opequon
Direct Impacts	767	1,858	1,201	788	1,531	809	0	0
Secondary Impacts	1,041	721	285	2,343	949	2,143	2,026	350
CUMULATIVE IMPACTS	***1,808***	***2,579***	***1,486***	***3,131***	***2,480***	***2,952***	***2,026***	***350***

TABLE 28
CUMULATIVE WILDLIFE IMPACT ASSESSMENT MATRIX FOR FORESEEABLE FUTURE FEDERAL ACTIONS WITHIN 30-MINUTE CONTOUR

	WILDLIFE HABITAT IMPACTS	BIODIVERSITY IMPACTS	MITIGATION/ MANAGEMENT PLANS
FLOODWALL - MOOREFIELD, WV	Over 90% of impacts to cropland or urban land (21 ac)	No involvement of threatened or endangered species.	Wetland and upland revegetation plan
STONY RUN WATER SUPPLY DAM - HARDY COUNTY, WV	Approx. loss of 70 acres forested habitat	No involvement of threatened or endangered species. Creation of open water habitat.	None proposed.
CANAAN VALLEY NATIONAL WILDLIFE REFUGE	Preservation of 28,000 acres	Preservation of diverse plant and animal populations, including 1 threatened and 1 endangered species.	Comprehensive management plan developed
GEORGE WASHINGTON NATIONAL FOREST	Multiple use management of over 100,000 forested acres	Management plan to conserve specific elements of biodiversity and restore others where needed.	Comprehensive land and resource management plan
MONOGAHELA NATIONAL FOREST	Multiple use management of over 500,000 forested acres	Plan to promote populations of management indicator species, including threatened and endangered species.	Comprehensive land and resource management plan

the associated shoreline edge would provide food and cover resources for waterfowl, wading birds, and other species associated with aquatic environments. This could increase the overall species diversity in a region dominated by upland deciduous forest.

The proposed Canaan Valley National Wildlife Refuge would encompass nearly 11,330 ha (28,000 ac) of relict boreal (northern) habitat with diverse flora and fauna communities. Canaan Valley's high altitude and cold, humid climate have maintained a unique relict boreal ecosystem which supports an assemblage of plant and animal life considered unusual for its latitude in the eastern United States. Nearly 288 species of mammals, birds, reptiles, amphibians, and fish are known or expected to occur here, including one threatened (Cheat Mountain salamander) and one endangered (Virginia northern flying squirrel) species. This area is nationally recognized as a breeding and fall migration concentration area for the American woodcock, and supports many other migratory species, including raptors, waterfowl, wading birds, shorebirds, and neotropical migrants.

Both National Forests have prepared Final Environmental Impact Statements that contain wildlife management plans that address the habitat needs of a variety of wildlife species. Each plan chose management indicator species to represent important game species, threatened and endangered species, species whose habitats may be influenced by management activities, and non-game species of special interest. Management plans call for the monitoring of population levels of the indicator species and management of their habitats to maintain viable population numbers.

The cumulative effect of the above foreseeable actions is currently one of a positive nature for wildlife habitat. Over 30% of the land area within the 30-Minute Contour (240,000 ha, 600,000 ac) is currently being managed to maintain species diversity and promote population levels of both game and non-game species. West Virginia Division of Natural Resources also owns and manages an additional 7,000 ha (17,000 ac) for wildlife within Wildlife Management Areas located within the 30-Minute Contour.

III. RARE, THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) of 1973 (16 USC §1531-1543) declares the intention of Congress to protect all Federally listed threatened and endangered species and designated critical habitat of such species occurring both in the United States and abroad. Section 7 of the ESA requires that Federal agencies, such as FHWA, ensure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. The USFWS is the primary regulatory agency responsible for ESA compliance. The USFWS maintains additional categories which do not provide legal protection, but should be considered during the planning process for any Federal project. These additional categories are Proposed Endangered, Proposed Threatened, and Candidate Species. Coordination with state and Federal resource agencies revealed no potential involvement with either Proposed or Candidate Species designated 'Category 1' or 'Category 3'. However, six 'Category 2' Candidate Species were identified within or near the project area and are discussed below.

The State of West Virginia relies upon Federal legislation to protect vertebrate, invertebrate, and plant resources. The West Virginia Department of Commerce, Labor, and Environment's Natural Heritage Program (NHP), within the Division of Natural Resources (DNR), maintains a database with the known location of Federally listed Threatened and Endangered species, as well as a list of Rare Species. The Natural Heritage Program places species on this list based on their population status within West Virginia. These species, which may be limited in West Virginia but more abundant and wide-spread in other states, are not afforded special legal protection as are Federally listed Threatened and Endangered species. However, a review of the potential impacts to these species was considered in the planning process through coordination with the NHP.

In addition to Federally protected species, there is state legislation that provides protection to plant and animal species deemed Threatened or Endangered within the Commonwealth of Virginia. These designations are based on population levels within Virginia and do not necessarily represent the population status of a particular species throughout its geographic distributional range. In Virginia, both the Virginia Department of Game and Inland Fisheries (VDGIF) and the Virginia Division of Natural Heritage (VDNH) maintain databases on the presence of Federal and state listed Threatened and Endangered plant and animal species. A review of the potential impacts to these species was considered in the planning process.

One Federally listed Threatened wildlife species and one Federally listed Endangered plant species are known to exist within the proposed project area, but not necessarily within the construction limits of the proposed alignments. In addition, one state listed (Virginia) Threatened species, and a number of Federally listed Candidate species and Species of Special State Concern (West Virginia) potentially exist within the proposed project area. Table 29 summarizes the occurrence of Federal and state Threatened, Endangered, and Candidate species within the proposed project area. This information is presented by watershed.

A. FEDERALLY LISTED SPECIES

1. CHEAT MOUNTAIN SALAMANDER

The Cheat Mountain salamander (*Plethodon nettingi*) was listed by the Federal government as a Threatened species by the US Fish and Wildlife Service (USFWS) in September, 1989 (Federal Register, Vol. 53, No. 188:37814-37818).

a. Methods

Meetings were conducted in July 1993 with state and Federal environmental regulatory and resource agencies to discuss the potential impact of the proposed project on the Cheat Mountain salamander. The USFWS provided US Geological Survey (USGS) quadrangle maps with potential salamander habitat areas designated for field review. These areas were entered into the GIS database.

Dr. Thomas Pauley of Marshall University is the recognized expert on the Cheat Mountain salamander and was retained to lead the field investigations of potential salamander habitat. A meeting was held on September 27, 1993, with Dr. Pauley to discuss potential impact areas and strategies for field surveys. Dr. Pauley recommended a two phase investigation consisting of an initial field review to identify areas of suitable habitat, followed by detailed surveys within these areas to determine the presence or absence of the animal. Initial field investigations were conducted with Dr. Pauley on October 21-22, 1993. Dr. Pauley conducted additional investigations of the proposed IRA in early March, 1994. Two major areas of concern were investigated based on elevations near 915 m (3,000 feet), vegetational composition of the landscape and existence of suitable cover objects (rocks, logs, leaf material). The first area was located along Route 93 between Davis, West Virginia and Mount Storm Lake, and the second was from Olson Road (Forest Service Road 18) east to the town of Douglas, West Virginia. Pedestrian and vehicular surveys were conducted along the alignments within potential salamander habitat. Based on vegetative habitat characteristics and the presence of forest floor litter, those areas deemed suitable habitat for the Cheat Mountain salamander were delineated on USGS quadrangle maps. Potential habitat areas were then revised in the GIS database.

TABLE 29
POTENTIAL INVOLVEMENT OF FEDERAL AND STATE ENDANGERED, THREATENED, AND CANDIDATE SPECIES

		WATERSHEDS																			
		TYGART VALLEY RIVER		CHEAT RIVER			N. BRANCH POTOMAC RIVER				S. BRANCH POTOMAC		CACAPON RIVER				SHENANDOAH RIVER				
SPECIES	STATUS	IRA	Line A	IRA	Line A	Line S	IRA	Line A	Line F	Line P	IRA	Line A	IRA	Line A	Line R	Line B	IRA	Line A	Line D1	Line D2	Line L
Cheat Mountain Salamander (*Plethodon nettingi*)	Federal Threatened	0	0	A	A	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Running Buffalo Clover (*Trifolium stoloniferum*)	Federal Endangered	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock Vole (*Microtus chrotorrhinus carolinensis*)	Fed/WV C2/S3	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New England Cottontail (*Sylvilagus transitionalis*)	Fed/WV C2/S3	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loggerhead Shrike (*Lanius ludovicianus*)	Fed/WV/VA C2/S1/Threat.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B	C	C	0	0	C
Wood Turtle (*Clemmys insculpta*)	VA Threatened	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	D	D	D	D	0
Kate's Mountain Clover (*Trifolium virginicum*)	Fed/WV C2/S2S3	0	0	0	0	0	0	0	0	0	0	0	B	0	0	0	0	0	0	0	0
Mountain Pimpernal (*Taenidia montana*)	Fed/WV C2/S3	0	0	0	0	0	0	0	0	0	0	0	B	0	0	0	0	0	0	0	0

INVOLVEMENT CODES: A = Potential habitat surveyed May/June, 1994--No Cheat Mountain salamanders found within construction limits of proposed project
B = Documented occurrence by West Virginia Natural Heritage Program
C = Potential habitat exists, no documented records within project alternatives
D = VDGIF Documented occurrence along Duck Run, none observed during intensive stream and wetland work in this area
0 = No involvement

STATUS CODES: C2 = Category 2 species, under study for listing as Threatened or Endangered
S1 = Critically imperiled in the state; 5 or fewer occurrences
S2 = Imperiled in the state; 6 to 20 occurrences
S3 = Rare or uncommon in the state; 20 to 100 occurrences

b. Existing Environment

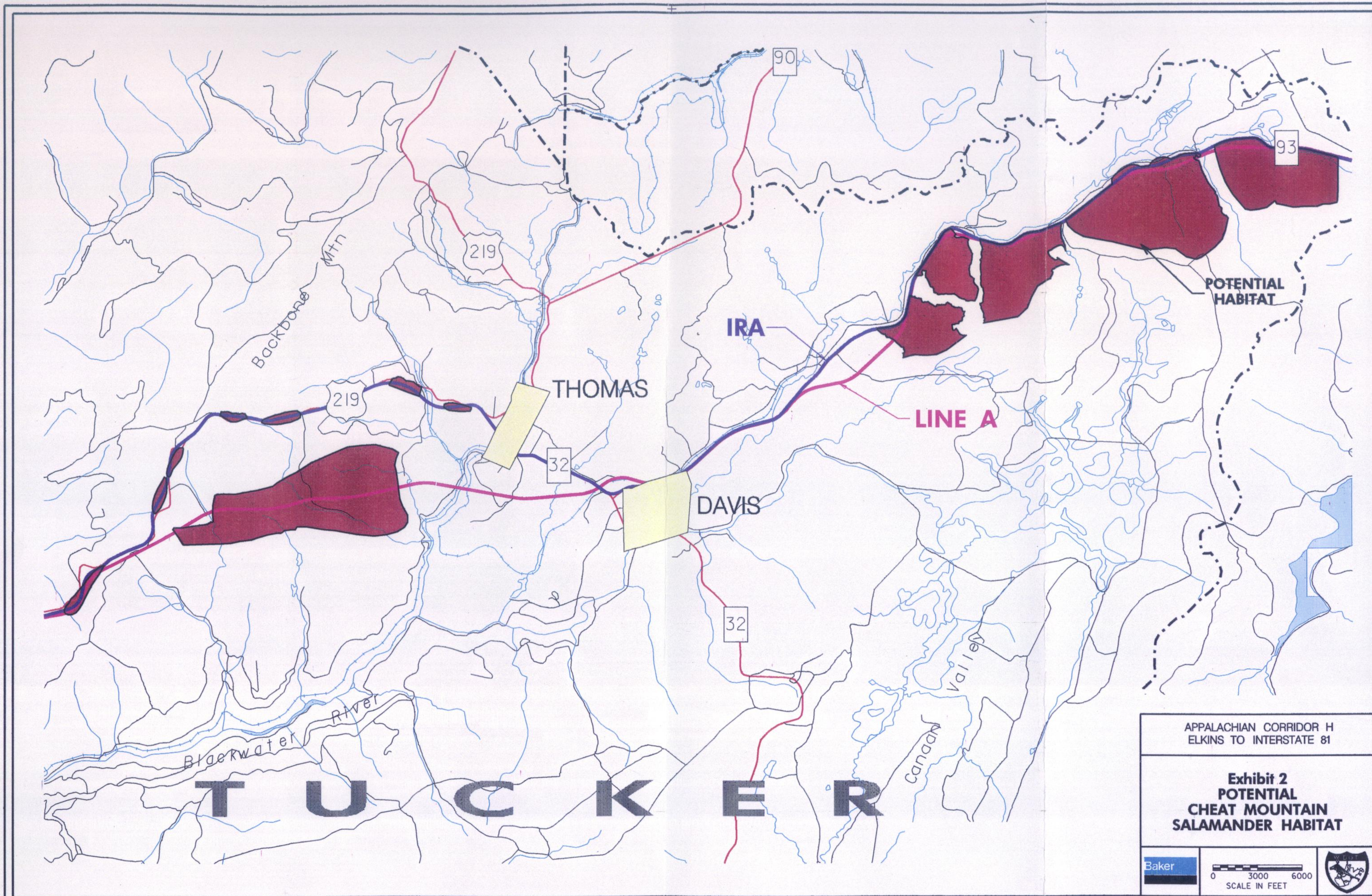
The Cheat Mountain Salamander is a small woodland salamander currently known to exist at 68 sites within an approximately 1,813 square kilometer (700 square-mile) area in West Virginia (USFWS 1991). This salamander is found near elevations of 915 meters (3,000 feet) in red spruce (*Picea rubens*), hemlock (*Tsuga canadensis*) and mixed deciduous forests dominated by yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), and black cherry (*Prunus serotina*) (Pauley, 1994). Most of the known populations consist of less than ten individuals confined within a small territory. The presence of forest floor litter such as decayed logs, flat rocks, fallen limbs, and leaf material is an important habitat component, providing foraging cover and daytime refugia.

Several confirmed populations of the Cheat Mountain salamander occur along Backbone Mountain in the North Branch of the Potomac River watershed. None of the confirmed populations occur within the current alignments; however, several areas of potentially suitable habitat were identified during the field investigation (Exhibit 2).

c. Impacts

Habitat modifications that remove the forest canopy are reported to be the primary factors affecting the Cheat Mountain salamander. Removal of the forest canopy would permit a greater percentage of sunlight to reach the forest floor, resulting in an increase in soil temperature and a decrease in soil moisture, both important microhabitat components (USFWS 1991). Man-made and natural events such as mining activities, utility rights-of-ways, timbering, wildfires, insect infestations, and road development all contribute to canopy reduction. Highway construction would potentially impact the Cheat Mountain salamander through direct loss of habitat and indirectly through habitat modification.

As shown in Exhibit 2, the initial salamander field investigation revealed several areas of potentially suitable habitat that would be impacted by either the IRA or Line A. This includes approximately 9.7 kilometers (6 miles) adjacent to and south of Route 93 between Davis, West Virginia and Mount Storm (impacted by Line A and the IRA), approximately 4.5 kilometers (2.8 miles) from Olson Road (Forest Service Road 18) east to the town of Douglas, West Virginia (impacted by Line A); and approximately 4.3 kilometers (2.7 miles) adjacent to US 219 from Olson Road (Forest Service Road 18) to Benbush (impacted by the IRA).



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Cool temperatures precluded a search for the salamander at the time of the initial survey. The salamander remains underground for the winter after several hard frosts and becomes active in the spring when the nighttime temperatures remain above 45°F. Dr. Pauley and a team of herpetologists conducted detailed field surveys in May and June of 1994 to search for Cheat Mountain salamanders in these locations. No Cheat Mountain salamanders were found within the construction limits of the Improved Roadway or Build Alternatives (See Appendix C for Pauley report).

2. RUNNING BUFFALO CLOVER

Running buffalo clover (*Trifolium stoloniferum)* was listed as an Endangered species by the US Fish and Wildlife Service (USFWS) on July 6, 1987, (50FR 21478-21480).

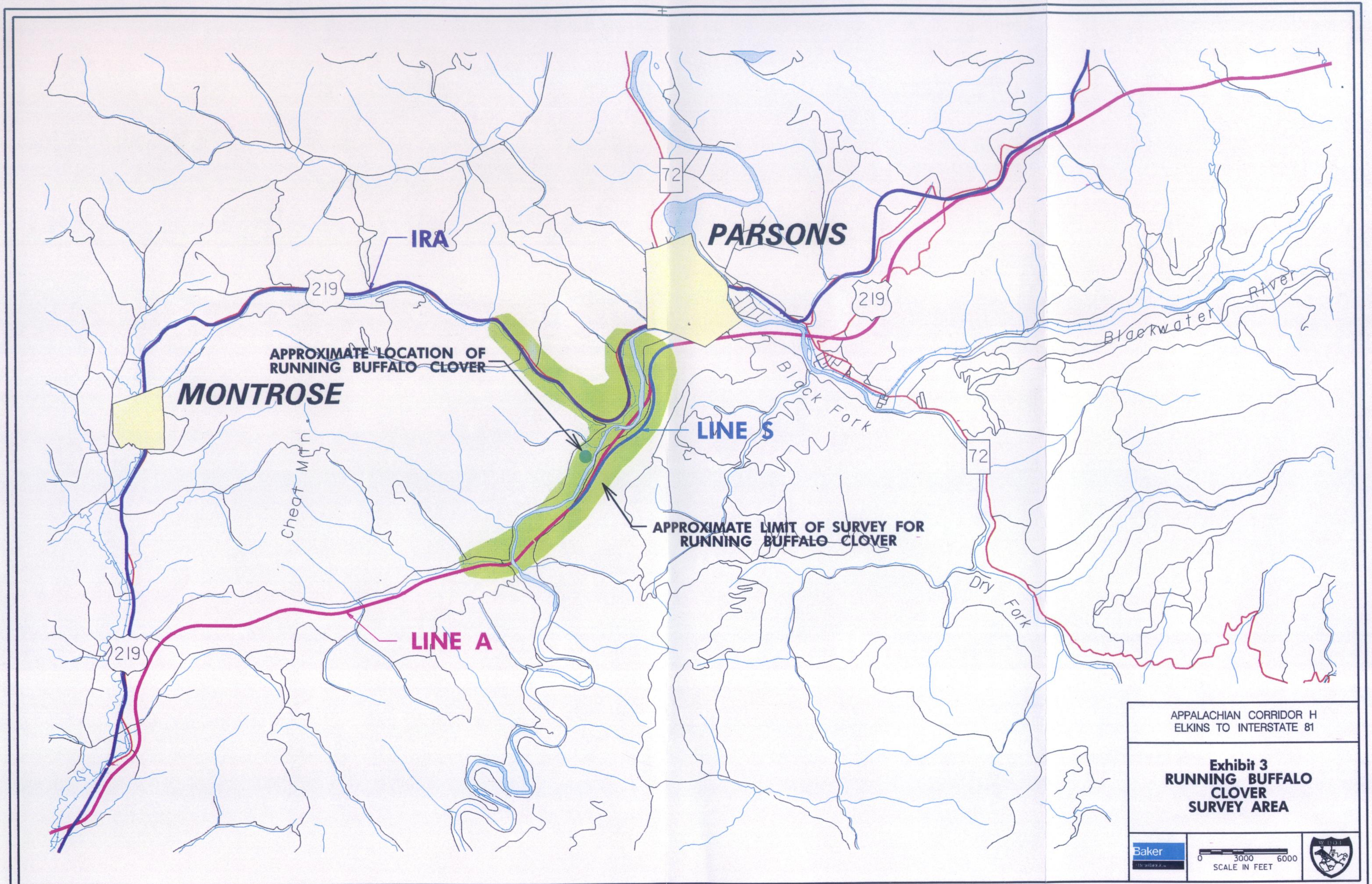
a. Methods

Meetings were conducted in July 1993 with the USFWS to discuss the potential impact of the proposed project on running buffalo clover populations. The USFWS expressed concern over potential impacts to the known clover population west of Parsons, West Virginia along Shavers Fork in the Cheat River watershed, and provided USGS mapping with the approximate location of this population. This information was entered into the GIS database for analysis.

Mr. William Tolin of the USFWS was consulted in the formulation of a sampling protocol to address this issue. A systematic survey was conducted of all pedestrian and /or vehicular trails and adjacent habitat that intersects the current alignments, up to 2.5 miles from the above referenced clover population. The survey included an area up to 4 kilometers (2.5 miles) from the above referenced clover population (Exhibit 3). Prior to the field survey, a field review was conducted with the USFWS to a known running buffalo clover population. During this review, an environmental staff botanist photographed the plant and studied its morphological characteristics to aid in field identification during the field survey.

b. Existing Environment

Running buffalo clover is a plant species that was historically associated with migration trails of large herds of bison and elk. This clover seems restricted to areas of moist fertile soils, partial shade and requires some sort of moderate disturbance such as mowing or trampling (Cambell *et al.,* 1988, Cusick 1989).This plant was once widely distributed from Kansas to West Virginia, but is currently found in only a small portion of its former range. Scientists speculate that a major reason for the decline of this species is the



/corh/shtplot/final/wildlife/tr/tclogrph.dgn absence of the large migratory herbivores that once provided soil enrichment, periodic habitat disturbance and seed dispersal apparently necessary for the proliferation of this plant (USFWS 1989). Current populations are threatened by direct habitat destruction, excess human disturbance (such as all-terrain vehicle use), and by vegetative competitors that shade out and kill individual plants.

c. Impacts

The current location of the alignments overlaps running buffalo clover potential habitat west of Parsons, West Virginia in the Cheat River Watershed (Exhibit 3). Field investigations of this potential habitat were conducted in September 1993. During the survey, one clover species, white clover (*Trifolium repens*), was identified in numerous sites within the study area. No running buffalo clover populations were found along any of the pedestrian or vehicular trails identified as intersecting the proposed alignments within 4 kilometers (2.5 miles) of the known population. No impacts to this species are expected to occur due to either the IRA or the Build Alternative. The No-Build Alternative would not impact this species.

3. FEDERALLY LISTED CANDIDATE SPECIES

In accordance with 50 CFR 402.12 species under study for Federal listing as Threatened or Endangered that potentially occur within the project area were identified.

a. Methods

There are six 'Category 2' plant and animal species which have been documented within or near the proposed project area (Table 24). Category 2 species are those for which the information now in the possession of the USFWS indicates that proposing to list as threatened or endangered is possibly appropriate, but further field studies are required to provide conclusive data on biological vulnerability before final determinations can be made.

b. Existing Environment and Impacts

Two plant species, Kate's mountain clover (*Trifolium virginicum*) and mountain pimpernal (*Taenidia montana*), are located in a group of shale barrens adjacent to WV 55, northeast of Wardensville. These plants were identified during a WVNHP rare species survey of these shale barrens. These species would not be impacted by the No-Build or the Build Alternative. However, the IRA would potentially impact these plant species in this area. Due to insufficient scientific information on the population status of these species, it is difficult to make impact assessments at this time.

If the IRA is selected, coordination with the appropriate resource agencies would be initiated and a detailed investigation would be conducted. Based on these results, design modifications could be made for the final EIS.

The rock vole (*Microtus chrotorrhinus carolinensis*) was documented by the WVNHP west of Parsons, adjacent to US 219 near Porterwood. This species is associated with rocky habitats within cool, moist forests of yellow birch, maple, and hemlock with a dense understory of herbaceous vegetation. This species would not be impacted by the No-Build or the Build Alternative. However, the IRA would potentially impact this species in this area. Due to insufficient scientific information on the population status of this species, it is difficult to make an impact assessments at this time. If the IRA is selected, coordination with the appropriate resource agencies would be initiated and a detailed investigation would be conducted. Based on these results, design modifications could be made for the final EIS.

The New England cottontail (*Sylvilagus transitionalis*) was documented by the WVNHP east of Davis, WV adjacent to WV 93. This species is associated with dense forests at higher elevations of both coniferous and deciduous canopy vegetation. This species would not be impacted by the No-Build, Build, or Improved Roadway Alternatives. General wildlife sign and observations were recorded during extensive stream sampling, wetlands delineation field work, and HEP data collection in this area. No New England cottontails were observed during these field efforts.

During a public meeting, an occurrence of the brook floater mussel (*Alasmidonta varicosa*) was reported within the North Fork of Patterson Creek, approximately 2.3 km (1.4 miles) northeast of Medley, WV. However, the WVDNHP has not identified this location. The IRA would cross the North Fork of Patterson Creek at this location by a simple span bridge, and as such, would have a minimal impact on any mussel species present in this area. If the IRA is selected, coordination with the appropriate resource agencies would be initiated to confirm the population status of this species at the above referenced location. This species would not be impacted by the No-Build or the Build Alternatives.

The loggerhead shrike is a 'Category 2' Candidate Species and is listed as Threatened in the state of Virginia. This species is discussed in the following section.

B. VIRGINIA STATE LISTED SPECIES

In addition to Federally protected species, the state of Virginia has legislation that provides protection to plant and animal species deemed Threatened or Endangered within the state. These designations are based on population levels within Virginia and do not necessarily represent the population status of a particular species throughout its geographic distributional range. In Virginia, both the Virginia Department of Game and Inland Fisheries (VDGIF) and the Virginia Division of Natural Heritage (VDNH) maintain databases on the presence of Federal and state listed Threatened and Endangered plant or animal species.

1. WOOD TURTLE

The wood turtle (*Clemmys insculpta)* is listed by the state of Virginia as a Threatened species (Virginia Regulation 325-01-1, § 13) and has been identified by VDNH and VDGIF as having potential involvement with the proposed alignments.

a. Methods

The Virginia Division of Natural Heritage (VDNH) and the Virginia Department of Game and Inland Fisheries (VDGIF) were contacted to identify potential habitat of the wood turtle that would be potentially affected by the proposed alignments. VDNH and VDGIF expressed concern over potential impacts of the proposed alignments (IRA, Line A, Line D1, and Line D2) where they parallel and intersect Duck Run and Cedar Creek. Wildlife signs and observations were recorded during the extensive stream sampling and wetlands delineation field work in this area.

b. Existing Environment

The wood turtle is a medium-sized turtle found primarily in and near clear brooks and streams in deciduous woodlands in Virginia. Most activity is restricted to home ranges of 0.4 to 2.4 hectares (1 to 6 acres). These turtles are omnivorous and consume a wide variety of both terrestrial and aquatic plant and animal matter. Northern Virginia is the southern extent of this species distributional range. Little is known of the ecological requirements or behavior of the wood turtle in Virginia. The presence of forest floor litter (decayed logs, flat rocks, fallen limbs, leaf material) is an important habitat component, providing foraging cover and daytime refugia.

c. Impacts

In Virginia, the current location of all alignments (the IRA, Line A, Line D1, and Line D2) would overlap wood turtle habitat along Duck Run and Cedar Creek in the Shenandoah River watershed. Line D2 would impact the greatest amount of potential wood turtle habitat (88 ha, 216 ac) while the IRA would impact the least (15 ha, 37 ac). However, no wood turtles were observed during field investigations in the vicinity of Cedar Creek or Duck Run. The wood turtle would not be impacted under the No-Build Alternative.

2. LOGGERHEAD SHRIKE

The loggerhead shrike (*Lanius ludovicianus)* is listed by the state of Virginia as a Threatened species (Virginia Regulation 325-01-1, § 13). The loggerhead shrike is a medium sized bird found primarily in open country with scattered trees and shrubs. Typical breeding and wintering habitats in Virginia consist of short grassland, such as closely grazed pasture, especially in areas with scattered hedgerows and fence lines. Shrikes often nest in dense brush or areas with thorny trees such as hawthorns (*Crataegus* spp.) or locusts (*Robinia pseudoacacia, Gleditsia triacanthos*). Insects, small reptiles, amphibians, birds and small mammals make up the majority of the shrike's diet. Prey is habitually impaled in thorn trees or on barbed wire fences.

The loggerhead shrike population has experienced a general decline in the northeastern part of the country with documented declines in New York and Ontario, and has apparently been extirpated from New England (Brauning 1992). By the early 1980s, the shrike had almost completely disappeared from many previously known locations in West Virginia (Hall 1983). Virginia has experienced similar declines throughout the state (USFWS unpub. Breeding Bird Survey (BBS) data). The reason for this decline in the Northeast is unclear. Possible explanations include pesticide contamination and habitat degradation. Subtle changes in pasture and grassland habitat may impact shrike foraging success and ultimately affect the population dynamics of the species. As agricultural practices of grazing and regular mowing have changed, large areas of pasture and grassland have been left idle. Vegetational succession has replaced short grass habitat with shrubs and dense herbaceous plants. This landscape may impair the shrike's visual ability to locate successfully and capture prey species.

a. Methodology

VDNH and VDGIF were contacted to identify potential habitat of the shrike that would be affected by the proposed alignments. VDGIF documented this species nesting in the southeastern section of the Mountain Falls quadrangle and suggests that other nests may occur within the project area where suitable habitat conditions are present. The GIS was used to identify suitable habitat within the alignments. Suitable habitat was defined as Anderson Level 21 (Cropland and Pasture) and 31 (Herbaceous Rangeland).

b. Existing Environment and Impacts

The location of the proposed alignments does not impact the known nesting area identified by VDGIF. Wildlife signs and observations were recorded during the extensive stream sampling, wetlands delineation field work and HEP data collection along the alignments. No loggerhead shrikes were observed during the course of these field investigations. However, all alignments impact potential shrike habitat. Line A would impact 21 ha (52 ac) of potential habitat while the IRA would impact 9 ha (22 ac). These impacts represent less than 1% of the regional potential shrike habitat. The loggerhead shrike would not be impacted by the No-Build Alternative.

C. WEST VIRGINIA RARE SPECIES

Coordination with WVNHP documented the potential occurrence of nine Rare plant species within the proposed alignments (Table 30). Six of the nine species were located during a WVNHP rare species survey northeast of Wardensville in a group of shale barrens adjacent to WV 55. This area would be potentially impacted by development of the IRA. Three species occur within the Davis, WV quadrangle along WV 93. These plants are associated with wetlands and wet areas near Beaver Creek. These species would be potentially impacted by both the IRA and Line A. Due to insufficient scientific information on the population status of these species, it is difficult to make a quantitative impact assessment at this time. Strausbaugh and Core (*Flora of West Virginia,* 1977) list several localities for each species, but no indication of population size is available. Six additional Rare plant species were identified during wetland field investigations, but were not impacted by the alignments (Table 30).

Where possible, alignments were developed to avoid known populations of Species of Special State Concern. Three of these species are associated with wetlands and/or riparian areas. Avoidance and minimization of wetland impacts across the proposed project area would minimize any potential impacts to the these species. The remaining species are associated with shale barrens that include two 'Category 2' Candidate Species. As stated above, if the IRA is selected, coordination with the appropriate resource agencies would be initiated and a detailed investigation would be conducted. Based on these results, design modifications could be made for the final EIS.

TABLE 30
WEST VIRGINIA DEPARTMENT OF NATURAL HERITAGE RARE SPECIES WITHIN THE PROPOSED PROJECT AREA

RARE SPECIES [1]	USGS QUAD	ALTERNATIVE
Hoary Sedge (*Carex canescens*)	Davis	IRA, Line A
Northern Stitchwort (*Stellaria calycantha*)	Davis	IRA, Line A
Thread Rush (*Juncus filiformis*)	Davis	IRA, Line A
Shale Barren Bindweed (*Convolvulus purshianus*)	Wardensville	IRA
Dodder (*Cuscuta indecora*)	Wardensville	IRA
Milk Pea (*Galactia volubilis*)	Wardensville	IRA
Pussytoes Ragwort (*Senecio antennariifolius*)	Wardensville	IRA
Shale Barren Evening-primrose (*Oenothera argillicola*)	Wardensville	IRA
Shale Barren Goldenrod (*Solidago harrisii*)	Wardensville	IRA
[1]Based on West Virginia Natural Heritage Program (WVNHP) Data, February, 1994		
ADDITIONAL RARE SPECIES DOCUMENTED WITHIN THE PROPOSED PROJECT AREA[2]	**WETLAND SITE #[3]**	**ALTERNATIVE**
Jointed Rush (*Juncus articulatus*)	1285, 1286, 1325A, 1339D	None
Large Grass-leaved Rush (*Juncus biflorus*)	720, 1331	None
Needle-pod Rush (*Juncus scirpoides*)	613, 1507C	None
Torrey's Rush (*Juncus torreyi*)	907, I-66-1	None
Swamp Saxifrage (*Saxifraga pennsylvanica*)	1024, 1321B, 1321C, 1321D	None
Marsh Speedwell (*Veronica scutellata*)	1301A	None
[2]Based on Wetlands Field Investigations	[3]See ***Wetlands Technical Report*** for Location Information	

IV. FOREST FRAGMENTATION AND BIODIVERSITY

A. LITERATURE REVIEW

Natural landscapes are typically composed of a mosaic of habitats differing in size, shape, and vegetative structure and composition (Verner 1986). If undisturbed long enough, such landscapes tend to reach a stage in which units of the mosaic retain fairly stable local plant communities or climax patterns (Whittaker 1953). However, natural disturbances in the form of fires, storms, landslides, earthquakes and erosion contribute to reduce the patch size of existing habitat units and to alter their vegetative composition, often to earlier successional stages. These activities can produce a variety of direct and indirect impacts to existing plant and animal communities. Verner (1986) suggests that because so many species of terrestrial vertebrates are adapted to breed successfully in disturbed habitats, it might be inferred that natural disturbance has been a frequent and widespread occurrence in geologic history. In addition, many plant species have evolved to pioneer disturbed landscapes, serving to begin the vegetational succession process. Therefore, it is not possible to present all fragmentation of habitat as either "good" or "bad" since it operates at varying scales on each species (USDA, FEIS George Washington National Forest, 1993).

Human activities such as the construction of powerlines, residential and industrial developments, agricultural practices and roadways can produce habitat fragmentation resulting in a change to the vegetation of the successional community. Of particular concern in the central and eastern United States is the fragmentation of forest habitat and its resulting effect on biodiversity. Forest fragmentation is the process whereby large, continuous, and often homogenous areas of forest are broken into smaller often isolated tracts surrounded by a matrix of cultivated land, residential development, or other nonforest land use. Forest fragmentation is a function of several parameters:

- patch size - the areal extent of the resulting habitat fragments;
- patch isolation - the characteristics of the surrounding land use;
- total reserve area - the sum of patches and contiguous forest;
- edge - the transition area between two or more habitat types;
- connectivity - the habitat linkages among patches.

Minimizing forest fragmentation promotes the natural patterns and connectivity of wildlife habitats that are key components of biodiversity (CEQ, 1993). The physical alteration of existing land use and changing land use patterns that lead to habitat simplification and fragmentation, disrupt species interactions and ecosystem processes. A regional assessment of forest fragmentation was used to determine potential effects on existing biodiversity within the 30-Minute Contour.

A great deal of research has been done to evaluate the effect of forest fragmentation on the distribution and abundance of wildlife species. Due to the complex nature of the interacting parameters outlined above and the number of different wildlife species potentially involved, no consensus has been reached by the body of scientific researchers as to the overall effects of forest fragmentation on wildlife species. Most published scientific literature to date deals with avian species and their response to this phenomenon. A review of this literature was conducted to examine and summarize the major research findings on this topic.

Many researchers have studied the potential effects of forest fragmentation on avian communities. Robins et al. (1980) determined that gaps greater than 100 m (330 ft.) in contiguous forest habitats produced isolation characteristics in the small habitat fragments created. Anderson (1979) showed that transmission-line corridors wider than 61 m (200 ft) created grassland/shrub habitats within the forest. These corridors created new vegetative communities that when considered with the total bird population of the deciduous forest resulted in a greater variety and diversity of birds in the region. Rosenberg and Raphael (1986) found that bird and amphibian species richness increased significantly on more fragmented stands of Douglas-fir forests and in study plots containing more edge. A variety of species were able to utilize the more diverse vegetative component of the edge-forest ecotone.

A major topic of research has focused on the potential impact of forest fragmentation on neotropical migrant and interior forest dwelling songbirds. Neotropical migrants winter in Central America and the Caribbean, and to a lesser extent in South America, but breed in North America. A number of researchers have reported on the population decline of these species between the late 1940's and the late 1980's (see Finch 1991). Several causes have been suggested for this decline; the loss of winter habitat in Latin America (Hall 1984, Ambuel and Temple 1982), brood parasitism by the brown-headed cowbird (Molothrus ater) (Brittingham and Temple 1983), a low rate of colonization and a high rate of extinction in small, isolated woodlots (Whitcomb et al., 1981), the lack of critical microhabitats (Lynch and Whigham 1984) and higher rates of nest predation in small woodlots compared to large forest tracts (Robbins 1980, Ambuel and Temple 1983, Wilcove 1985). Hall (1984) suggests that some decreases in the number of neotropical species may be density dependent and result from the movement of bird species from optimal to suboptimal habitat as populations fluctuate over time.

Forest succession should be considered another potential factor influencing the changing diversity and population numbers of forest bird species. Martin (1960) reported on the changing bird populations that accompany vegetational succession. Freemark and Merriam (1986) found that habitat heterogeneity (spatial variability in habitat conditions within forest stands) was an important factor in determining bird species assemblages. Baird (1990) analyzed population changes in breeding birds in a Western New York forest from 1930 to 1980. He found the largest population decline among forest species that generally build nests less than 2 meters (6.6 feet) above the ground. He attributed this decline to the heavy browsing of white-tailed deer which has dramatically altered the understory vegetative composition. Baird observed both local increases and decreases over the past 50 years in a number of neotropical and short-distance migrants, as well as several permanent residents. Baird's study did not provide clear evidence that species which migrate to the Neotropics are declining more rapidly than short-distance migrants or permanent resident species.

Several research efforts on the effects of forest fragmentation on avian species have been conducted in the Midwest. In this area, once large expanses of contiguous forest have been replaced by small woodlots that have been extensively isolated by surrounding agricultural land. These woodland "islands" have served as study areas where the theories of island biogeography have been explored for terrestrial ecosystems. MacArthur and Wilson (1967) proposed that the number of species resident on an island is influenced primarily by area, but also by habitat diversity, age of the island, and its isolation. The Midwest's landscape mosaic has provided researchers the opportunity to study a number of fragmentation parameters such as patch size and edge effect. Temple (1986) defined the functional habitat unit for area sensitive species (core area) as the area of forest more than 100 m from an edge, instead of the total forest area observed. Further studies by Temple and Cary (1988), found significant differences in nesting success (18%, 58%, 70%) of forest interior dwelling birds within three distances from edge categories (< 100 m, 100-200 m, > 200 m) and classified these as poor, marginal and good quality habitat respectively. They attributed these differences to nest predation, brood parasitism and competition that are associated with edge habitats. Robinson (1992) found that small isolated woodlots (< 70 hectares (170 acres)) appeared to serve as population sinks for many species of Neotropical migrants and contained several species that are considered area-sensitive elsewhere in their range, including the worm-eating warbler (Helmitheros vermivorus) and ovenbird (Seiurus aurocapillus). However, most species suffered high nest predation and parasitism rates due to the edge-dominated forest patch configuration.

Blake and Karr (1987) studied breeding bird communities of isolated woodlots in Illinois. They found that the number and type of bird species breeding in these habitats was primarily dependent on the area of the woodlot. Differences observed among woodlot bird populations were attributed to the degree of isolation of each woodlot. Woodlots in this study were typically separated by many kilometers. They suggested that woodlots that were by themselves too small to support certain species, could do so if there were additional habitat located nearby. Lynch and Whigham (1984) studied breeding bird communities in upland forest patches of Maryland and found that vegetation characteristics, rather than patch geometry, appeared to play the dominant role in determining community composition and local abundance for the majority of bird species. Woodland patches in this study did not display the same degree of isolation as the Illinois study and were generally separated by small distances (0.1-1 km). The complex inter-relationship between area, isolation and vegetative habitat characteristics influenced almost every bird species within the study area. Robbins et al., (1989) found many similarities with the above study, but also some important differences. A more comprehensive sampling effort yielded data on a wider variety of habitat components and bird species.

This study determined that 51% of the bird species were correlated with forest area as opposed to 26% in the Lynch and Whigham (1984) study.

Some researchers have attempted to determine the optimal forest patch size necessary to provide breeding habitat for all species of forest nesting birds. Blake and Karr (1984) found that forest interior species were not well represented in woodlots < 30 hectares (70 acres). However, species differ in many life history characteristics that influence occurrence in isolated patches of habitat and determination of optimal reserve size is dependent on species specific ecology. Robbins et al., (1989) studied area requirements of forest birds in Maryland and adjacent counties in Pennsylvania, West Virginia, and Virginia. Twenty-six avian species showed a significant increase in probability of occurrence as forest area increased and were considered to be area-sensitive. The authors emphasize that even in forest tracts > 3000 ha (7410 acres), species such as the northern parula warbler (Parula americana) and cerulean warbler (Dendroica cerulea) had occurrence probabilities < 0.4. They suggest that if smaller forest tracts containing streams and bottom-land habitat (preferred by these species) were preserved, these birds could likely reside there. As in other studies, proximity to other forest stands (isolation) was also found to influence the minimum breeding area for some species.

In landscapes dominated by agricultural use (cropland, pastures), much of the remaining forest is in linear tracts along streams. These forested strips provide habitat for a variety of bird species, including several area-sensitive neotropical migrants (Keller et al., 1993). In addition, these areas have been found to improve water quality by reducing the sediment and nutrient content of agricultural runoff (Peterjohn and Correll 1984, Paterson and Schnoor 1993). Croonquist and Brooks (1993) found that naturally vegetated riparian corridors > 125 m (410 ft.) were needed to support the full complement of bird communities. However, protecting at least a 25 m (80 ft.) wide corridor on each bank provided feeding, resting, or migrating corridors for uncommon, sensitive species including forest interior and neotropical migrants birds.

While some researchers (Whitcomb et al., 1981) indicate that populations in fragmented habitats are declining at a rapid rate for reasons associated with such fragmentation (e.g., habitat island size, high predation, and frequent brood parasitism), bird population declines have also been observed in relatively undisturbed forests. Holmes et al. (1986) conducted studies in an unfragmented (3,075 hectare (7,600 acre)), temperate, deciduous forest (Hubbard Brooks, New Hampshire) for 16 consecutive breeding seasons. Bird community dynamics varied over time, with many species (70%) declining during this period. Individual species responded to a variety of environmental factors that operated on local, regional and global scales. Five major factors were identified that influence bird numbers in the forest; food abundance, breeding season weather, successional habitat changes, interspecific aggression, and winter mortality. Hall (1984) found that both the number of species and population of neotropical migrants had declined in an undisturbed portion of the Cheat Mountains in West Virginia. The author states that a precise reason for this decline cannot be assigned, but suggests that tropical deforestation as well as local climatic and weather factors may be contributing components.

Holmes and Sherry (1988) suggest that there is little agreement on the factors that regulate songbird populations. At the unfragmented Hubbard Brooks research area, 42% of the regularly occurring species declined from 1969 to 1986, including 4 neotropical migrant species. Based on their research findings, the authors conclude that forest fragmentation is probably not a factor in the observed decline of avian species over most of New Hampshire where forests predominate and where urban development is only beginning to affect the landscape. One neotropical migrant species that declined considerably was the least flycatcher (Empidonax minimus). This decline was attributed to the gradual maturing of the woodlands throughout the state of New Hampshire. This species favors conditions of intermediate succession with open subcanopies beneath dense upper canopy vegetation. Population trends varied for the least flycatcher from nearby states suggesting that regional land-use patterns may be an important factor in affecting habitat suitability for this species. Other species that may have been affected by changing habitat structure were the American redstart and the wood thrush. Both species reach maximal densities in mid-successional forests. The authors suggest that it is premature to attribute observed population trends in North America songbirds to any one causal factor.

Böhning-Gaese et al. (1993) used the Breeding Bird Survey (BBS) data to analyze trends in breeding populations of 47 insectivorous passerines in central and eastern North America, including long distance neotropical migrants. BBS data may be useful for identifying large scale trends in bird abundance and for providing perspective about the generality of those trends. The results suggest that those species that winter in the tropics did not experience strong decreases in their populations. Long distance neotropical migrants experienced a small, nonsignificant decreasing trend, whereas residents and short-distance migrants increased strongly. The declines observed were attributed to breeding ground predation and not to deforestation of wintering habitat in tropical America.

Finch (1991), as part of the USDA Forest Service's role in the Neotropical Migratory Bird Conservation Program, reviewed and summarized the current information on population trends of neotropical migratory birds and the factors affecting migrant populations on the wintering and breeding grounds. The author concluded that sufficient information was lacking on the population status and causes of population changes of neotropical migrants to develop an effective management plan to conserve these species.

B. METHODOLOGY

Large forested tracts are important habitat for area sensitive species and species requiring large territories. These forested areas contain other microhabitats such as streams and associated riparian corridors that are utilized by a wide variety of wildlife species for feeding and/or breeding purposes. To assess the effects that a new highway corridor may have on species and biological communities, indicator species were chosen to represent area sensitive and landscape dependent (sensitive to changing land use patterns) species. Forest interior neotropical migrant bird species were used to assess the potential impacts of forest fragmentation on area sensitive species. Changing land use patterns due to highway construction were assessed to determine the potential effects on landscape dependent species such as the wild turkey (Meleagris gallopavo), black bear (Ursus americanus), and bobcat (Felis rufus) (Brook and Croonquist, 1990). This analysis was restricted to the Build and Improved Roadway Alternatives.

Breeding bird survey (BBS) data was obtained from the US Fish and Wildlife Service's Office of Migratory Bird Management. Breeding bird population trend information was received for West Virginia and Virginia. This information was reviewed to determine the present population trends of neotropical migrant bird species within West Virginia and Virginia. As the cowbird (Molothrus ater) is implicated as one factor in the decline of neotropical migrants (Brittingham and Temple 1983), population trends of this species were also reviewed.

Forest fragment size (patch size) is an important factor in determining utilization by forest-interior neotropical migrant species. Of particular concern was the creation of small forest patches that may be unusable by interior neotropical migrants for breeding purposes. Impacts that would potentially create small forest patches were assessed using land use/land cover data acquired through the interpretation of 1" = 1,000' scale aerial photography and selected groundtruthing. This photography encompassed an area approximately 3.2 km (2 miles) wide and 192 km (120 miles) in length and provided an accurate account of the potential creation by the proposed highway of relatively small (less than 150 ha, 370 ac) forest fragments that were entirely within the photography boundaries. Larger forest polygons (greater than 150 ha, 370 ac could extend beyond the limits of the photography, making an accurate assessment of their total size impractical using these data. GIS analysis determined the number of forest patches created by the construction of both Line A and the IRA. This information was used to assess the potential impact on minimum breeding area requirements for four neotropical migrants that occur within the proposed project area. These species were chosen to represent interior forest dwelling species whose breeding area requirements span a number of forest patch sizes.

Potential changes in land use patterns were assessed using USGS 1:250,000 scale digital Anderson Level II land use/land cover data. GIS analysis determined the amount of several land use/land cover types before and after proposed highway construction within the 30-Minute Contour. The 1:250,000 scale digital data provided a broad overview of the existing land use/land cover within a large geographic area and allowed an assessment of potential changes at a "regional" scale.

Total reserve area or the total amount of forest habitat is another important factor to species that utilize large areas of this habitat type. GIS analysis determined the total acreage of forest habitat within the 30-Minute Contour before and after highway construction.

Further analysis to consider edge effects due to road construction were assessed by placing a 200m buffer on the construction limits of the proposed highway and recalculating the number and size of forest patches within the limits of the aerial photography. This was an attempt to define the core area available for area sensitive species after secondary effects of nest predation, brood parasitism and competition (associated with edge habitats) were considered (Temple and Cary, 1988).

C. EXISTING ENVIRONMENT

Breeding bird survey (BBS) data and minimum breeding area requirements are summarized in Table 31A. Within West Virginia, the population trends showed an increase for three of the four indicator species with varying minimum breeding area requirements. Virginia had two species that had declining population trends. The cowbird showed a decreasing population trend in West Virginia (-4.1%) and a slight increase in Virginia (0.2%). This may reflect the overall land use patterns within the two states and the species ability to exploit these patterns. Cowbirds are able to utilize open areas of traditional foraging habitat (agriculture/pasture) as a base from which to parasitize forest dwelling species. West Virginia is predominantly a forested state, whereas Virginia has a larger agricultural component interspersed with forest. This is reflected in the land use patterns for the 30-Minute Contour. Of the 592,642 ha (1,464,418 ac) in West Virginia and 136,137 ha (336,394 ac) in Virginia, forested habitat comprises 80% and 52% of West Virginia and Virginia land use respectively, while agriculture/pasture makes up 42% in Virginia and 18% in West Virginia.

D. IMPACTS

Table 31B summarizes the changes in the number of forest patches less than 150 ha (370 ac) due to construction of the Build and Improved Roadway Alternatives. Based on the land cover mapping prepared from 1"=1,000' scale aerial photography, a total of 206 forest patches less than 150 ha would be created due to the construction of the Build Alternative (Line A). Fifty three percent (110) of these patches would be less than 1 ha (2.5 ac) in size. Based on the indicator species minimum breeding area requirements (Table 27), parcels less than 1 ha in size would not be suitable habitat for breeding purposes. However, forest patches smaller than that required for breeding may be used as foraging or resting areas. These areas can also serve as population sinks for non-breeding individuals (Robinson, 1992). These parcels comprise less than 1% of the

TABLE 31A
MINIMUM BREEDING AREA REQUIREMENTS AND BREEDING BIRD SURVEY DATA FOR PROPOSED PROJECT AREA FOREST INTERIOR NEOTROPICAL MIGRANTS1

SPECIES		MINIMUM BREEDING AREA		POPULATION2 TRENDS 1982-91	
		Hectares	Acres	WV	VA
Wood thrush	*Hylocichla mustelina*	1	2.5	-0.3	-2.7
Red-eyed vireo	*Vireo olivaceus*	2.5	6	0.7	3.9
Ovenbird	*Seiurus aurocapillus*	6	15	7.1	-0.9
Veery	*Catharus fuscescens*	20	49	6.6	*
Brown-headed cowbird	*Molothrus ater*			-4.1	0.2

1Robbins et al. 1989.

2Average percent annual change

* - No data available

TABLE 31B
FOREST PATCHES CREATED COMPARED TO MINIMUM AREAL BREEDING REQUIREMENTS OF NEOTROPICAL MIGRANT INDICATOR SPECIES

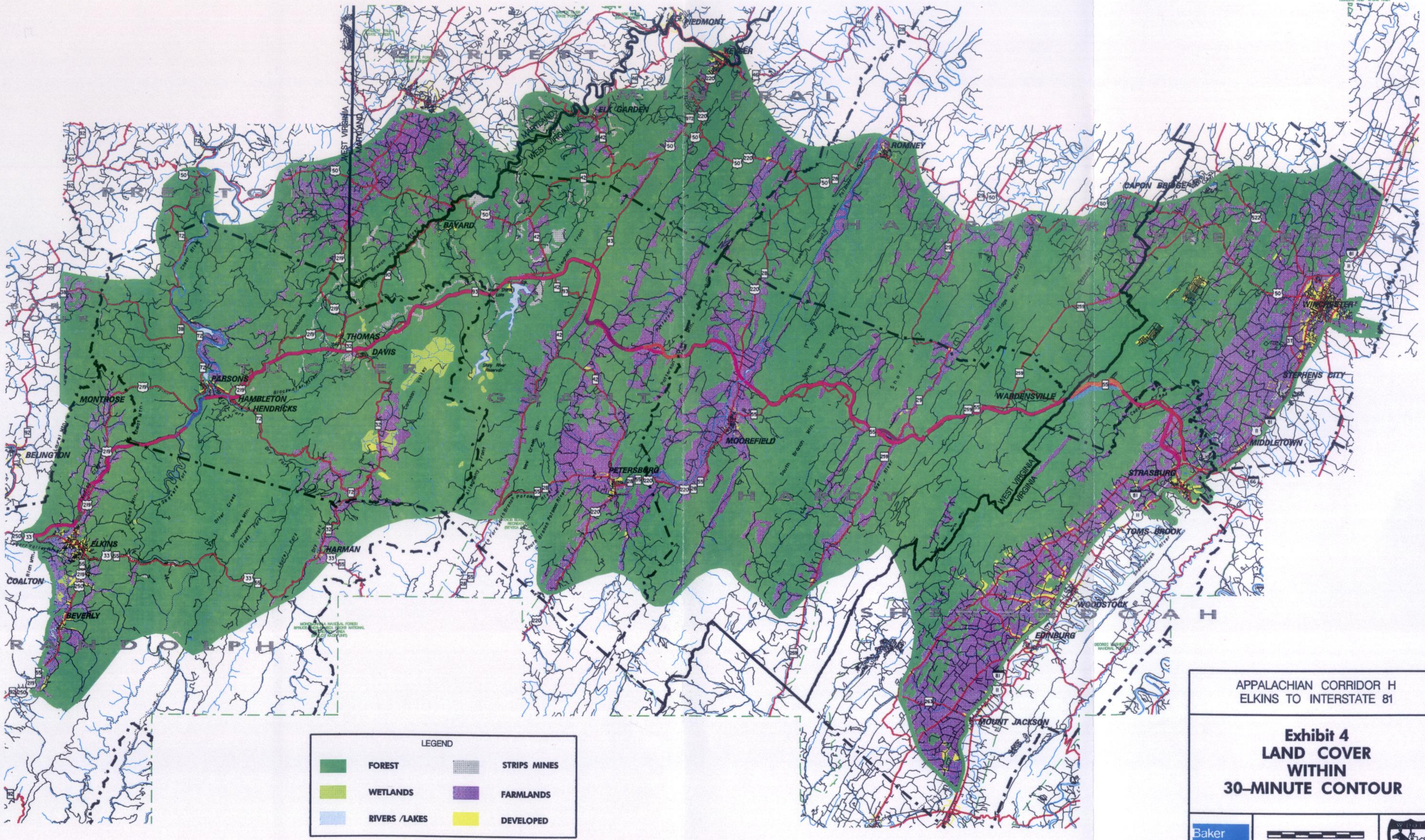
MINIMUM AREAL BREEDING REQUIREMENTS MET (# OF SPECIES)	PATCH SIZE		BUILD ALTERNATIVE - LINE A			IRA		
				CHANGE IN AREA			CHANGE IN AREA	
	Hectares	Acres	# OF PATCHES CREATED	Hectares	Acres	# OF PATCHES CREATED	Hectares	Acres
0	**0-1**	**0-2.5**	110	30	74	91	19	47
1	**1 - 2.5**	**2.5-6**	27	43	106	13	5	12
2	**2.5-6**	**6.0-15**	16	60	148	10	48	120
3	**6-20**	**15-49**	26	304	751	6	63	156
4	**20-150**	**49-370**	27	1,100	2,718	13	484	1,195

forest habitat within the above mapped area. Forty seven percent (96) of the created forest patches could be utilized for breeding purposes by at least one species of interior forest dwelling neotropical migrant and 13% (27) could be utilized by all four indicator species.

Approximately 1,587 ha (3,921 ac) of existing land would be altered due to construction of Line A (Table 5). This represents less than 1% of the total land within the 30-Minute Contour. From a regional perspective, no change in land use patterns would occur. Large forest patches (> 500 ha, 1,235 ac) would remain to accommodate species with wide ranging territory requirements. Any effects on landscape dependent species, such as the wild turkey, black bear, and bobcat, would be minimal. The total amount of forest habitat after highway construction within the 30-Minute Contour would be 540,952 ha (1,336,692 ac). This represents less than a 1% loss of regional forest lands.

Approximately 779 ha (1,925 ac) of existing land would be altered due to construction of the IRA (Table 5). This represents less than 1% of the total land within the 30-Minute Contour. From a regional perspective, no change in land use patterns would occur. The total amount of forest habitat after highway construction would be 541,757 ha (1,335,870 ac). This represents less than a 1% loss of regional forest lands.

The 30-Minute Contour Anderson Level I land use/land cover is presented in Exhibit 4. This area is dominated by a forested landscape and is overall, relatively unfragmented. Exhibit 5 presents a more detailed view of the land cover within the Black Fork watershed. This watershed is representative of the existing land cover throughout West Virginia and portions of Virginia. This watershed is dominated by forested cover in relatively large, unfragmented parcels. Exhibit 6 presents a detailed view of the land cover in the Strasburg, Virginia area. The mosaic of land use patterns in this area is representative of a fragmented landscape. Forest parcels are scattered and isolated by existing agricultural land thereby decreasing their habitat suitability for many neotropical migrant and other animal species. Based on the data discussed above, construction of either the Build Alternative or the IRA would not result in the development of the mosaic land cover patterns present in the Strasburg, Virginia area.



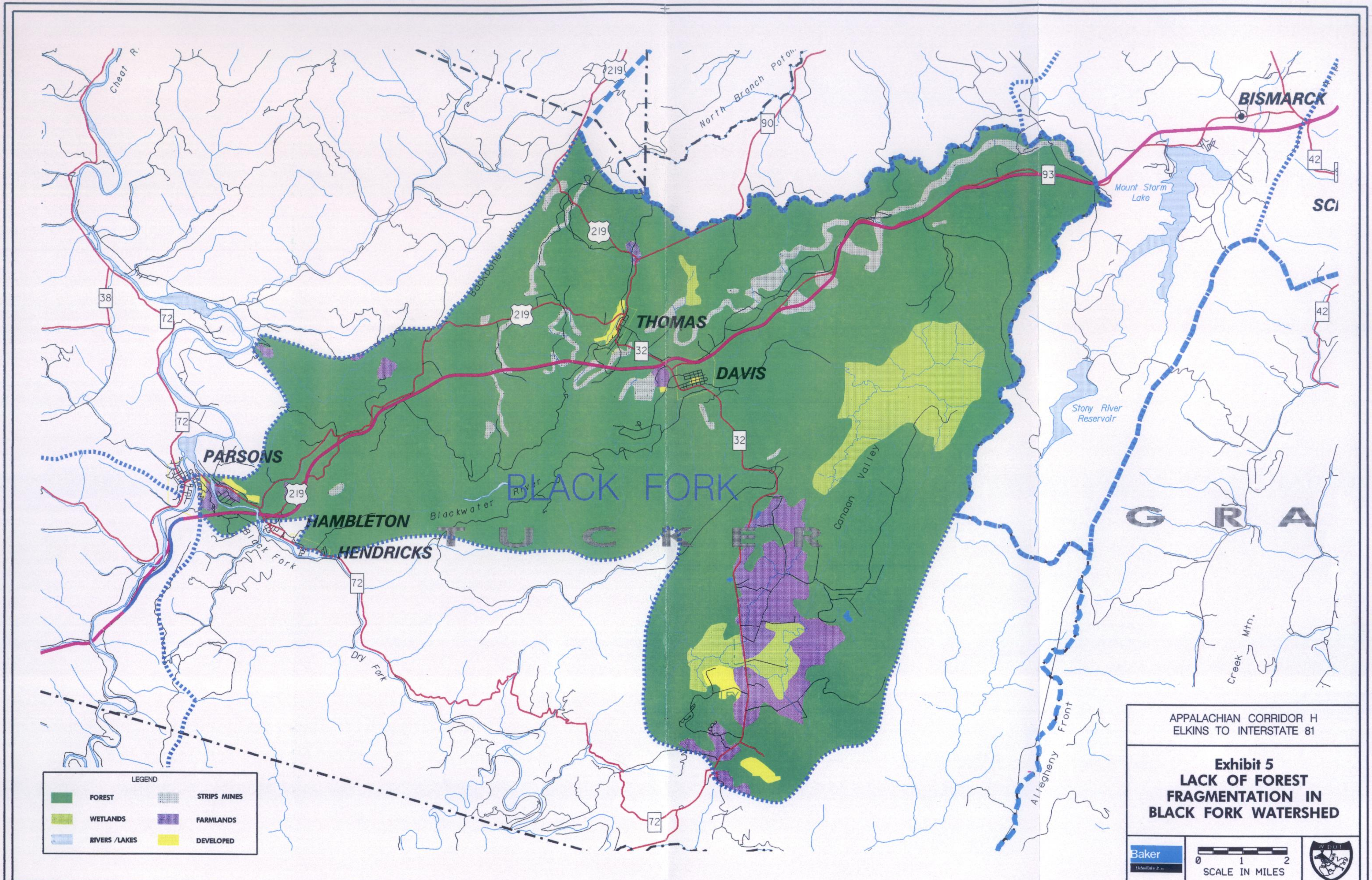
APPALACHIAN CORRIDOR H
ELKINS TO INTERSTATE 81

Exhibit 4
LAND COVER WITHIN 30-MINUTE CONTOUR

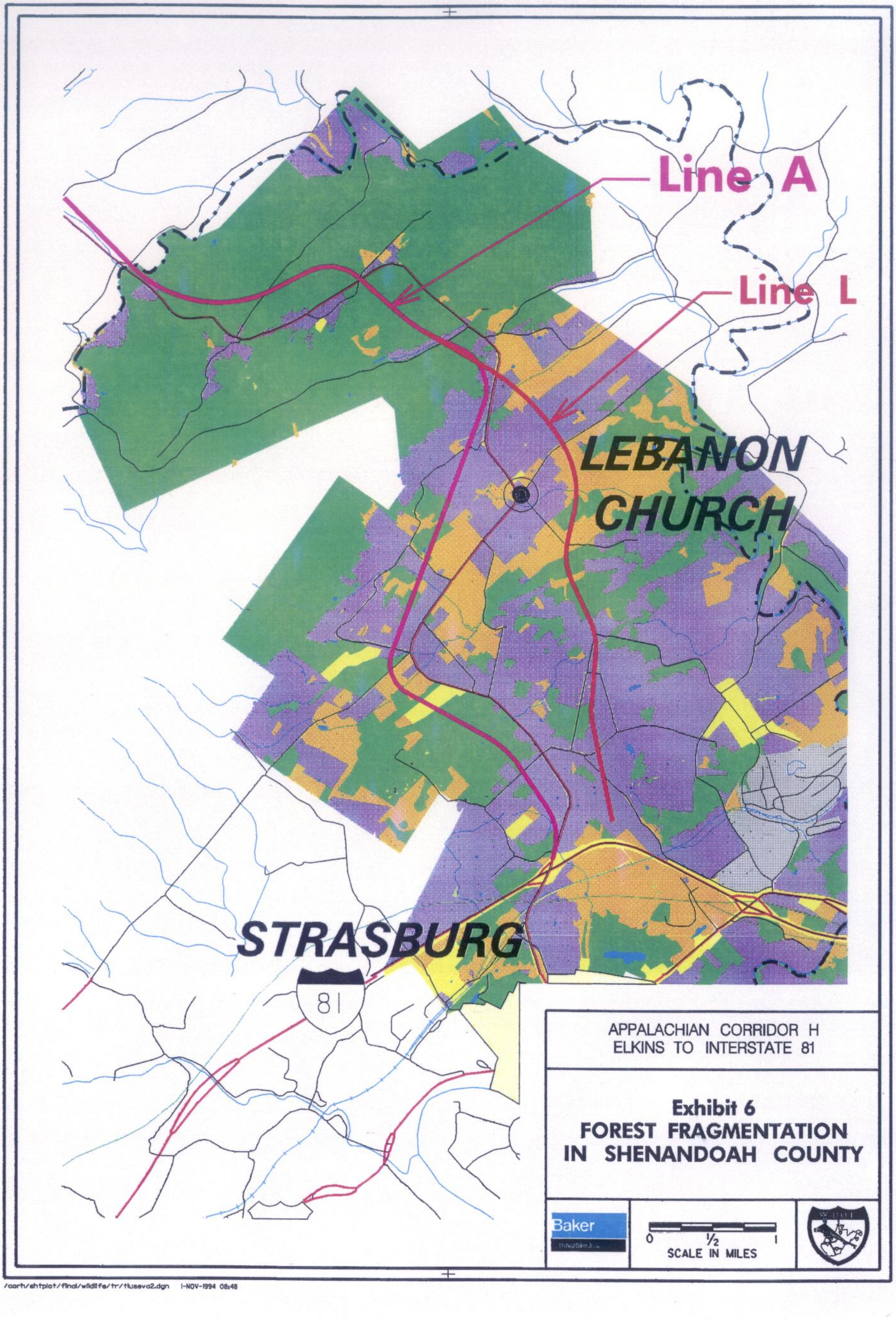
Baker

0 1 2 3 4 5 6 7
SCALE IN MILES

/porh/shtplot/final/wildlife/tr/tluse30m.dgn-NOV-1994 08:38



/corh/shtplot/final/wildlife/tr/tlusebf.dgn 22-SEP-1994 15:47



/corh/shtplot/final/wildlife/tr/tluseva2.dgn 1-NOV-1994 08:48

E. EDGE EFFECTS

Table 32 summarizes the changes in the number of forest patches less than 150 ha (370 ac) available for area sensitive species after impacts of nest predation, brood parasitism and competition (associated with edge habitats) were considered. Additional habitat along highway construction limits was removed from adjacent forest parcels to address edge effect constraints. These impacts are associated with both the Build and Improved Roadway Alternatives. The number of forest patches created in each size category for these alternatives is less than that shown in Table 31B. The expanded impact area, an additional 200 m perpendicular to the construction limits, "removes" many small forest patches from potential breeding use by the area sensitive indicator species due to edge effect constraints. However, these forest patches could be utilized by the breeding indicator species for foraging and resting, and could provide suitable habitat for non-breeding and immature individuals. This also does not preclude these areas from use by landscape dependent species, but it is likely that some, such as the wild turkey (Michael, 1975) would avoid this area. While the distribution of "usable" forest patch size would change slightly, large patches (> 500 ha, 1,235 ac) would remain to accommodate species with wide ranging territory requirements. From a regional perspective, no change in land use patterns would occur.

Approximately 6,470 ha (15,987 ac) of existing forested land could be influenced by edge effect impacts associated with Line A, an 18% increase from the estimated original forest impacts. Approximately 3,530 ha (8,720 ac) could be influenced by edge effect impacts associated with the IRA, a 9% increase from the estimated original forest impacts. Both the IRA and Build Alternative represent a 1% loss of regional forest lands for breeding use by the forest interior neotropical migrant indicator species.

TABLE 32
EDGE EFFECTS ON CREATED FOREST PATCHES COMPARED TO MINIMUM AREAL BREEDING REQUIREMENTS OF NEOTROPICAL MIGRANT INDICATOR SPECIES

		# OF PATCHES CREATED	
MINIMUM AREAL BREEDING REQUIREMENTS MET (# OF SPECIES)	PATCH SIZE (HA)	BUILD ALTERNATIVE - LINE A	IRA
0	0-1	61	38
1	1 - 2.5	14	4
2	2.5-6	10	0
3	6-20	11	1
4	20-150	14	11

V. WILDLIFE MORTALITY

A. LITERATURE REVIEW

The most visible effect of roads on wildlife is animal mortality resulting from collisions with motor vehicles. However, data that documents impacts to populations rather than individuals of avian or mammalian wildlife species remain unclear. Generally, highway construction results in the creation of a right-of-way (ROW) and a median strip that represents an edge where contiguous vegetation once existed. Many wildlife species are able to exploit and utilize the habitat created by the ROW and its associated edge habitat. One study suggests that ROWs are a source of potential wildlife habitat that have been largely ignored by resource managers (Oetting and Cassel, 1971). Highway mortality has been identified as a serious threat to the continued existence of the Florida panther (*Felis concolor coryi*), but this is a rare instance where the death of a few individuals directly impacts the survival of the entire species population. No wildlife species populations identified as occurring or potentially occurring within the study area would be impacted in this manner.

Several studies have documented the effects of highways on wildlife. Burke and Sherburne (1982) assessed the impact on the distribution, abundance and diversity of wildlife before, during and after construction of Interstate 95 in northern Maine. Data from this study suggest that the effect on the breeding-bird and small-, medium- and large-mammal populations has been limited to immediate loss of habitat and that this habitat loss is probably insignificant for those species studied. Furthermore, some wildlife species were documented adapting to and exploiting the newly created ROW habitat.

An intensive and geographically extensive investigation, funded as an FHWA research project and carried out by the USFWS, attempted to determine the effects, both positive and negative, of highways on the diversity, density and spatial distribution of a variety of wildlife species including birds, small and large mammals and amphibians and reptiles (Adams and Geis, 1982). This study was conducted along interstate highways and county roads in three geographic regions; the Southeast (the piedmont regions of Virginia, North Carolina, South Carolina), the Midwest (Illinois) and the Northwest (Oregon and northern California). No significant regional differences were observed. When the information from the three study areas was combined, the major results were:

- seventy-six percent of the road wildlife mortality occurred on interstate highways;
- no differences were found in the distribution of the majority of bird species with respect to distance from roads;
- small mammal community structure and abundance differed between ROW and adjacent habitats;

- no significant difference was detected in deer distribution in relation to interstate highways, but deer appeared to avoid county roads;
- road mortality appeared to occur in a density-dependent manner, i.e. species killed in greatest numbers were those attracted to ROW habitat (meadowlark (*Sturnella magna*), indigo bunting (*Passerina cyanea*), field sparrow (*Spizella pusilla*), red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), deer mouse (*Peromyscus maniculatus*) and several vole and rabbit species).

Michael (1975) conducted a study in Cooper's Rock State Forest in northern West Virginia to measure the impact of Interstate 68 (Corridor E) on wildlife populations. This area is dominated by deciduous upland forest with vegetative species similar to that found in the present study area. The major results of this study were:

- the majority of bird and mammal populations encountered during this study were not adversely affected as a result of highway construction;
- game species populations were not affected by highway construction;
- highway mortality observed appeared to be density dependent.

More detailed information is presented below on the effects of highways on individual groups of wildlife species.

1. REPTILES AND AMPHIBIANS

Adams and Geis (1982) reported that reptiles and amphibians made up 19% highway wildlife mortality. No salamander species were recorded during the road mortality study. The study concluded that salamanders do not readily cross interstate highways and are not attracted to ROW habitat. In the Southeast study area, the eastern box turtle (*Terrapene carolina*) was the most common species killed.

2. BIRDS

Adams and Geis (1982) reported that birds made up the largest percentage (38%) of wildlife mortality. In the Southeast study region, 50% of the highway bird mortality was incurred by 5.5% of the species recorded in plots adjacent to highways. The high mortality for the eastern meadowlark, indigo bunting and field sparrow was the direct result of their greater abundance within habitats adjacent to the highway. These data indicate that such mortality is density-dependent. Many woodland species such as the Carolina chickadee (*Parus carolinensis*), tufted titmouse (*Parus bicolor*), wood thrush (*Catharus guttatus*), red-eyed vireo (*Vireo olivaceus*) and woodland warblers made up a significant portion (24%) of the bird community along highways but were not recorded during the road mortality survey. Statistical analyses were performed on twelve species of breeding birds (red-bellied woodpecker (*Melanerpes carolinus*), acadian flycatcher (*Empidonax virescens*), blue jay (*Cyanocitta cristata*), carolina chickadee, tufted titmouse, carolina wren (*Thryothorus ludovicianus*), wood thrush, red-eyed vireo, summer tanager (*Piranga rubra*), northern cardinal (*Cardinalis cardinalis*), indigo bunting and rufous-sided towhee (*Pipilo erythrophthalmus*)) recorded in upland forest habitat along highways. The wood thrush was more abundant away from the highways, while the remaining 11 species showed no difference in relative abundance with respect to distance from the roadway. Analyses were also conducted on wintering bird populations and produced similar results. The American kestrel (*Falco sparverius*) and red-tailed hawk (*Buteo jamaicensis*) were also observed using the ROW and median strip to hunt and capture small mammals.

Burke and Sherburne (1982) found breeding bird population densities in Maine did not vary between 0 and 400 m away from the highway either during the preconstruction or postconstruction phase of the study. Species composition appeared to change in response to the forest and ROW edge created along the highway. Several bird species chipping sparrows (*Spizella passerina*) yellowthroats (*Geothlypis trichas*), chestnut-sided warblers (*Dendroica pennsylvanica*), common crows (*Corvus brachyrhynchos*) and ravens (*Corvus corax*) exploited and utilized newly created ROW habitat. Other bird species continued to use the adjacent forest habitat and showed no adverse response to the created edge habitat. The ovenbird (*Seiurus aurocapillus*), a forest interior, neotropical migrant, was abundant in the adjacent forest habitat and appeared unaffected in relation to distance from the ROW.

Oetting and Cassel (1971) reported on the successful use of ROW habitat for nesting by a number of duck species. This study found that management of ROW habitat (adjusting the mowing maintenance schedule) can successfully enhance waterfowl reproduction. The authors also presented data from a number of studies in which game birds showed a preference for nesting along and within ROW habitats which comprised a small proportion of the total available nesting habitat.

Michael (1975) found the greatest number of individual birds, number of species and species diversity within the edge habitat separating the ROW from the upland forest. The most abundant birds within this habitat type were; European starling (*Sturnus vulgaris*), common crow, red-eyed vireo, indigo bunting, rufous-sided towhee, tufted titmouse, black-capped chickadee (*Parus atricapillus*), northern cardinal, wood thrush and red-winged blackbird. Species diversity indices increased in all three habitat types studied (ROW, edge, forest) after road construction. Several species of birds which appeared to increase in response to highway construction were the starling, indigo bunting, song sparrow (*Melospiza melodia*), killdeer (*Charadrius vociferus*) and common crow. Wild turkey (*Meleagris gallopavo*) distribution did not change in relation to the highway during and after highway construction. These birds continued to use the forested portion of the study area, but were not found using the area immediately adjacent to the highways.

3. MAMMALS

Adams and Geis (1982) found that small mammals made up 17% of the wildlife mortality on highways, and that mortality was greatest for those species with highest densities in the ROW habitat (density dependent mortality). In the Southeast study area, the two most common species recorded in the road mortality study were the hispid cotton rat (*Sigmodon hispidus*) and the meadow vole (*Microtus pennsylvanicus)*. No evidence was found to indicate that road mortality was detrimental to the populations of these two species. Adams and Geis (1982,1983) also found that small mammal diversity and density were greater in ROW habitat than in adjacent habitat and that the highway mortality observed did not appear to be detrimental to populations of these species. They suggest that ROW habitat and its accompanying edge are attractive not only to grassland species, but to many less habitat-specific species that make use of the ROW-edge-adjacent habitat complex. One grassland species, the meadow vole, has exploited the open, grassy roadside vegetation associated with interstate highway ROWs to expand its range through forested and intensive agricultural regions (Getz et al., 1978). The aggregation of large populations of small mammals (mice, moles, voles) represents a potential food resource that could be exploited by a number of avian and mammalian predators (Michael 1975).

Available data appear to indicate that multilane highways inhibit movements of some small mammals adapted to forested habitats, while small mammals adapted to open country (meadow vole) readily venture onto the road surface (Oxley *et al.,* 1974). Adams and Geis (1982) found evidence that large roads and accompanying ROW habitat inhibited the movement of 28% of the 40 small mammal species and suggested additional research was needed in this area.

Large mammals made up 31% of the wildlife mortality along interstate highways (Adams and Geis, 1982). However, species such as opossums (*Didelphis virginiana*) and skunks (*Mephitis mephitis*) persist for long periods of time and tend to inflate the actual large mammal mortality numbers. A more accurate reflection of mortality was obtained by estimating the road kill on a daily basis. When this was done, large mammals comprised 14% of the total highway mortality. White-tailed deer made up less than 1% of the total wildlife mortality in this study. The data in this study indicated that road size and traffic volume per se are not critical disturbing factors to deer. Other large mammals have shown an avoidance of highways. Brody and Pelton (1989) suggest that the behavior of bears in response to roads is probably learned and is linked to the "costs and benefits" experienced by individuals. In their North Carolina study, radio-collared bears demonstrated a pronounced avoidance of Interstate 40.

ROW and adjacent habitat use by large mammals has also been documented (Burke and Sherburne 1982, Adams and Geis 1982, Michael 1975). Cottontail rabbits (*Sylvilagus floridanus*) were more abundant in habitats adjacent to the highway than in areas farther away from the road. White-tailed deer were observed foraging within ROW habitat and red foxes (*Vulpes vulpes*) were found using ROW habitat to hunt for mice and moles.

B. CONCLUSIONS

The construction of the proposed highway project would convert current natural habitats (forests, agriculture, and pasture) to early successional grassy or shrubby vegetation commonly associated with highway right-of-ways. Potential highway-wildlife impacts would likely follow those observed on the Appalachian Corridor E (Interstate 68) study (Michael, 1975), which parallels other studies reviewed. These results indicate that highway construction and operation would not adversely affect the majority of birds and mammals, including game species. Highway mortality would be density dependent. That is, species killed in greatest numbers would be those attracted to right-of-way habitat with high population densities, such as edge associated birds, and small/medium sized mammals. As no endangered, threatened or special concern species are associated with highway rights-of way habitat on this project, there would be no impact to these species. Highway wildlife mortality would continue to occur on existing roadways with the No-Build Alternative. Impacts would be similar to those found by Adams and Geis (1981) for county roads. Highway wildlife mortality would potentially increase with the IRA. In conjunction with road improvements (widening), new segments of roadway would be constructed, thereby increasing the probability of vehicle/wildlife encounters. Wildlife mortality would potentially be the greatest for the Build Alternative. Adams and Geis (1981) found that 76 percent of road wildlife mortality occurred on four lane interstate highways. Line A would be expected to follow these observed results.

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APPENDIX A

HEP EVALUATION SPECIES AND HABITAT VARIABLES

APPENDIX A

EVALUATION SPECIES[1]	COVER TYPE (USFWS)[2]	HABITAT VARIABLES
American woodcock **(*Scolopax minor*)** • Short-distance migrant • Invertebrate carnivore (worms) • Ground nester	PFO, UFOD, UFOE	• Soil moisture class • Soil texture class • % canopy cover shrubs/herbs above 50 cm high • Density of trees (#/ha)
Barred Owl **(*Strix varia*)** • Permanent resident • Vertebrate carnivore • Cavity nester	PFO, UFOD, UFOE	• Mean DBH of overstory trees • % canopy cover trees • Density of trees DBH > 51cm (#/ha)
Black-capped Chickadee **(*Parus atricapillus*)** • Permanent resident • Insectivorous gleaner • Cavity nester	PFO, UFOD, UFOE	• % canopy cover of trees • Mean ht. of overstory trees • Density of snags that have 10-25cm DBH (#/ha)
Brown Thrasher **(*Toxostoma rufum*)** • Short-distance migrant • Omnivorous ground forager • Shrub nester	AO, AP, UF, UFOD, UFOE, UGG, USHD	• Density of woody stems > 1m tall (trees & shrubs) (#/ha) • % canopy cover of trees • % of ground surface covered by litter > 1cm deep
Downy Woodpecker **(*Picoides pubescens*)** • Permanent resident • Insectivorous bark gleaner • Cavity nester	PFO, UFOD, UFOE	• Basal area of trees (m^2/ha) • Density of snags that have > 15cm DBH (#/ha)
Eastern Cottontail **(*Sylvilanus floridanus*)** • Ground grazing herbivore • Ground nester	AO, AP, UF, UFOD, UFOE, UG, USHD	• % canopy of shrubs (all woody plants < 6m tall) • % canopy cover of trees • % canopy of persistent herbaceous vegetation

APPENDIX A. (Continued)

EVALUATION SPECIES[1]	COVER TYPE (USFWS)[2]	HABITAT VARIABLES
Eastern Meadowlark *(Sturnella magna)* • Permanent resident • Insectivorous ground gleaner • Ground nester	AP, UF, UG	• % canopy cover of herbaceous vegetation • % canopy cover that is grasses • Mean ht. of herbaceous canopy during spring (cm) • Mean distance to a perch site (tall plant, post, wire) • % canopy of shrubs (all woody plants < 6m tall)
Eastern Wild Turkey *(Meleagris gallopavo)* • Permanent resident • Omnivorous ground gleaner • Ground nester • Primary game species • Landscape dependent	AC, AP, PFO, UFOD, UFOE, USHD, UF, UG	• % canopy cover of herbaceous vegetation • Mean ht. of herbaceous canopy (not of individual plants) (cm) • Density of hard mast trees that are > 25.4cm DBH (#/ha) • Mean DBH, hard mast trees > 25.4cm DBH • % canopy cover of trees • Mean DBH of overstory trees • % of canopy cover that is evergreen sp. • % canopy of shrubs (all woody plants < 6m tall) • % of shrub canopy cover that is soft mast producing sp. • % canopy cover of soft mast trees • Mean distance to forest or tree savanna cover type • Type of crop • Annual crop management practices
Gray Squirrel *(Sciurus carolinensis)* • Herbivore • Tree cavity/crevice nester	PFO, UFOD	• % of tree canopy cover hard mast producing sp. • # of hard mast sp. with canopy cover > 1% • % canopy cover of trees • Mean DBH of overstory trees

APPENDIX A. (Continued)

EVALUATION SPECIES[1]	COVER TYPE (USFWS)[2]	HABITAT VARIABLES
Hairy Woodpecker ***(Picoides villosus)*** • Permanent resident • Insectivorous bark gleaner • Cavity nester	PFO, UFOD	• Density of snags that have > 25cm DBH (#/ha) • Mean DBH of overstory trees (cm) • % canopy cover of trees • Canopy cover of overstory pines
Mink ***(Mustela vison)*** • Vertebrate carnivore • Wetland dependent mammal	PFO, PSS	• % of year with surface water present within cover type • % canopy cover trees, shrubs, persist. herbaceous vegetation • % canopy cover of trees and shrubs within 100m of wetland edge
Muskrat ***(Ondatra zibethicus)*** • Herbivore • Wetland dependent mammal	PEM, PSS	• % canopy cover of emergent herbaceous plants • % of year with surface water present within cover type • % emerg. veg. consising of Olney, 3 sq. bulrush, cattail
Pileated Woodpecker ***(Dryocopus pileatus)*** • Permanent resident • Insectivorous bark excavator • Cavity nester	PFO, UFOD, UFOE	• % canopy cover of trees • Density of trees > 51cm DBH (#/ha) • Density of tree stump >.3m high & 18cm dia. & logs > 18cm dia. (#/ha) • Density of snags that have >38cm DBH (#/ha) • Mean DBH of snags that have > 38cm DBH (cm)
Pine Warbler ***(Dendroica pinus)*** • Short-distance migrant • Insectivorous gleaner • Pine canopy nester	UFOD, UFOE	• % tree canopy closure of overstory pines • % of dom. canopy pines with decid. understory in upper 1/3 layer • Mean ht. of overstory trees (> 80% as tall as tallest tree) (m)

APPENDIX A. (Continued)

EVALUATION SPECIES[1]	COVER TYPE (USFWS)[2]	HABITAT VARIABLES
Red-winged Blackbird *(Agelaius phoeniceus)* • Permanent resident • Omnivore • Shrub nester • Facultative wetland species	PEM	• Emergent veg. is broad leaved monocots • Water regime (1:H2O usu. pres. all yr; 2:usu. dry part of year) • Presence of carp within wetland • Presence of larvae of emergent aquatic insects in wetland • Emergent herbaceous cover
Ruffed Grouse *(Bonasa umbellus)* • Permanent resident • Omnivore • Ground nester	UFOD, UFOE, USHD	• Density of coniferous woody plants > .9m tall (#/ha) • Density of deciduous trees (#/ha) • Density of deciduous shrub stems ≥ .9m and < 6m tall (#/ha) • Mean ht. coniferous plant sp. that can get > 6m tall (m) • Mean ht. of deciduous woody plant sp. that can get > 6m tall • Mean ht. of woody plant sp. that do not get > 6m tall • Avg. radius of circles encompassing 20 mature aspens • Avg. lowest branch ht. of conifers (m)
Veery *(Catharus fuscescens)* • Neotropical migrant • Omnivorous ground gleaner • Ground nester • Facultative wetland species	PFO, PSS	• % canopy of deciduous shrubs (all woody plants < 6m tall) • Mean ht. of deciduous shrub canopy (m) • % canopy cover of herbs in late spring-early summer • Mean ht. of herbaceous canopy in late spring-early summer

APPENDIX A. (Continued)

EVALUATION SPECIES[1]	COVER TYPE (USFWS)[2]	HABITAT VARIABLES
White-tailed Deer *(Odocoilius virginianus)* • Large mammalian herbivore • Primary big-game species • Habitat generalist	AC, AO, AP, UF, UG, UFOD, UFOE, USHD, PFO, PSS, PEM	• Avrage dry matter yield of suitable forage (gDW/m^2) • # of stems/ha of shrub and tree spp. that provide mast fall-winter
Yellow Warbler *(Dendroica petechia)* • Neotropical migrant • Insectivorous gleaner • Shrub nester • Facultative wetland species	PSS, USHD	• % canopy cover of deciduous shrubs (< 6m tall) • Mean ht. of deciduous shrub canopy (m) • % of deciduous shrub canopy hydrophitic sp.

[1]DeGraaf and Rudis 1983, Hall 1983, Brooks and Croonquist 1990, *Habitat Suitability Index Models* USFWS
[2]USFWS Cover Types:

- AC - Cropland
- AO - Orchard
- AP - Pasture or Hayland
- PEM - Palustrine Emergent Wetland
- PFO - Palustrine Forested Wetland
- PSS - Palustrine Scrub/Shrub Wetland
- UF - Forbland
- UFOD - Deciduous Forest
- UFOE - Evergreen Forest
- UG - Grassland
- USHD - Deciduous Shrubland

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HEP FIELD DATA

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CORRIDOR H - HEP DATA ENTRY FORM				
AO/22:	**Orchard (& shelterbelt)**	Plot 1	Plot 2	Plot 3
VCVLT03	% of ground surface covered by litter > 1 cm	0.3	0.25	0.3
VCVTR01	% canopy cover of trees (%)	0.6	0.6	0.6
VDNSH02	Density of woody stems >1 m tall (#/ha)	932	955	990
X123V3	Average dry matter yield of suitable forage	0	0	0
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	465	480	472

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CORRIDOR H - HEP DATA ENTRY FORM											
AP/21:	PASTURE OR HAYLAND	Plot 1	Plot 2	s6-3-8/11	s6-3-8/11	s6-3-8/11	s1-1-9/9	s1-1-9/9	s7-2-9/9	s7-2-9/9	s7-2-9/9
SDIFo01	Mean distance to forest cover type (m)	16.8	10.7	122	65	69	76	76	112	112	112
SDIPS01	Mean distance to a perch site	6.1	15.5	122	65	69	30	30	112	112	112
VCVHE01	Percent canopy cover of herbs	0.85	0.9	0.7	0.6	0.75	0.85	0.9	0.9	0.95	0.9
VCVLT03	% of ground surface covered by litter > 1 cm	0.1	0.1	0.05	0	0.05	0.05	0.05	0.1	0.05	0.15
VCVSH01	% canopy cover of shrubs	0	0	0	0	0	0	0	0	0	0
VCVTR01	% canopy cover of trees (%)	0.05	0	0	0	0	0	0	0	0	0
VDNSH02	Density of woody stems >1 m tall (#/ha)	0	0	0	0	0	0	0	0	0	0
VHTHE01	Mean height of herbaceous canopy	5.1	5.1	5	10	5	10	10	15	15	15
VHTHE03	Mean height of herbaceous canopy during spring (cm)	30.5	30.5	30	30	30	10	10	15	15	15
VRCGR01	% of herbaceous canopy cover that is grasses	0.7	0.8	0.93	0.92	0.87	0.85	0.85	0.9	0.9	0.9
X123V3	Average dry matter yield of suitable forage	4	4	5.6	4.8	6	6	6	6	6	6
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	0	0	0	0	0	0	0	0	0	0
X66V4	Diversity Index (Diversity index)	0.5	0.5	1	1	1	1	1	1	1	1

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CORRIDOR H - HEP DATA ENTRY FORM											
AC/21:	CROPLAND	Plot 1	Plot 2	s6-3-8/11	s6-3-8/11	s6-3-8/11	s6-3-9/11	s6-3-9/11	s6-3-9/11	s6-3-9/11	s6-3-9/11
SDIFo01	Mean distance to forest cover type (m)	76.2	99.1	198	214	244	1000	1000	1000	1000	1000
UAPAP01	Annual crop management practice (Code 1-7)	4	4	4	4	4	4	4	4	4	4
UAPCR01	Type of crop (see lex listing for codes 1-34)	7	7	7	7	7	7	7	7	7	7
VCVHE04	% canopy cover of persistent herbs	0	0	0	0	0	0	0	0	0	0
VCVSH01	% canopy cover of shrubs	0	0	0	0	0	0	0	0	0	0
VCVTR01	% canopy cover (%)	0.75	0.8	0.8	0.85	0.85	0.9	0.9	0.9	0.9	0.9
X123V3	Average dry matter yield of suitable forage	5	5	6	6	6	6	6	6	6	6
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	0	0	0	0	0	0	0	0	0	0
X66V4	Diversity Index (Diversity index)	0	0	0	0	0	0	0	0	0	0

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CORRIDOR H - HEP DATA ENTRY FORM									
PEM/62:	**PALUSTRINE EMERGENT WETLAND**	s16-2	s16-2	s5-4	s5-4	s5-4	s12	s12	s12
TFRDP01	Percent of year surface water present in cover type	1	1	0.2	0.2	0.2	0.8	0.8	0.8
VCVEM01	% canopy cover of emergent herbaceous plants	0.9	0.9	0.8	0.7	0.8	0.9	0.9	0.9
X123V3	Average dry matter yield of suitable forage	2	3	0	2	0	0	0	0
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	0	0	0	0	0	0	0	0
X46V8	% emergent herbaceous veg. (Olney, bulrush, cattail)	0	0	0	0	0	0	0	0
X61V3	% of wetland basin persist. emerg. veg.	0	0	0	0	0	0.75	0.75	0.75
X95V1	Emergent veg. is broad leaved monocots (N=1, Y=2)	1	1	1	1	1	1	1	1
X95V2	Water regime (1:H2O usu. pres. all yr; 2:usu. dry part	2	2	2	2	2	2	2	2
X95V3	Presence of carp within wetland (N=1, Y=2)	1	1	1	1	1	1	1	1
X95V4	Presence of larvae of emergent aquatic insects	2	2	2	2	2	2	2	2
X95V5	Emerg. herb. cov. (1: open H2O=emerg; 2: dense emerg.; 3: emrg< open H20)	2	2	2	2	2	2	2	2

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CORRIDOR H - HEP DATA ENTRY FORM							
PFO/61:	PALUSTRINE FORESTED WETLAND	s16-2	s16-2	s16-2	s16-2	pltstdy	pltstdy
SSO01	Soil moisture class (See lex)	2	2	2	2	2	2
SSO02	Soil texture class (See lex)	10	10	10	10	10	10
TFRDP01	Percent of year surface water present in cover type	0.25	0.25	0.4	0.4	0.5	0.5
VBAWO01	Basal area of trees	51	8	48	87	24	32
VCVEM01	% canopy cover of emergent herbaceous plants	0	0	0	0	0	0
VCVHE01	% canopy cover of herbs	0.7	0.75	0.75	0.65	0.75	0.15
VCVHE03	% canopy cover herb. late sprg/summer	0.7	0.75	0.75	0.65	0.75	0.15
VCVHM03	% soft mast shrub canopy cover	0.2	0	0.2	0.2	0	0.2
VCVOS03	Canopy cover of overstory pines (%)	0	0	0	0	0	0.05
VCVSH01	% canopy cover of shrubs	0.25	0.1	0.3	0.5	0.1	0.3
VCVSH02	% canopy cover decid. shrubs	0.25	0.01	0.3	0.5	0.1	0.3
VCVSH04	% canopy cover of shrubs & herbs above 50 cm	0.5	0.2	0.4	0.7	0.5	0.3
VCVSM01	% canopy cover of soft mast trees (%)	1	1	0.2	0	0	0
VCVTR01	% of canopy trees (%)	0.6	0.5	0.9	0.7	0.5	0.85
VCVTR02	% canopy cover overstory trees (%)	0.4	0.5	0.9	0.7	0.5	0.85
VCVTR05	% canopy cover trees, shrubs, pers. herbs	0.85	0.6	0.9	0.9	0.9	0.9
VCVWO02	% canopy cover trees/shrubs w/i 100m wtlnd edge	0.6	0.7	0.6	0.5	0.3	0.4
VDBHM02	Mean DBH, hard mast trees > 25.4 cm DBH (cm)	0	0	0	0	55.6	0
VDBSN02	Mean DBH of snags that have > 38 cm DBH (cm)	39	-	-	-	-	-
VDBTR01	Mean DBH of overstory trees	35	16	26	46	55.6	32
VDNDB04	Density of trees > 51 cm DBH (#/ha)	0	0	0	0	100	0
VDNHM01	Density of hard mast trees that are > 25.4 cm DBH	0	0	0	0	300	0
VDNSN02	Density of snags that have 10-25 cm DBH (#/ha)	0	0	0	0	0	100
VDNSN03	Density of snags that have > 15 cm DBH (#/ha)	100	0	0	0	0	0
VDNSN04	Density of snags that have > 38 cm DBH (#/ha)	100	0	0	0	0	0
VDNSN07	Density of snags that have > 25 cm DBH (#/ha)	100	0	0	0	0	0
VDNTR02	Density of trees (#/ha)	300	200	300	300	300	600
VDNTR04	Density of trees DBH > 51 cm (#/ha)	0	0	0	0	100	0

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CORRIDOR H - HEP DATA ENTRY FORM							
PFO/61:	**PALUSTRINE FORESTED WETLAND**	**s16-2**	**s16-2**	**s16-2**	**s16-2**	**pltstdy**	**pltstdy**
VHTHE02	Mean ht. herb. canopy late sprg/summer	15	20	20	20	30.5	10
VHTSH04	Mean ht. decid. shrubs	1.8	2	2.4	1.5	1	1.4
VHTTR01	Mean ht. of overstory trees (i.e., > 80% as tall as	15.2	9.5	15	21	15	12
VRCEV01	% of tree canopy cover that is evergreen sp. (%)	0	0	0	0	0	0.05
VRCHM01	% of tree canopy cover hard mast producing sp. (%)	0	0	0.05	0.1	0.25	0.1
VSDHM01	# of hard mast tree sp. with canopy cover > 1% (#)	0	0	1	1	3	1
X105V2	% canopy cover of vegetation & downfall <= 30 cm	0.65	0.6	0.25	0.4	0.1	0.1
X123V3	Average dry matter yield of suitable forage	3	3	2	2	3	2
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	0	0	100	0	300	100
X22V1	% cover type flooded (avg. sprg/early summer)	0.85	0.8	0.8	0.85	0.75	0.7
X39V3	Density of stumps > 0.3 m high & 18 cm dia. logs	0	0	0	0	0	0
X46V8	% emergent herbaceous veg. (Olney, bulrush, cattail)	0	0	0	0	0	0

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CORRIDOR H - HEP DATA ENTRY FORM													
PSS/61:	**PALUSTRINE SCRUB/SHRUB WETLAND**	s16-2	s16-2	s12-2	s12-2	s12-2	s12-2	s12-2	s4-1	s4-1	s4-1	s12-2	s12-2
TFRDP01	Percent of year surface water present in cover type	0.5	0.5	1	1	1	1	1	1	1	1	1	1
VCVEM01	% canopy cover of emergent herbaceous plants	0.1	0.1	0.3	0.5	0.4	0.45	0.5	0.2	0.2	0.3	0.3	0.2
VCVSH02	% canopy cover of deciduous shrubs	0.85	0.9	0.5	0.45	0.6	0.8	0.7	0.75	0.8	0.8	0.85	0.8
VCVTR05	% canopy cover trees, shrubs, pers. herbs	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
VCVWO02	% canopy cover trees/shrubs w/i 100m wtlnd edge	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.8	0.8	0.8	0.7	0.7
VHTSH04	Mean ht. of deciduous shrub canopy	3	2.3	2.7	1.5	1.9	1.3	2.3	3	2.7	2.7	2.3	2.3
VHTSH05	Mean ht. of deciduous shrub canopy	3	2.3	2.7	1.5	1.9	1.3	2.3	3	2.7	2.7	2.3	2.3
VRCSH01	% of deciduous shrub canopy cover hydrophytic	0.9	0.9	1	1	1	1	1	1	1	1	1	1
WDP01	Mean water depth (m)	0	0	0.05	0	0	0	0	0.05	0	0	0.05	0.05
X123V3	Average dry matter yield of suitable forage	2	2	2	2	2	2	2	2	2	2	2	2
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	0	0	0	0	0	0	0	0	0	0	0	0
X139V1	Emerg. hydroph. class	4	4	4	4	4	4	4	4	4	4	4	4
X22V1	% cover type flooded spring/early summer	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.8	0.8	0.8	0.6	0.6
X46V8	% emergent herbaceous veg. (Olney, bulrush, cattail)	0.1	0	0	0	0	0	0	0	0	0	0	0
VCVHE03	% cover herb	0.5	0.4	0.8	0.7	0.9	0.9	0.8	0.5	0.8	0.7	0.75	0.8
VHTHE02	Avg. ht. herb	20	15	25	10	13	10	10	46	30	30	25	25

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CORRIDOR H - HEP DATA ENTRY FORM													
UF/31:	FORBLAND	Plot 1	Plot 2	Plot 3	s5-1/8/11	s5-1/8/11	s12-4-8/12	s12-4-8/12	s12-4-8/12	s12-4-8/12	s2-1-9/9	s2-1-9/9	s2-1-9/9
SDSIFO01	Mean distance to forest or tree savanna cover type (m)	66.3	74.7	80	21	18	46	15	30	50	26	26	26
SDIPS01	Mean distance to a perch site	42.7	30.5	45.7	21	18	18	34	9	12	9	9	9
VCVHE01	% canopy cover of herbs	0.95	0.75	0.95	1	1	0.7	0.95	0.8	0.75	0.85	0.9	0.9
VCVHE04	% canopy cover of persistent herbs	0.8	0.75	0.5	0.85	0.85	0.2	0.5	0.7	0.7	0.7	0.75	0.75
VCVLT03	% of ground surface covered by litter > 1 cm deep	1	1	0.5	0.6	0.4	0.7	0.35	0.4	0.2	0.15	0.25	0.25
VCVSH01	% canopy cover of shrubs	0.05	0.25	0	0.05	0	0.3	0.05	0.2	0.25	0.15	0.2	0.2
VCVTR01	Mean DBH of overstory trees	0	0	0	0	0	0	0	0	0	0	0	0
VDNSH02	Density of woody stems >1 m tall (#/ha)	0	800	100	100	0	1000	100	800	900	300	400	400
VHTHE01	Mean height of herbaceous canopy	45.7	45.7	15.2	76	61	30	30	46	91	46	51	46
VHTHE03	Mean ht. of herbaceous canopy during spring (cm)	45.7	45.7	15.2	15	15	15	15	15	20	23	25	23
VRCGR01	% of herbaceous canopy cover that is grasses	0.68	0.47	0.21	0.05	0.15	0.07	0.32	0.12	0.07	0.12	0.09	0.09
X123V3	Average dry matter yield of suitable forage	5	5	5.5	4.5	5	3	3.8	3.2	3	3.4	3.6	3.6
X123V4	# stems/ha shrub/ tree spp. fall-winter mast	0	800	100	100	0	500	100	400	500	100	100	100
X66V4	Diversity Index	1	1.5	1.5	1.2	1.2	2	2	2	2	2	2	2

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CORRIDOR H - HEP DATA ENTRY FORM																	
UFOD/41:	DECIDUOUS FOREST	Plot1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	sec3-1	sec3-1	sec3-1	sec3-1	sec3-1	s13-3 8/5	s13-3 8/5	s13-3 8/5	s13-3 8/5	s13-3 8/5
SSO01	Soil moisture class (see lex.)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SSO02	Soil texture class (see lex.)	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
VBAWO01	Basal area of trees (if cut at 1,4 m high) (m2/ha)	85.5	45.2	61.5	49	25	125.6	82.40208	18.70383	68.33768	83.222	58.99794	221.0121	221.6823	100.9248	151.2563	123.3167
VCVHE01	% canopy cover of herbs (non-woody plants)	0.02	0.02	0.01	0.02	0.02	0.02	0.05	0.05	0.02	0.02	0.02	0.2	0.35	0.55	0.3	0.15
VCVHE04	% canopy cover of persistent herbs	0.02	0.02	0.01	0.02	0.02	0.02	0	0.02	0	0	0.01	0.05	0.02	0.01	0	0.02
VCVHM03	% of shrub canopy cover soft mast sp.	0.4	0.6	0.25	0	0.05	0.05	0	0	0	0	0	0	0	0	0	0
VCVLT03	% of grnd. surf. covered by litter > 1 cm deep (%)	1	0.9	0.98	0.9	0.9	0.85	0.2	0.5	0.5	0.45	0.9	1	1	1	1	1
VCVOS03	Canopy cover of overstory pines (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VCVSH01	% canopy cover of shrubs (all woody plants < 6 m)	0.7	0.7	0.8	0.4	0.4	0.5	0.2	0.5	0.55	0.45	0.5	0.45	0.5	0.25	0.4	0.4
VCVSH04	% canopy cover of shrubs & herbs above 50 cm	0.4	0.5	0.6	0.4	0.2	0.15	0.2	0.5	0.55	0.5	0.5	0.45	0.5	0.25	0.4	0.4
VCVSM01	% canopy cover of soft mast trees	0.25	0.15	0	0	0.1	0.2	0.1	0	0	0	0	0	0.1	0	0	0
VCVTR01	% canopy cover of trees	0.3	0.25	0.4	0.5	0.65	0.4	0.7	0.5	0.6	0.3	0.35	0.7	0.6	0.7	0.85	0.7
VCVTR02	% canopy cover overstory trees	0.3	0.1	0.4	0.5	0.65	0.1	0.7	0.3	0.6	0.3	0.35	0.7	0.6	0.7	0.85	0.7
VDBHM02	Mean DBH, hard mast trees > 25.4 cm DBH (cm)	37.0	0	28	31.5	22.6	15.5	0	36	33	36	33	28	46	36	38	30
VDBSN02	Mean DBH of snags that have > 38 cm DBH (cm)	41						89									
VDBTR01	Mean DBH of overstory trees (i.e., dia. 1.4 m high) (cm)	37	20	28	31.5	22.6	13.5	29	36	23	36	30	25	38	25	36	30
VDNDB04	Density of trees > 51 cm DBH (#/ha)	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
VDNDE01	Density of deciduous trees (#/ha)	600	400	300	200	200	800	400	200	400	400	400	700	500	500	400	400
VDNHM01	Density of hard mast trees > 25.4 cm DBH (#/ha)	100	100	200	200	200	0	0	100	100	200	200	300	300	100	300	300
VDNNL01	Density of coniferous woody plant > .9 m tall (#/ha)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VDNSH01	Den. of deci. shrub stems >= .9 m and < 6m (#/ha)	3300	2200	7000	1700	3600	800	700	1900	2000	1700	1900	1700	1600	2200	1700	1100
VDNSH02	Den. of woody stems >1 m tall (trees & shrubs) (#/ha)	3900	2600	7300	1900	3800	1600	1100	2100	2400	2100	2300	2400	1700	2700	2100	1500
VDNSN02	Density of snags that have 10-25 cm DBH (#/ha)	300	400	300	100	100	100	0	0	0	0	0	0	100	0	100	0
VDNSN03	Density of snags that have > 15 cm DBH (#/ha)	400	300	300	100	100	500	100	100	100	0	0	0	100	100	0	0
VDNSN04	Density of snags that have > 38 cm DBH (#/ha)	100	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0
VDNSN07	Density of snags that have > 25 cm DBH (#/ha)	200	0	300	0	0	400	100	100	100	0	0	0	0	100	0	0
VDNTR02	Density of trees (#/ha)	600	400	300	200	200	800	400	200	400	400	400	700	500	500	400	400
VDNTR04	Density of trees DBH > 51 cm (#/ha)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VHTDE02	Mean ht. of dec. woody plant sp. that can get > 6m (m)	0.9	0.9	1.7	0.9	1.5	1.8	2	6	6	6	5	2	3	3	5.5	5.5
VHTHE01	Mean height of herbaceous canopy (cm)	2.5	2.5	2.5	2.5	2.5	2.5	8	8	5	5	10	25	25	13	10	36
VHTNL02	Mean ht. coniferous plant sp. that can get > 6 m tall (m)																
VHTSH07	Mean ht. of woody plant sp. that do not get > 6 m	0.9	0.6	0.9	0.3	0.6	0.3			0.5	0.3						
VHTTR01	Mean ht. of overstory trees (m)				12.8	15.2	11	14	18	14	13	15	18	20	18	20	17
VRCEV01	% of tree canopy cover that is evergreen sp. (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VRCHM01	% of tree canopy cover hard mast producing sp. (%)	0.05	0.1	0.4	0.5	0.65	0	0	0.3	0.6	0.3	0.35	0.7	0.5	0.7	0.85	0.7
VSDHM01	# of hard mast tree sp. with canopy cover > 1% (#)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
X105V2	% can. cover of veg. and downfall <= 30 cm abv grd	0.12	0.2	0.15	0.15	0.2	0.15	0.15	0.1	0.25	0.4	0.05	0.2	0.55	0.65	0.45	0.25
X123V3	Ave. dry matter yield of suit. forage	4	4	2	2	2	3	0.4	0.4	0.2	0.2	0.2	0.8	1.9	2.2	1.7	0.6
X123V4	# stems/ha of shrub/tree mast fall-winter (#)	100	100	300	200	400	200	500	400	600	800	1000	1500	1000	1200	700	900
X28V1	% tree canopy closure of overstory pines				0	0	0	0	0	0	0	0	0	0	0	0	0
X28V3	% of dom. canopy pines with decid. understory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X39V3	Density of tree stumps and logs	300	300	0	100	100	100	100	0	0	100	0	0	0	200	0	0
X66V4	Diversity Index	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
X86V1	Avg. radius of circles encompassing 20 aspen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X86V2	Avg. lowest branch ht. of conifers (m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX B
HEP FIELD DATA

CORRIDOR H - HEP DATA ENTRY FORM																
UFOD/41:	DECIDUOUS FOREST	s4-1 8/11	s4-1 8/11	s4-1 8/11	s4-1 8/11	s4-1 8/11	s13-2 8/12	s13-2 8/12	s13-2 8/12	s13-2 8/12	s13-2 8/12	s14-3 8/13	s14-3 8/13	s14-3 8/13	s14-3 8/13	s14-3 8/13
SSO01	Soil moisture class (see lex.)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SSO02	Soil texture class (see lex.)	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
VBAWO01	Basal area of trees (if cut at 1,4 m high) (m2/ha)	217.6761	209.1212	28.49868	100.0217	54.58531	293.0591	221.6823	208.4703	139.8449	42.67014	205.8766	49.70691	6.827223	67.59488	110.1793
VCVHE01	% canopy cover of herbs (non-woody plants)	0.05	0.05	0.01	0.01	0	0.2	0.1	0.03	0.03	0.2	0.1	0.05	0.1	0.03	0.05
VCVHE04	% canopy cover of persistent herbs	0.05	0.05	0.01	0.01	0	0	0	0	0	0.15	0	0.02	0.03	0	0.02
VCVHM03	% of shrub canopy cover soft mast sp.	0.1	0.5	0.1	0	0	0	0	0	0	0	0	0	0	0	0
VCVLT03	% of grnd. surf. covered by litter > 1 cm deep (%)	1	1	1	0.98	1	0.9	0.95	1	0.95	0.9	0.9	0.75	0.95	0.75	0.45
VCVOS03	Canopy cover of overstory pines (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VCVSH01	% canopy cover of shrubs (all woody plants < 6 m)	0.1	0.05	0.1	0	0.15	0.55	0.7	0.65	0.9	0.4	0.4	0.5	0.45	0.15	0.1
VCVSH04	% canopy cover of shrubs & herbs above 50 cm	0.1	0.05	0.1	0	0.15	0.55	0.7	0.15	0.7	0.1	0.45	0.5	0.45	0.15	0.1
VCVSM01	% canopy cover of soft mast trees (%)	0	0	0	0	0	0.75	0.2	0	0	0	0	0	0	0	0
VCVTR01	% canopy cover of trees (%)	0.8	0.9	0.6	0.45	0.85	0.8	0.9	0.85	0.9	0.95	0.8	0.9	0.75	0.95	0.85
VCVTR02	% canopy cover overstory trees (%)	0.8	0.9	0.6	0.45	0.85	0.7	0.9	0.85	0.9	0.4	0.7	0.75	0.65	0.8	0.8
VDBHM02	Mean DBH, hard mast trees > 25.4 cm DBH (cm)	30	30	33	30	0	0	0	35	30	0	43	0	0	43	53
VDBSN02	Mean DBH of snags that have > 38 cm DBH (cm)															
VDBTR01	Mean DBH of overstory trees (i.e., dia. 1.4 m high) (cm)	28	30	33	25	23	56	38	23	22	30	38	34	15.5	28	53
VDNDB04	Density of trees > 51 cm DBH (#/ha)	0	0	0	0	0	200	100	0	0	0	100	0	0	0	100
VDNDE01	Density of deciduous trees (#/ha)	600	600	300	600	500	500	500	700	700	200	500	300	200	400	300
VDNHM01	Density of hard mast trees > 25.4 cm DBH (#/ha)	500	500	100	100	0	0	0	0	100	0	300	0	0	100	200
VDNNL01	Density of coniferous woody plant > .9 m tall (#/ha)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VDNSH01	Den. of deci. shrub stems >= .9 m and < 6m (#/ha)	200	200	100	0	1000	1700	2500	600	3000	500	1500	1200	1500	300	100
VDNSH02	Den. of woody stems >1 m tall (trees & shrubs) (#/ha)	800	800	400	600	1500	2200	3000	1300	3700	700	2000	1500	1700	700	400
VDNSN02	Density of snags that have 10-25 cm DBH (#/ha)	100	0	0	100	0	100	0	100	0	0	0	100	100	0	0
VDNSN03	Density of snags that have > 15 cm DBH (#/ha)	0	0	0	300	0	0	0	100	0	0	0	100	100	0	0
VDNSN04	Density of snags that have > 38 cm DBH (#/ha)	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0
VDNSN07	Density of snags that have > 25 cm DBH (#/ha)	0	0	100	200	0	0	0	0	0	0	0	0	0	0	0
VDNTR02	Density of trees (#/ha)	600	600	300	600	500	500	500	700	700	200	500	300	200	400	300
VDNTR04	Density of trees DBH > 51 cm (#/ha)	0	0	0	0	0	0	0	0	0	0	100	0	0	0	100
VHTDE02	Mean ht. of dec. woody plant sp. that can get > 6m (m)	6	6	6		6	3	1.5	0.3	0.8	0.3	3	2.4	1.8	4.6	2.4
VHTHE01	Mean height of herbaceous canopy (cm)	10	8	6	8		10	5	15	10	13	5	8	15	8	13
VHTNL02	Mean ht. coniferous plant sp. that can get > 6 m tall (m)															
VHTSH07	Mean ht. of woody plant sp. that do not get > 6 m															
VHTTR01	Mean ht. of overstory trees (m)	15	14	18	17	15	18	20	17	15	17	20	21	17	20	18
VRCEV01	% of tree canopy cover that is evergreen sp. (%)	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
VRCHM01	% of tree canopy cover hard mast producing sp. (%)	0.8	0.9	0.6	0.45	0.6	0.1	0	0.85	0.7	0	1	0.4	0.5	0.6	0.9
VSDHM01	# of hard mast tree sp. with canopy cover > 1% (#)	3	3	2	3	3	1	0	1	1	0	4	2	1	2	2
X105V2	% can. cover of veg. and downfall <= 30 cm abv grd	0.1	0.05	0	0	0	0.25	0.2	0.7	0.3	0.4	0.2	0.15	0.15	0.25	0.1
X123V3	Ave. dry matter yield of suit. forage	0.4	0.4	0.1	0.1	0	1.6	0.8	0.4	0.4	1.6	0.8	0.4	0.8	0.4	0.4
X123V4	# stems/ha of shrub/tree mast fall-winter (#)	800	600	400	600	1000	500	500	700	700	200	500	200	100	200	200
X28V1	% tree canopy closure of overstory pines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X28V3	% of dom. canopy pines with decid. understory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X39V3	Den. of tree stumps and logs	100	200	200	100	0	100	0	200	0	0	100	100	100	0	0
X66V4	Diversity Index	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
X86V1	Avg. radius of circles encompassing 20 aspen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X86V2	Avg. lowest branch ht. of conifers (m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX B
HEP FIELD DATA

CORRIDOR H - HEP DATA ENTRY FORM							
UFOE/42:	EVERGREEN FOREST	Plot 1	Plot 2	Plot 3	s12-3-9/1	s12-3-9/1	s12-3-9/1
SSO01	Soil moisture class (see lex)	3	3	3	3	3	3
SSO02	Soil texture class (see lex)	7	7	7	7	7	7
VBAWO01	Basal area of trees	105	132	56	267	264	249
VCVHE04	% canopy cover of persistent herbs	0.05	0.1	0.4	0	0	0
VCVHM03	% of shrub canopy cover soft mast sp.	0	0.15	0.05	0	0	0
VCVLT03	% of ground surface covered by litter > 1 cm deep	1	1	1	1	1	1
VCVOS03	Canopy cover of overstory pines (%)	0.5	0.7	0.5	0.95	0.95	0.95
VCVSH01	% canopy cover of shrubs	0.05	0.25	0.05	0	0	0
VCVSH04	% canopy cover of shrubs & herbs above 50 cm	0.05	0.35	0.05	0	0	0
VCVSM01	% canopy cover of soft mast trees (%)	0	0	0	0	0	0
VCVTR01	% canopy cover of trees (%)	0.5	0.7	0.5	0.95	0.95	0.95
VCVTR02	% canopy cover overstory trees (%)	0.5	0.7	0.5	0.95	0.95	0.95
VDBHM02	Mean DBH, hard mast trees > 25.4 cm DBH (cm)	-	-	-	-	-	-
VDBSN02	Mean DBH of snags that have > 38 cm DBH (cm)	-	-	-	-	-	-
VDBTR01	Mean DBH of overstory trees	16.5	15.3	17.9	23	23	22
VDNDB04	Density of trees > 51 cm DBH (#/ha)	0	0	0	0	0	0
VDNDE01	Density of deciduous trees (#/ha)	100	0	200	0	0	0
VDNHM01	Density of hard mast trees that are > 25.4 cm	0	0	0	0	0	0
VDNNL01	Density of coniferous woody plant > .9 m tall (#/ha)	600	1100	200	800	800	800
VDNSH01	Density of deciduous shrub stems	100	0	200	0	0	0
VDNSH02	Density of woody stems >1 m tall (trees & shrubs)	800	1100	600	800	800	800
VDNSN02	Density of snags that have 10-25 cm DBH (#/ha)	100	0	200	0	0	0
VDNSN03	Density of snags that have > 15 cm DBH (#/ha)	100	0	200	0	0	0
VDNSN04	Density of snags that have > 38 cm DBH (#/ha)	0	0	0	0	0	0
VDNSN07	Density of snags that have > 25 cm DBH (#/ha)	0	0	0	0	0	0
VDNTR02	Density of trees (#/ha)	700	1100	400	800	800	800
VDNTR04	Density of trees DBH > 51 cm (#/ha)	0	0	0	0	0	0
VHTDE02	Mean ht. of dec. woody plant sp. that can get > 6m (m)	2	-	3	-	-	-
VHTNL02	Mean ht. coniferous plant sp. that can get > 6 m	-	-	-	-	-	-
VHTSH07	Mean ht. of woody plant sp. that do not get > 6 m	-	-	-	-	-	-
VHTTR01	Mean ht. of overstory trees	11	11	11	11	11	11
VRCEV01	% of tree canopy cover that is evergreen sp. (%)	0.95	1	0.7	1	1	1
X105V2	% can. cover of veg. and downfall <= 30 cm abv grd	0.25	0.6	0.55	0.1	0.1	0.1
X123V3	Average dry matter yield of suitable forage	4	5.6	1.6	1	1	1
X123V4	# stems/ha of shrub/tree mast fall-winter (#)	0	0	0	0	0	0
X28V1	% tree canopy closure of overstory pines (except	0.5	0.7	0.5	0.95	0.95	0.95
X28V3	% of dom. canopy pines with decid. understory	0	0	0	0	0	0
X39V3	Den. of tree stumps and logs	0	0	0	0	0	0
X66V4	Diversity Index (Diversity index)	0.5	0.5	0.5	0.5	0.5	0.5
X86V1	Avg. radius of circles encompassing 20 aspen	-	-	-	-	-	-
X86V2	Avg. lowest branch ht. of conifers (m)	6.1	6.1	7.6	6	6	6

APPENDIX B
HEP FIELD DATA

CORRIDOR H - HEP DATA ENTRY FORM											
UG/31:	Grassland	Plot 1	Plot 2	s13-3-8/5	s13-3-8/5	s13-3-8/5	s13-3-8/5	s4-1-8/11	s4-1-8/11	s4-1-8/11	s4-1-8/11
SDIFO01	Mean distance to forest or tree savanna cover type (m)	31.1	18.3	38	39	34	33	39	40	37	46
SDIPS01	Mean distance to a perch site	30.5	22.9	18	18	24	21	15	15	37	46
VCVHE01	% canopy cover of herbs	0.9	0.8	1	1	1	1	0.9	0.75	0.98	0.95
VCVHE04	% canopy cover of persistent herbs	0.8	0.4	0.8	0.8	0.75	0.8	0.75	0.5	0.95	0.85
VCVLT03	% of ground surface covered by litter > 1 cm deep	1	0.45	0.9	0.9	0.85	0.9	0.9	0.75	0.95	0.95
VCVSH01	% canopy cover of shrubs	0.1	0.15	0	0	0	0	0.02	0.05	0	0
VCVTR01	% canopy cover of trees (%)	0	0	0	0	0	0	0	0	0	0
VDNSH02	Density of woody stems >1 m tall (trees & shrubs)	200	700	0	0	0	0	0	200	0	0
VHTHE01	Mean height of herbaceous canopy (cm)	30	50.8	30	30	25	30	20	15	15	20
VHTHE03	Mean ht. of herbaceous canopy during spring (cm)	20.3	25.4	15	15	13	15	20	15	20	20
VRCGR01	% of herbaceous canopy cover that is grasses (%)	0.7	0.4	0.9	0.9	0.8	0.85	0.89	0.67	0.92	0.85
X123V3	Average dry matter yield of suitable forage	6.4	4	7	7	6.4	6.8	7.2	6	7.8	7.6
X123V4	# stems/ha of shrub/tree mast fall-winter (#)	200	600	0	0	0	0	0	0	0	0
X66V4	Diversity Index	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

APPENDIX B
HEP FIELD DATA

CORRIDOR H - HEP DATA ENTRY FORM													
USHD/32:	DECIDUOUS SHRUBLAND	Plot 1	Plot 2	Plot 3	Plot 4	s3-1-8/10	s3-1-8/10	s3-1-8/10	s3-1-8/10	s13-2-8/12	s13-2-8/12	s13-2-8/12	s2-3-9/9
SDIFO01	Mean distance to forest or tree savanna cover type (m)	103	99.1	99.1	105.2	38	38	41	37	166	164	156	20
VCVHE01	% canopy cover of herbs (non-woody plants)	0.02	0.45	0.02	0.05	0.1	0	0	0	0.2	0.5	0.75	0.15
VCVHE04	% canopy cover of persistent herbs	0	0	0	0	0.05	0	0	0	0.05	0	0.3	0
VCVHM03	% of shrub can. cover soft mast	0.6	0	0.05	0.05	0.55	0.6	0.65	0.65	0.1	0	0.1	0.25
VCVLT03	% of ground surface covered by litter > 1 cm deep	0.5	0.9	0.95	0.9	0.95	0.95	0.9	0.9	1	1	1	1
VCVSH01	% canopy cover of shrubs (woody plants < 6m)	0.9	0.85	0.95	0.8	0.85	0.95	0.9	0.9	0.8	0.85	0.65	0.9
VCVSH02	% canopy cover of decid. shrubs < 6 m	0.9	0.85	0.95	0.8	0.85	0.95	0.9	0.85	0.8	0.85	0.65	0.9
VCVTR01	% canopy cover of trees	0.2	0	0	0	0.05	0	0	0.05	0	0	0	0
VDNDE01	Density of deciduous trees (#/ha)	200	0	0	0	100	0	0	100	0	0	0	100
VDNNL01	Density of coniferous woody plant > .9 m tall (#/ha)	0	0	0	0	0	0	0	0	0	0	0	0
VDNSH01	Density of decid. shrub stems >= .9 m and < 6m (#/ha)	10000	10500	11500	14500	5100	4800	2500	4300	7500	8200	8000	5200
VDNSH02	Den. of woody stems >1 m tall (trees & shrubs) (#/ha)	10200	10500	11500	14500	5200	4800	2500	4300	7500	8200	8000	5200
VHTDE02	Mean ht. of decid. woody plant sp. that can get >6m	4.6	5.5	5.5	5.5	5	3	2	4	3.7	3.7	3	1.8
VHTHE01	Mean ht. of herb. canopy (cm)	7.6	30.5	5.1	10.2	20	-	-	-	46	25	30	20
VHTNL02	Mean ht. coniferous plant sp. that can get > 6 m tall (m)	-	-	-	-	-	0.3	-	-	-	-	-	-
VHTSH05	Mean ht. of deciduous shrub canopy (m)	4.6	5.5	5.5	5.5	1.2	1.7	1.2	1.2	3.7	3.7	3	1.8
VHTSH07	Mean ht. of woody plant sp. that do not get > 6 m	-	-	-	-	0.6	0.8	0.9	0.6	-	-	-	-
VRCSH01	% of decid. shrub canopy cover hydrophytic sp.	0	0	0	0	0	0	0	0	0	0	0	0
X123V3	Ave. dry matter yield suitable forage	1	1	1.5	1.5	1	1	1	1	1.5	1	2.4	2
X123V4	# stems/ha of shrub/tree sp. provide mast fall/winter (#)	8000	8100	8500	9000	5100	4800	2500	4200	7500	8200	8000	5200
X66V4	Diversity Index	0.5	0.5	0.5	0.5	1.5	1.5	1.5	1.5	1	1	1	1
X86V1	Avg. radius of circles encomp. 20 mature male aspens	0	0	0	0	0	0	0	0	0	0	0	0
X86V2	Avg. lowest branch ht. of conifers (m)	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX C

CHEAT MOUNTAIN SALAMANDER REPORT

REPORT TO MICHAEL BAKER JR., INC.

SURVEYS FOR THE CHEAT MOUNTAIN SALAMANDER (PLETHODON NETTINGI) IN THE POTENTIAL IMPACT AREA OF CORRIDOR H BUILD AND IMPROVED ROADWAY ALTERNATIVES

PREPARED BY THOMAS K. PAULEY, PH.D.

SURVEYS FOR THE CHEAT MOUNTAIN SALAMANDER (PLETHODON NETTINGI) IN THE POTENTIAL IMPACT AREA OF CORRIDOR H BUILD AND IMPROVED ROADWAY ALTERNATIVES

Thomas K. Pauley, Ph.D.

Introduction. The Cheat Mountain salamander (*Plethodon nettingi*) is a small, terrestrial species that was first found in Randolph County, West Virginia in 1935 and described as a species in 1938. Today approximately 65 populations have been found in Pocahontas, Randolph, Tucker, and Pendleton counties of northeastern West Virginia. The known total range extends from the northern side of the Blackwater River Canyon south to near the town of Cass.

The typical habitat of *Plethodon nettingi* includes higher elevations with a canopy of Red Spruce and Yellow Birch and a ground cover of the liverwort *Bazzania*. However, there are some known populations in mixed deciduous forests. Elevation ranges from 2,640 ft. in the Blackwater River Canyon to over 4,800 ft. at Spruce Knob.

Two populations of *Plethodon nettingi* have been found 2 miles south of the potential impact area of the Build Alternative sites (BA) and Improved Roadway Alternative (IRA) sites. These populations are located on the northern rim of the Blackwater River Canyon at 3,200 ft. The major vegetation types in these populations are Hemlock, Yellow Birch, and Rhododendron. Elevation and vegetation types in the potential Build and Improved Roadway Alternative sites are similar to those associated with these *Plethodon nettingi* populations.

Three other species of salamanders are typically found with *Plethodon nettingi*. These include the redback salamander (*Plethodon cinereus*), Wehrle's salamander (*Plethodon wehrlei*), and the mountain dusky salamander (*Desmognathus ochrophaeus*).

This study examined potential habitats in areas that could be impacted by the construction of the Build and Improved Roadway Alternative near U.S. Route 219 and WV Route 93. The study area included 13 Build Alternative sites. Of these 13 sites, 4 were located between U. S. Forest Service Road 18 on Backbone Mountain and the town of Thomas. These sites included site 1 between U.S. Route 219 and Big Run, site 2 between Big Run and Tub Run, site 3 between Tub Run and Long Run, site 4 between Long Run and Middle Run. Nine additional sites were surveyed along WV Route 93 approximately 1.0 mile north of the intersection with Route 219 to the Tucker/Grant county line.

Improved Roadway Alternative sites included 7 sites along U.S. Route 219 and 2 sites along WV Route 93. The sites along Route 219 extended from an elevation of 2,800 ft. on the west side of Backbone Mountain near U. S. Forest Service Road 18 northeast to the North Fork of the Blackwater River.

Methods and Materials. Surveys were conducted from May 10 through June 8, 1994 by walking transects and turning all cover objects with "herp" rakes. Data recorded at each site included salamander species, size classes, sexes, cover objects, dominant plant species, and elevation ranges. Surveys were conducted during the day by 3 biologists, Dr. Thomas K. Pauley and his graduate students.

Results and Discussion. Fourteen species of salamanders including Plethodon nettingi are known to occur near the study area (Table 1). In surveys conducted during this study, 7 species and 412 individuals were observed (Table 2). Plethodon nettingi was not found in any of the areas. The most common species included Plethodon cinereus (297 individuals) and Desmognathus ochrophaeus (87 individuals). Both of these species are known to occur in sympatry with Plethodon nettingi throughout its range.

Table 3 shows that 3 species of salamanders and 108 individuals were observed in site 1 (Figure 1). The dominant species were Desmognathus ochrophaeus (60 individuals) and Plethodon cinereus (47 individuals). The elevation range surveyed in site 1 was from 3,300 ft. to 3,560 ft. to the north and 3,475 ft. to the south. The dominant vegetation included Yellow Birch, Black Cherry, Beech, Hemlock, and Rhododendron.

Eighty-eighty salamanders were observed in site 2 (Figure 1 and Table 4). Of these, 74 were Plethodon cinereus and 13 Desmognathus ochrophaeus. Surveys were conducted between 3,300 ft. to 3,440 ft. Vegetation included Black Cherry, Yellow Birch, Hemlock, Rhododendron, and Red Spruce near the highest point.

Site 3 (Figure 1) had the greatest diversity of salamander species with 28 Plethodon cinereus, 23 Desmognathus ochrophaeus, 4 Plethodon glutinosus, and 1 Plethodon wehrlei (Table 5). Surveys were made from 3,160 ft. to 3,300 ft. Plant species included Beech, Red Maple, and Black Cherry.

In site 4 (Figure 1), 32 Desmognathus ochrophaeus, 67 Plethodon cinereus, and 4 Plethodon glutinosus were observed (Table 6). Elevation ranged from 3,180 ft. to 3,320 ft. Vegetation was composed of Black Cherry, Sugar Maple, Beech, and Yellow Birch.

Build Alternative sites along WV Route 93 had substantial fewer salamanders than sites near U.S. Route 219. In the 9 sites (sites 5-13) surveyed along Route 93 (Figures 2, 3, and 4), only 3 specimens of the common species Plethodon cinereus were observed (Table 7). The only other salamander species found were Red Efts (Notophthalmus v. viridescens) and Four-toed salamanders (Hemidactylium scutatum). The areas surveyed ranged in elevation from 3,120 ft. to 3,634 ft. Vegetation consisted of Yellow Birch, Red Maple, Black Cherry, Rhododendron, and Mountain Laurel. This area was very dry and, therefore, not optimal habitat for salamanders.

Salamanders were not found in the two IRA sites examined along Route 93 (Figure 5). These sites were located north of Route 93. The elevation in both sites was approximately 3,260 ft. Vegetation was Hemlock, Red Spruce, Red Maple, and Yellow Birch.

In the 7 Improved Roadway Alternative sites surveyed along U.S. Route 219 (Figures 6 and 7), 46 Plethodon cinereus and 56 Desmognathus ochrophaeus, and 1 Plethodon wehrlei were observed (Table 8). Sites surveyed ranged in elevation from 2,800 ft. to 3,500 ft. Vegetation consisted of Red Maple, Yellow Birch, Black Cherry, Hemlock, and Rhododendron.

Logs were the major cover objects used by both common salamander species, Plethodon cinereus and Desmognathus ochrophaeus, throughout the Build and Improved Roadway Alternative sites.

Reported submitted by T. K. Pauley
Thomas K. Pauley, Ph.D.

Date 6/15/94

Table 1. Salamander Species Known to Occur in the General Vicinity of the Proposed Corridor H Project.

Scientific Name	Common Name
Notophthalmus v. viridescens	Red Eft
Ambystoma maculatum	Spotted Salamander
Desmognathus f. fuscus	Northern Dusky Salamander
Desmognathus monticola	Seal Salamander
Desmognathus ochrophaeus	Mountain Dusky Salamander
Plethodon nettingi	Cheat Mountain Salamander
Plethodon cinereus	Redback Salamander
Plethodon wehrlei	Wehrle's Salamander
Plethodon glutinosus	Slimy Salamander
Aneides aeneus	Green Salamander
Hemidactylium scutatum	Four–Toed Salamander
Gyrinophilus p. porphyriticus	Northern Spring Salamander
Pseudotriton r. ruber	Northern Red Salamander
Eurycea bislineata	Northern Two–Lined Salamander

Table 2. Salamander Species Observed in the Proposed Corridor H Project.

Scientific Name	Common Name	Number Observed
Notophthalmus v. viridescens	Red Eft	5
Ambystoma maculatum	Spotted Salamander	Eggs
Desmognathus ochrophaeus	Mountain Dusky Salamander	87
Plethodon cinereus	Redback Salamander	297
Plethodon wehrlei	Wehrle's Salamander	2
Plethodon glutinosus	Slimy Salamander	16
Hemidactylium scutatum	Four-Toed Salamander	5

Table 3. Salamander Data Including Species, Sexes, Size Classes, and Cover Objects in Site 1 (Between US 219 and Big Run) of the Potential Build Alternative Impact Area.

Species	Cover Object			
	Log	Bark	Litter	Rock
Desmognathus ochrophaeus (Male)	13	0	0	8
Desmognathus ochrophaeus (Female)	11	0	0	9
Desmognathus ochrophaeus (Subadult)	12	0	0	5
Desmognathus ochrophaeus (Juvenile)	0	0	0	0
Desmognathus ochrophaeus (Undetermined)	1	0	0	1
Plethodon cinereus (Male)	9	0	0	0
Plethodon cinereus (Female)	20	3	0	2
Plethodon cinereus (Subadult)	10	0	0	0
Plethodon cinereus (Juvenile)	2	0	0	0
Plethodon cinereus (Undetermined)	1	0	0	0
Plethodon wehrlei (Male)	0	0	0	0
Plethodon wehrlei (Female)	0	0	0	0
Plethodon wehrlei (Subadult)	1	0	0	0
Plethodon wehrlei (Juvenile)	0	0	0	0
Plethodon wehrlei (Undetermined)	0	0	0	0
Plethodon glutinosus (Male)	0	0	0	0
Plethodon glutinosus (Female)	0	0	0	0
Plethodon glutinosus (Subadult)	0	0	0	0
Plethodon glutinosus (Juvenile)	0	0	0	0
Plethodon glutinosus (Undetermined)	0	0	0	0

Figure 1. Location of Build Alternative Sites 1, 2, 3, and 4 on Backbone Mountain (Lead Mine Quadrangle).

HAMBLETON (JUNC. W. VA. 72) 5.4 MI.
ELKINS 27 MI.

(MOZARK MOUNTAIN)
5062 II SE

35′ 623 625 32′30″ 627

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MN GN
0°54′
16 MILS

1976 MAGNETIC NORTH AT CENTER OF SHEET

W. VA

Table 4. Salamander Data Including Species, Sexes, Size Classes, and Cover Objects in Site 2 (Between Big Run and Tub Run) of the Potential Build Alternative Impact Area.

Species	Cover Object			
	Log	Bark	Litter	Rock
Desmognathus ochrophaeus (Male)	4	0	0	1
Desmognathus ochrophaeus (Female)	5	0	0	0
Desmognathus ochrophaeus (Subadult)	1	0	0	0
Desmognathus ochrophaeus (Juvenile)	0	0	0	1
Desmognathus ochrophaeus (Undetermined)	1	0	0	0
Plethodon cinereus (Male)	15	4	0	3
Plethodon cinereus (Female)	23	2	0	6
Plethodon cinereus (Subadult)	12	2	0	2
Plethodon cinereus (Juvenile)	2	0	0	0
Plethodon cinereus (Undetermined)	3	0	0	0
Plethodon wehrlei (Male)	0	0	0	0
Plethodon wehrlei (Female)	0	0	0	0
Plethodon wehrlei (Subadult)	0	0	0	0
Plethodon wehrlei (Juvenile)	0	0	0	0
Plethodon wehrlei (Undetermined)	0	0	0	0
Plethodon glutinosus (Male)	0	0	0	1
Plethodon glutinosus (Female)	0	0	0	0
Plethodon glutinosus (Subadult)	0	0	0	0
Plethodon glutinosus (Juvenile)	0	0	0	0
Plethodon glutinosus (Undetermined)	0	0	0	0

Table 5. Salamander Data Including Species, Sexes, Size Classes, and Cover Objects in Site 3 (Between Tub Run and Long Run) of the Potential Build Alternative Impact Area.

Species	Cover Object			
	Log	Bark	Litter	Rock
Desmognathus ochrophaeus (Male)	5	3	0	1
Desmognathus ochrophaeus (Female)	4	0	0	0
Desmognathus ochrophaeus (Subadult)	3	0	0	0
Desmognathus ochrophaeus (Juvenile)	2	0	0	1
Desmognathus ochrophaeus (Undetermined)	3	1	0	0
Plethodon cinereus (Male)	8	0	0	0
Plethodon cinereus (Female)	7	3	0	0
Plethodon cinereus (Subadult)	3	1	1	0
Plethodon cinereus (Juvenile)	1	1	0	0
Plethodon cinereus (Undetermined)	1	1	1	0
Plethodon wehrlei (Male)	1	0	0	0
Plethodon wehrlei (Female)	0	0	0	0
Plethodon wehrlei (Subadult)	0	0	0	0
Plethodon wehrlei (Juvenile)	0	0	0	0
Plethodon wehrlei (Undetermined)	0	0	0	0
Plethodon glutinosus (Male)	2	0	0	0
Plethodon glutinosus (Female)	0	1	0	0
Plethodon glutinosus (Subadult)	1	0	0	0
Plethodon glutinosus (Juvenile)	0	0	0	0
Plethodon glutinosus (Undetermined)	0	0	0	0

Table 6. Salamander Data Including Species, Sexes, Size Classes, and Cover Objects in Site 4 (Between Long Run and Middle Run) of the Potential Build Alternative Impact Area.

Species	Cover Object			
	Log	Bark	Litter	Rock
Desmognathus ochrophaeus (Male)	11	0	0	5
Desmognathus ochrophaeus (Female)	8	1	0	2
Desmognathus ochrophaeus (Subadult)	4	0	0	0
Desmognathus ochrophaeus (Juvenile)	1	0	0	0
Desmognathus ochrophaeus (Undetermined)	0	0	0	0
Plethodon cinereus (Male)	12	1	0	4
Plethodon cinereus (Female)	27	0	0	4
Plethodon cinereus (Subadult)	12	0	0	1
Plethodon cinereus (Juvenile)	5	0	0	0
Plethodon cinereus (Undetermined)	1	0	0	0
Plethodon wehrlei (Male)	0	0	0	0
Plethodon wehrlei (Female)	0	0	0	0
Plethodon wehrlei (Subadult)	0	0	0	0
Plethodon wehrlei (Juvenile)	0	0	0	0
Plethodon wehrlei (Undetermined)	0	0	0	0
Plethodon glutinosus (Male)	2	0	0	1
Plethodon glutinosus (Female)	0	0	0	0
Plethodon glutinosus (Subadult)	0	0	0	0
Plethodon glutinosus (Juvenile)	1	0	0	0
Plethodon glutinosus (Undetermined)	0	0	0	0

Figure 2. Location of Build Alternative Site 5 along West Virginia Route 93 (Davis Quadrangle).

3326
3300
3200
3180
3140
3100
3239
3290
3119
3120
3135
A
X
D
PIPELINE
JEEP
TRAIL
Radio
Tower
Creek
Lost
Run
Beaver
Strip Mine
Tipple
ABANDONED
93
BA
Sites

Figure 3. Location of Build Alternative Sites 6, 7, and 8 Along West Virginia Route 93 (Davis Quadrangle).

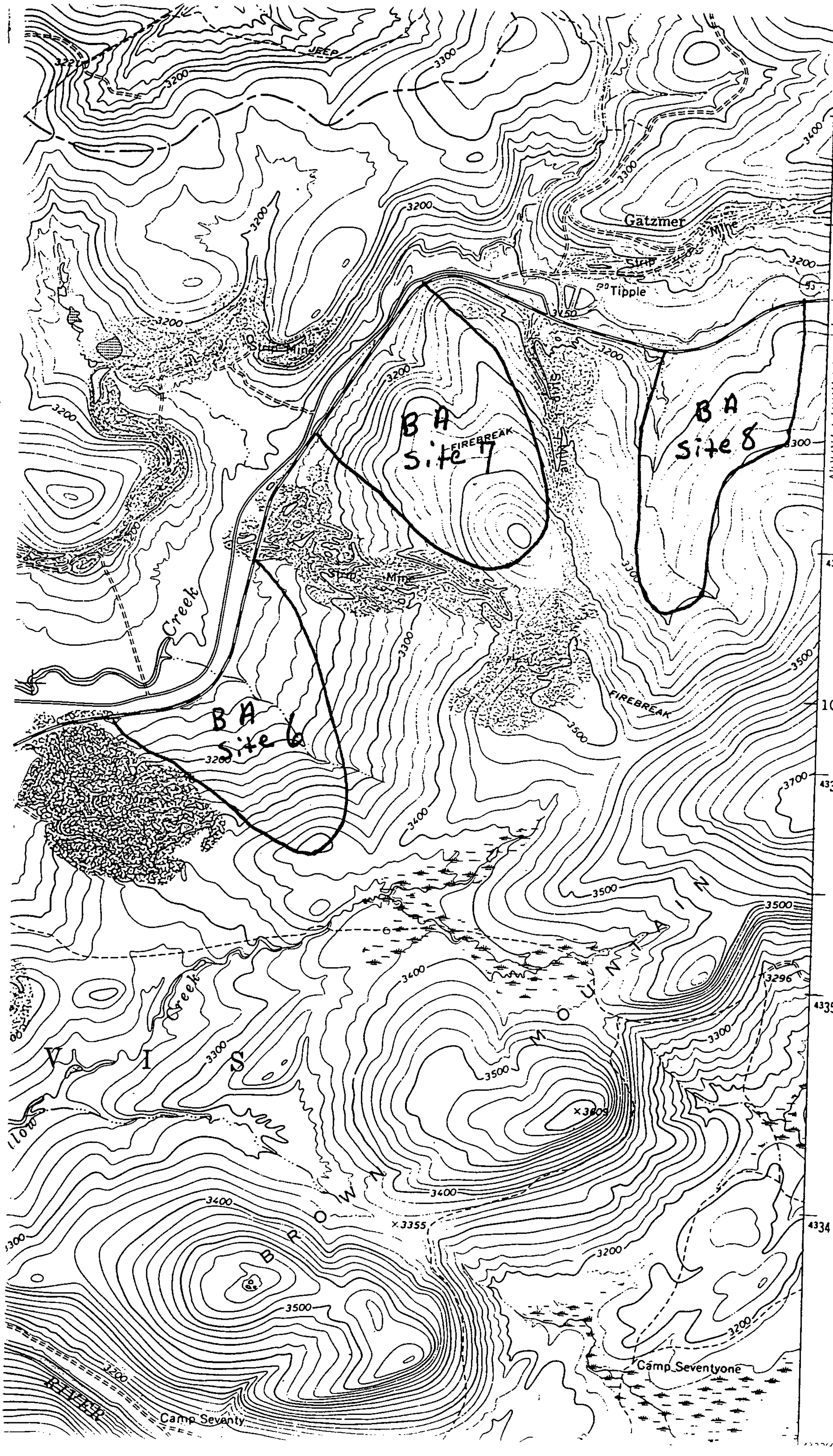
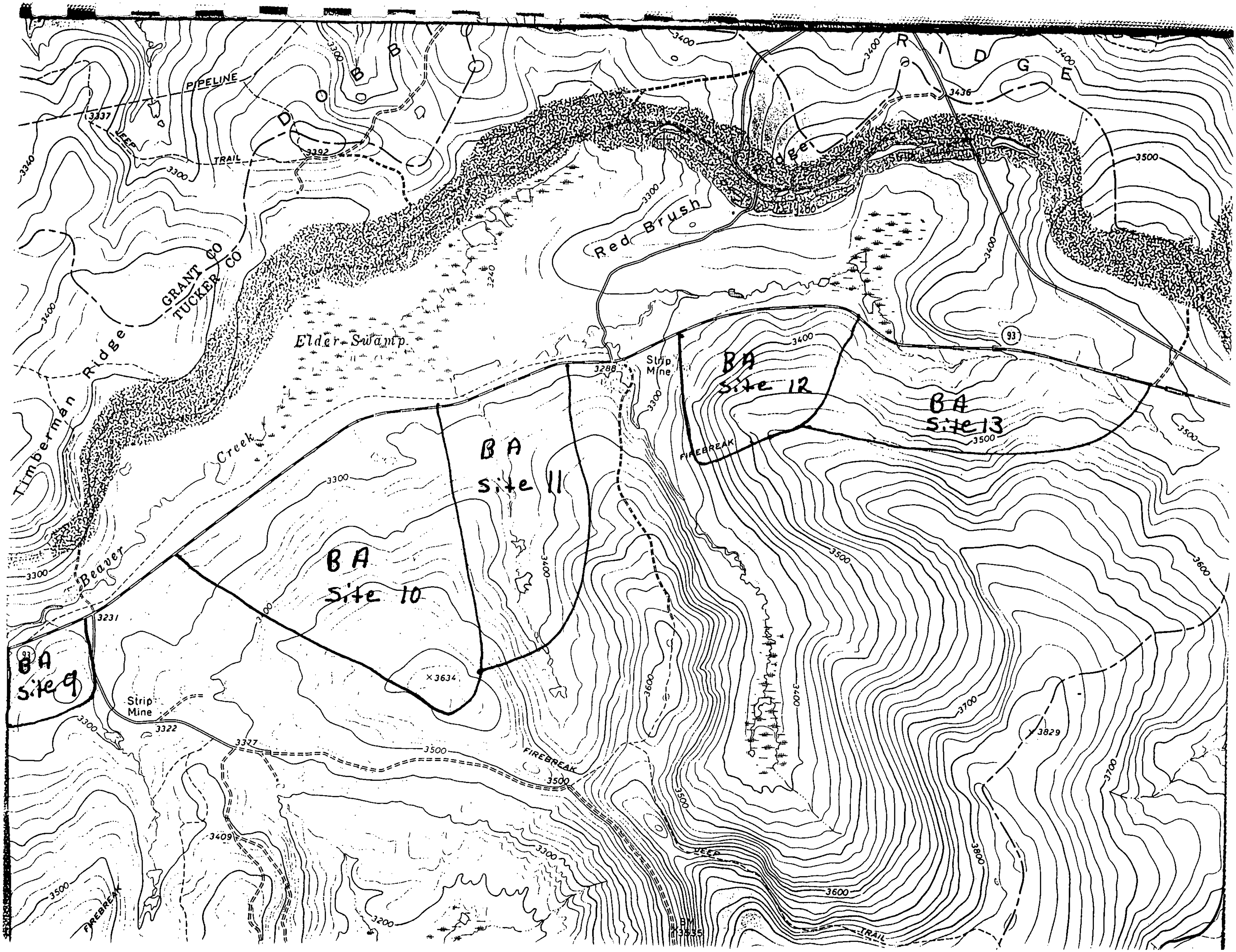

B A Site 7
B A Site 8
B A Site 6
FIREBREAK
Gatzmer
Strip Mine
Tipple
Creek
V I S
BROWN MOUNTAIN
Camp Seventyone
Camp Seventy
RIVER
(MOUNT STORM LAKE)
5162 III NE
3200
3300
3400
3500
3700
3296
×3355
10′
4337
4336
4335
4334

Figure 4. Location of Build Alternative Sites 9, 10, 11, 12, and 13 Along West Virginia Route 93 (Mount Storm Lake Quadrangle).



DOBBIN RIDGE
PIPELINE
JEEP TRAIL
Red Brush
Ridge
GRANT CO
TUCKER CO
Timberman Ridge
Elder Swamp
Beaver Creek
Strip Mine
FIREBREAK
BA Site 9
BA Site 10
BA Site 11
BA Site 12
BA Site 13
3337
3392
3436
3288
3231
3322
3327
3409
×3634
×3829
BM 3535
93

Table 7. Salamander Data Including Species, Sexes, Size Classes, and Cover Objects in Sites 5–9 (Along WV 93) of the Potential Build Alternative Impact Area.

Species	Cover Object			
	Log	Bark	Litter	Rock
Desmognathus ochrophaeus (Male)	0	0	0	0
Desmognathus ochrophaeus (Female)	0	0	0	0
Desmognathus ochrophaeus (Subadult)	0	0	0	0
Desmognathus ochrophaeus (Juvenile)	0	0	0	0
Desmognathus ochrophaeus (Undetermined)	0	0	0	0
Plethodon cinereus (Male)	1	0	0	0
Plethodon cinereus (Female)	2	0	0	0
Plethodon cinereus (Subadult)	0	0	0	0
Plethodon cinereus (Juvenile)	0	0	0	0
Plethodon cinereus (Undetermined)	0	0	0	0
Plethodon wehrlei (Male)	0	0	0	0
Plethodon wehrlei (Female)	0	0	0	0
Plethodon wehrlei (Subadult)	0	0	0	0
Plethodon wehrlei (Juvenile)	0	0	0	0
Plethodon wehrlei (Undetermined)	0	0	0	0
Plethodon glutinosus (Male)	0	0	0	0
Plethodon glutinosus (Female)	0	0	0	0
Plethodon glutinosus (Subadult)	0	0	0	0
Plethodon glutinosus (Juvenile)	0	0	0	0
Plethodon glutinosus (Undetermined)	0	0	0	0

Figure 5. Location of Improved Roadway Alternative Sites 1 and 2 Along West Virginia Route 93 (Mount Storm Lake Quadrangle).

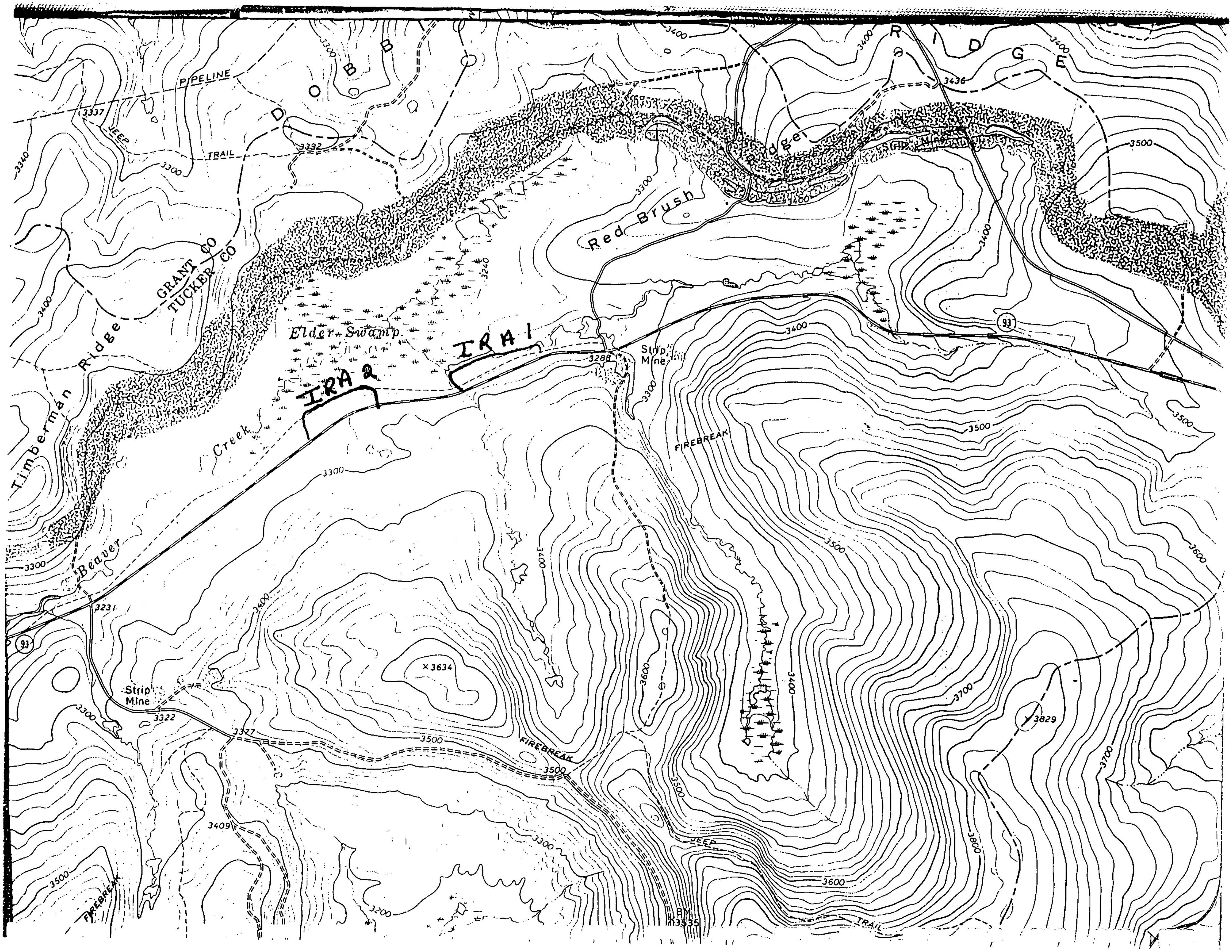
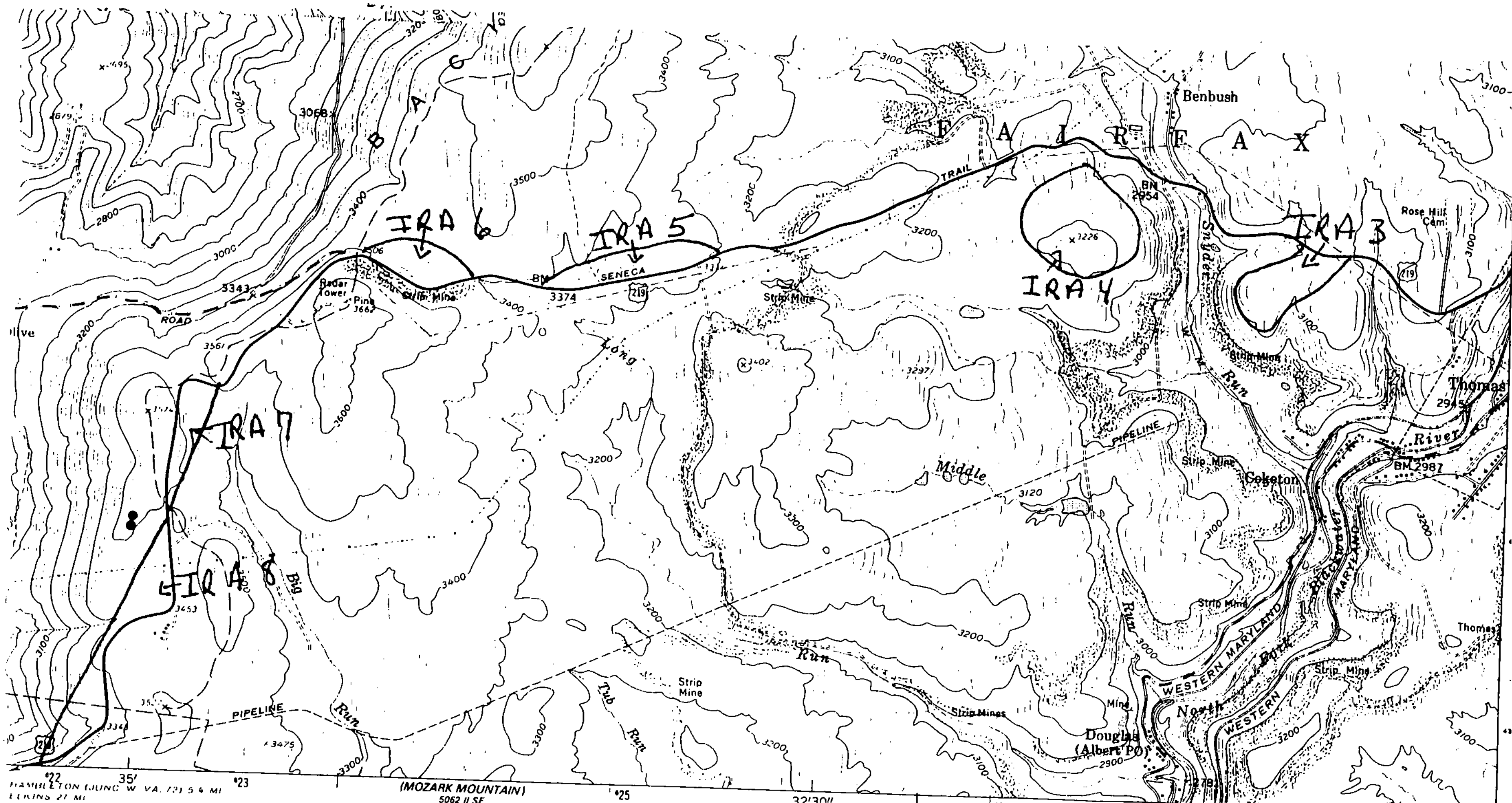

DOBBIN RIDGE
PIPELINE
JEEP TRAIL
3337
3392
3340
3300
3400
3436
3500
Ridge
Strip Mine
Red Brush
GRANT CO
TUCKER CO
Timberman Ridge
Elder Swamp
IRA 1
IRA 2
3240
3288
Strip Mine
Creek
Beaver
3231
93
FIREBREAK
3634
3829
3600
3700
3800
Strip Mine
3322
3377
3409
JEEP
TRAIL
BM 3535
3200

Figure 6. Location of Improved Roadway Alternative Sites 3, 4, 5, 6, 7, and 8 Along U. S. Route 219 (Lead Mine Quadrangle).



HAMBLETON (JUNC W. VA. 72) 5.4 MI
ELKINS 27 MI

(MOZARK MOUNTAIN)
5062 II SE

32'30"

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1978

39°07'30"
79°30'

SCALE 1:24 000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

0°54'
16 MILS

MAGNETIC NORTH
CENTER OF SHEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

W VA
QUADRANGLE LOCATION

Revisions shown in purple compiled from aerial photographs taken 1976. This information not field checked

ROAD CLASSIFICATION

Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U. S. Route

(BLACKWATER FALLS)
5162 III SW

LEAD MINE, W. VA.
NE/4 PARSONS 15' QUADRANGLE
N 3907.5—W 7930/7.5

1959
PHOTOREVISED 1976

Figure 7. Location of Improved Roadway Alternative Site 9 Along U.S. Route 219 (Mozark Mountain Quadrangle).

UNITED STATES
MENT OF THE INTERIOR
OLOGICAL SURVEY

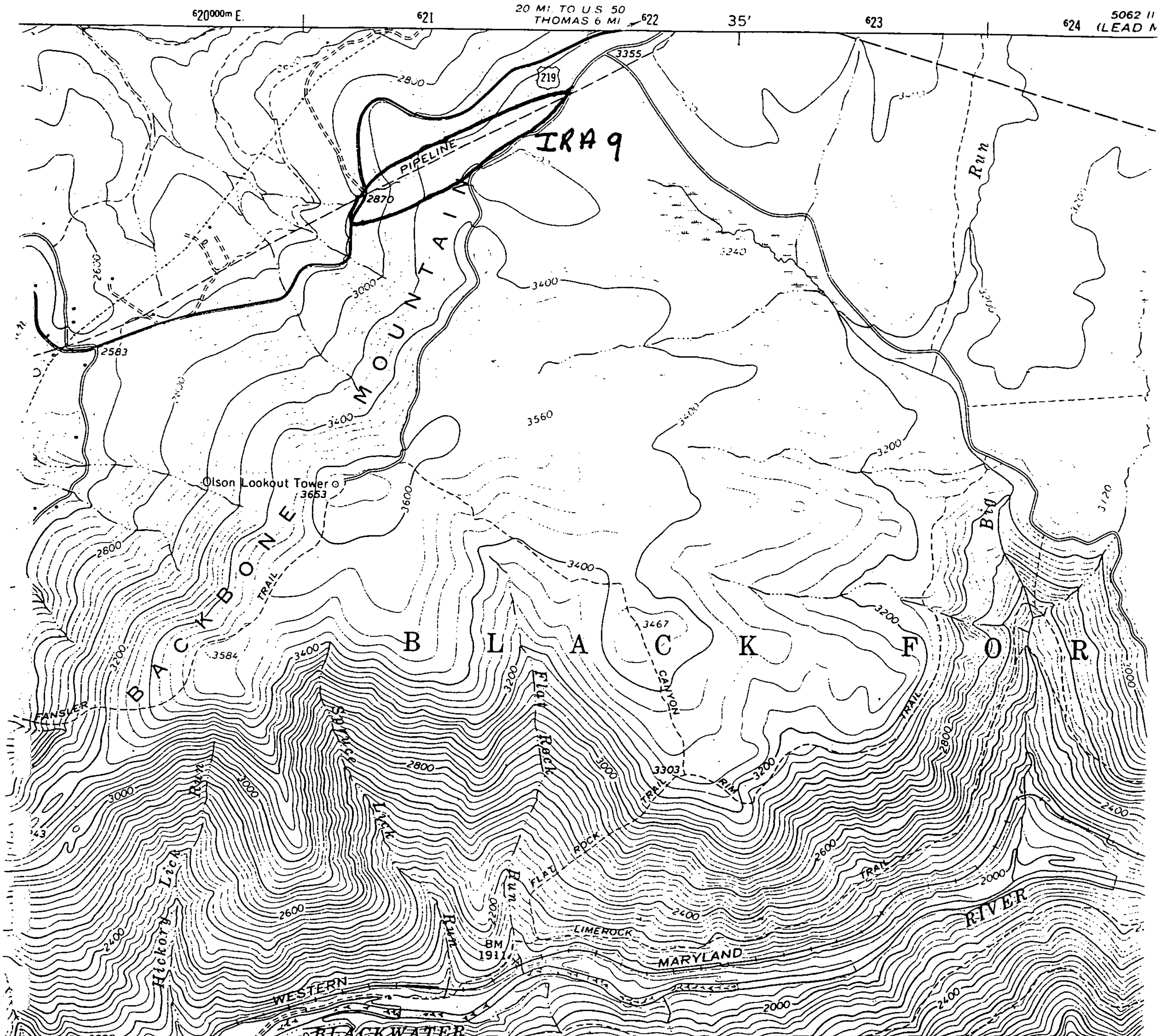


Table 8. Salamander Data Including Species, Sexes, Size Classes, and Cover Objects in Improved Roadway Alternative Sites.

Species	Cover Object			
	Log	Bark	Litter	Rock
Desmognathus ochrophaeus (Male)	13	0	0	8
Desmognathus ochrophaeus (Female)	11	0	0	9
Desmognathus ochrophaeus (Subadult)	12	0	0	3
Desmognathus ochrophaeus (Juvenile)	0	0	0	0
Desmognathus ochrophaeus (Undetermined)	0	0	0	0
Plethodon cinereus (Male)	9	0	0	0
Plethodon cinereus (Female)	20	3	0	2
Plethodon cinereus (Subadult)	10	0	0	0
Plethodon cinereus (Juvenile)	2	0	0	0
Plethodon cinereus (Undetermined)	0	0	0	0
Plethodon wehrlei (Male)	0	0	0	0
Plethodon wehrlei (Female)	0	0	0	0
Plethodon wehrlei (Subadult)	1	0	0	0
Plethodon wehrlei (Juvenile)	0	0	0	0
Plethodon wehrlei (Undetermined)	0	0	0	0
Plethodon glutinosus (Male)	0	0	0	0
Plethodon glutinosus (Female)	0	0	0	0
Plethodon glutinosus (Subadult)	0	0	0	0
Plethodon glutinosus (Juvenile)	0	0	0	0
Plethodon glutinosus (Undetermined)	0	0	0	0