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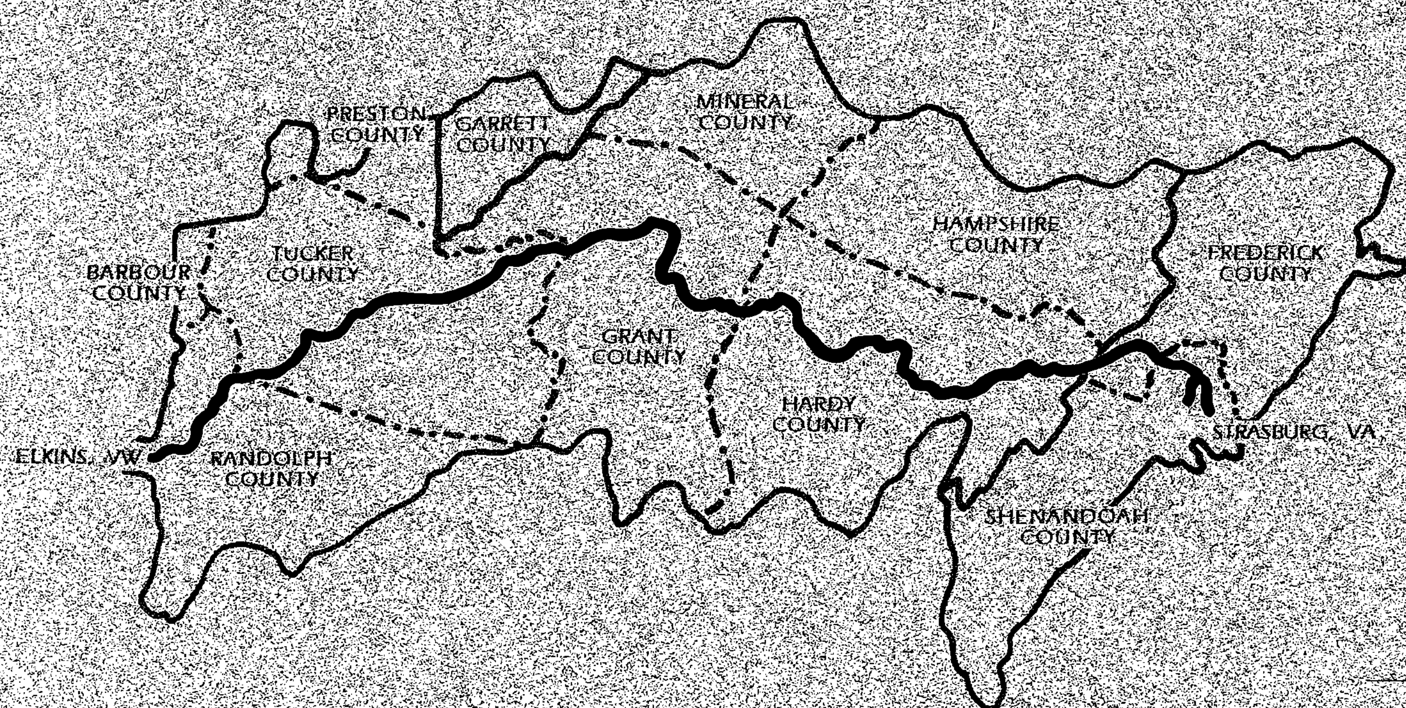
Federal Project: ADP-484 (59)

SECONDARY AND CUMULATIVE IMPACTS 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 Secondary and Cumulative Impacts 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 *Air, Noise and Energy Technical Report*, the *Socioeconomics Technical Report*, the *Vegetation and Wildlife Habitat Technical Report*, the *Streams Technical Report*, the *Wetlands 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 (IRA), 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 two-lane highway which would utilize existing roads as much as possible. The Build Alternative is a four-lane highway which would be constructed entirely on new location. Please refer to Section II of the SDEIS, for more information on the design criteria and design elements of these alternatives.

Analysis of a proposed project's secondary and cumulative impacts is a requirement of the National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality's (CEQ) NEPA regulations (40 CFR 1508). In 1992, the FHWA issued a position paper which states in part that, "to fulfill the general NEPA mandate of environmentally sensitive decision making, the FHWA and States must develop and use techniques to incorporate secondary and cumulative impact issues in the highway project development process" (Bank, 1992). In accordance with that mandate, this report presents an analysis of the secondary and cumulative impacts of the Corridor H alternatives. It begins with the analysis of induced development for the Build and Improved Roadway Alternatives (Section II-A), and assessment of corresponding secondary impacts (Section II-B). Cumulative impacts, based on the proposed action and other known or foreseeable Federal actions, are discussed in Section III. For continuity within a particular resource area, the assessment of secondary and cumulative ecological impacts is also included in the appropriate technical reports and summarized in the SDEIS.

Secondary impacts are defined as "those that are caused by an action and are later in time or farther removed in distance..." from the construction of the proposed project (Bank, 1992). To refine and more easily present the results of this analysis, secondary impacts are discussed in this study in two categories:

1. Those that are related to the construction, operation and maintenance of the proposed facility; that is, highway-related secondary impacts (sometimes called indirect impacts), such as stormwater runoff;
2. Those that are related to development that occurs as the result of the highway; that is, development-related secondary impacts, such as the possible relocation of a perennial stream associated with construction of an industrial park.

Cumulative impacts "result from the incremental consequences of an action when added to other past and reasonably foreseeable future actions...and are less defined than secondary effects (Bank, 1992)." Cumulative impacts have been evaluated in this study in three categories:

1. The sum of all direct impacts to a given resource, such as the total of all stream relocations within a watershed;
2. The sum of direct and secondary impacts to a given resource, such as the total of direct and secondary impacts to streams in a watershed;
3. The sum of all direct and secondary impacts to a given resource due to the proposed action, *plus* the potential impacts of reasonably foreseeable future Federal actions, such as the construction of the proposed highway, in addition to the construction of the Moorefield Flood Protection project.

The foreseeable future Federal actions identified and evaluated in this study include:

- Moorefield Floodwall Project
- Stony Run Dam
- Canaan Valley Wildlife Refuge
- George Washington National Forest Management
- Monongahela National Forest Management.

In order to evaluate secondary and cumulative impacts, FHWA recommends that a temporal and geographic framework be set for each project. The temporal frame is defined as the design year for a proposed highway project, which in this case is 2013. The geographic frame, or area of influence, is defined qualitatively in the guidance, and addressed specifically below.

II. SECONDARY IMPACT ANALYSIS

The analysis of induced development for the Build Alternative involved a multi-step process that is discussed in detail in the beginning of this section. An analysis of induced development for the IRA is also presented, which is followed by the assessment of the corresponding secondary economic and ecological impacts for the Build and Improved Roadway Alternatives.

A. INDUCED DEVELOPMENT APPROACH

Economic development that could be induced by the project can be divided into three types; industrial, commercial and service-oriented. Industrial development is predicted with respect to industrial parks based on reasonable projections. Commercial development is predicted by various models for growth at interchanges or intersections of new rural highways. Based on job growth predictions, an estimate is made of new residential development required, which is followed by growth in the service areas to support residential needs.

1. BUILD ALTERNATIVE INDUCED DEVELOPMENT

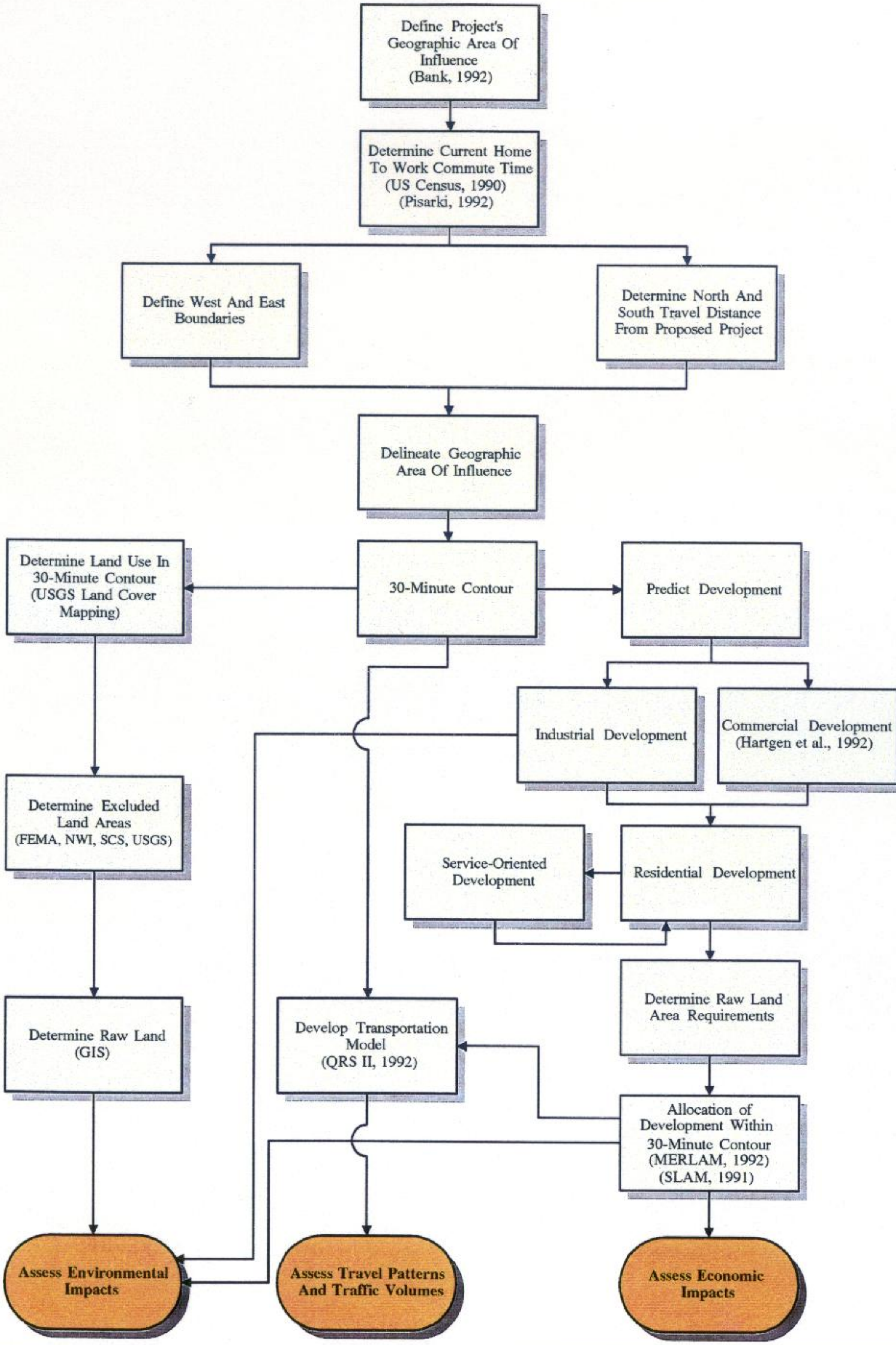
The process used to predict development for the Build Alternative is presented in Exhibit 1. The aggregate of all models and processes included in the flow chart is termed collectively as the Corridor H Development Model. The development predictions that follow apply to the Build Alternative, regardless of the particular alignment selected. The process begins with the determination of an area of influence for the project.

a. Determination of the Area of Influence

An "Area of Influence" was defined by Bank (1992) in a FHWA position paper entitled, *"Secondary and Cumulative Impact Assessment in the Highway Development Process"*. This guidance specifies that the first step in analyzing the impacts of a proposed highway facility is to define an area of influence in which the highway may affect development patterns or alter travel behaviors. Bank suggests that the area of influence could be determined by a transportation model and defined geographically as that area in which adding a new highway link to the transportation system would alter travel behavior. Therefore, a transportation model was developed for Corridor H and is based on the following assumptions:

- Home to work trips are one of the basic outputs of the trip generation component of a transportation model;
- A main component of trips within an area influenced by an economic development project would involve commuting from home to work and other commercial or business-related trips;

Exhibit 1
Corridor H Development Model



- The working population prefers to live within a reasonable commute time required to travel from home to work;
- Commute time is controlled by the current highway network.

Preferred commute time was taken from The National Personal Transportation Survey of 1992. This survey analyzed average travel times and associated travel patterns within the United States. It found that the average home to work commute in rural areas was 15 minutes (Pisarki, 1992). Additionally, data taken from the 1990 US Census for West Virginia indicated that 90% of all commute trips within the Corridor H census areas require no more than 30 minutes.

Using the 30 minute commute time, an area of influence was defined for the Build Alternative. The resulting *30-Minute Contour* will be used as the Area of Influence for this project and the corresponding transportation model. That is, all principal highways noted on official state maps were included in the highway network for the transportation model. A complete discussion of the transportation model and results are included in Section II of the SDEIS. The northern and southern boundaries of the 30-Minute Contour were determined by calculation of the distance a person could travel north or south of the Build Alternative within 30 minutes along the roads in the highway network. Once the north/south travel distance data were generated for each road, the 30 minute points of travel were connected to form northern and southern boundaries for the 30-Minute Contour. The western and eastern boundaries of the 30-Minute Contour were established as US 219/WV 92 and Interstate 81, respectively, which correspond to the logical termini for this project. Thus the delineated boundaries defined circumscribe a geographic area of influence that meets Bank (1992) definition. The 30-Minute Contour for the project is shown in Exhibit 2. It is interesting and confirming to note that the 30-Minute Contour closely represents the original geographic area known as "Corridor H" to be served by the proposed highway facility, and analyzed in the Corridor Selection SDEIS.

The 30-Minute Contour encompasses an area of over 7,000 sq. km. (2,800 square miles). This area includes all or part of the following counties: Barbour, Randolph, Tucker, Preston, Grant, Hardy, Mineral, and Hampshire in West Virginia; Frederick and Shenandoah in Virginia; and Garrett in Maryland and spans large parts of six watersheds defined as *regional project watersheds*. The sub-watersheds that directly "surround" the alignments were defined as *local project watersheds*, used primarily for direct impact assessment. A watershed overview is provided in Section III of the SDEIS. Also included in the 30-Minute Contour are portions of the Back Creek and Opequon Creek watersheds in Virginia.

b. Industrial Development

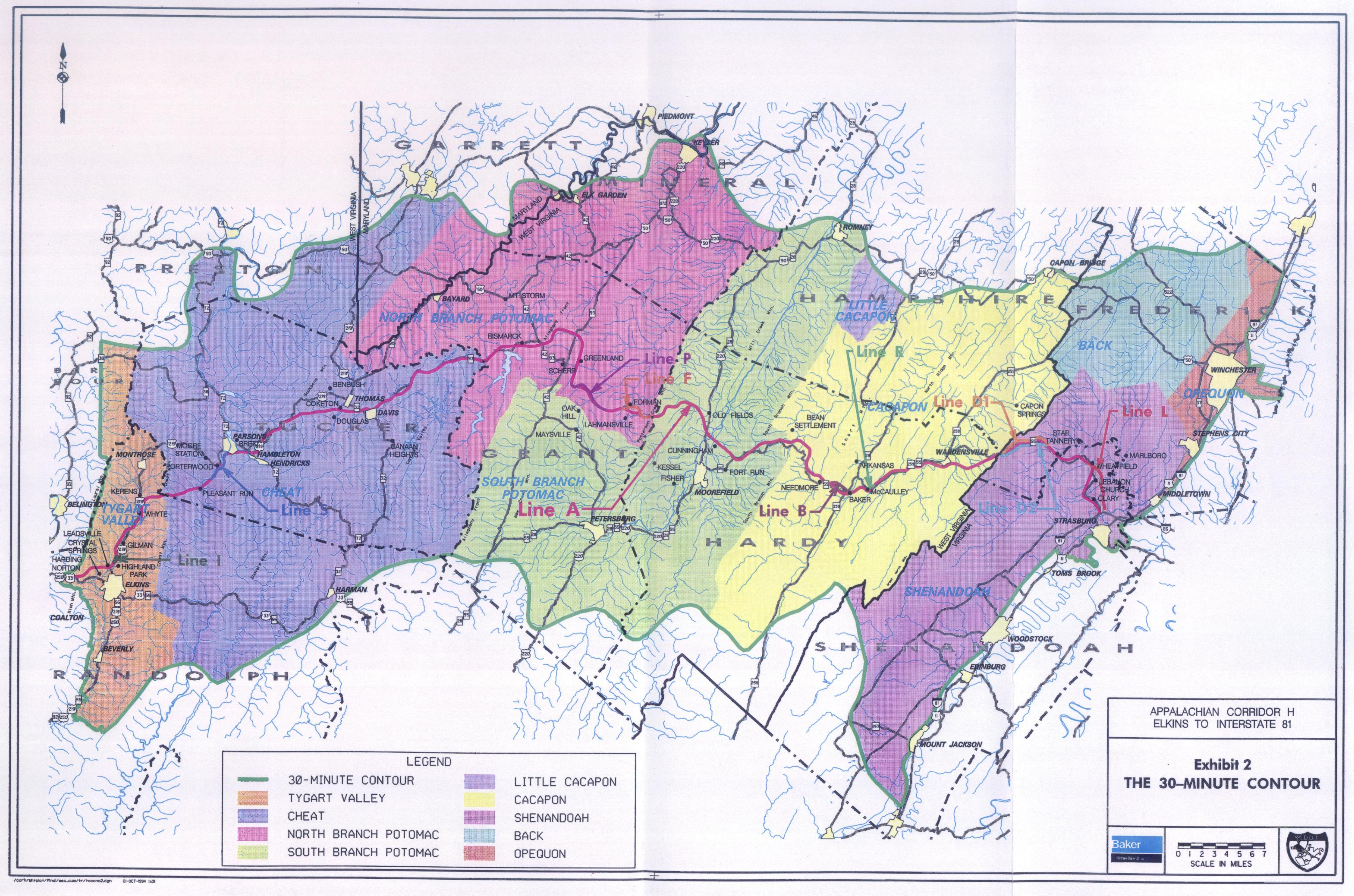
(1) Methodology

Industrial development within the 30-Minute Contour is projected to occur within those industrial parks that are already in existence or that are planned. This assumption is supported by the following:

- Information gathered from regional and local planning agencies indicated that they had designated the industrial parks as centers for development and in their recruitment efforts were only actively pursuing industries that would be tenants of these industrial parks;
- Tax and other incentives are available for industries that locate in industrial parks;
- Industrial parks already are or will be supplied with infrastructure required for industrial uses;
- Industrial parks are currently sited adjacent or close to existing or proposed highways.

Thirteen (13) industrial parks were identified within the 30-Minute Contour (Exhibit 3), occupying a total land area of 753 hectares (1860 acres). Currently, the aggregate occupancy rate is 36 percent (Table 1) providing work for over 6,000 employees. The current level of development of each industrial park was identified and a calculation of current employees per built-out hectare (acre) was made. A build-out scenario based on a 100% occupancy rate or full build-out of each industrial park was assumed by the year 2013. Employee projections were made by extrapolating to the full build-out scenario. The results show that approximately 10,000 additional jobs would be generated by the year 2013. Table 2 provides the existing and future jobs by industrial park and state.

Build-out scenarios were discussed with regional and local planners in West Virginia to confirm the appropriateness of the assumptions. In Virginia, growth rates associated with full build-out were compared to the growth rate goals in applicable comprehensive plans and found to be in agreement. The relationship between the construction of Corridor H and the growth in the Virginia parks was also discussed. Although the parks are expected to build out in the next twenty years regardless of the alternative selected for Corridor H, these figures were used in order to appropriately predict future residential development, travel patterns and impacts.


APPALACHIAN CORRIDOR H
ELKINS TO INTERSTATE 81
Exhibit 2
THE 30-MINUTE CONTOUR
LEGEND
30-MINUTE CONTOUR
TYGART VALLEY
CHEAT
NORTH BRANCH POTOMAC
SOUTH BRANCH POTOMAC
LITTLE CACAPON
CACAPON
SHENANDOAH
BACK
OPEQUON
SCALE IN MILES
Baker
GARRETT
MINERAL
PRESTON
TUCKER
GRANT
HAMPSHIRE
FREDERICK
HARDY
SHENANDOAH
RANDOLPH
Line A
Line B
Line D1
Line D2
Line F
Line I
Line L
Line P
Line R
Line S
ELKINS
PARSONS
THOMAS
DAVIS
PETERSBURG
MOOREFIELD
WARDENSVILLE
STRASBURG
WINCHESTER
KEYSER
ROMNEY
WOODSTOCK
EDINBURG
MOUNT JACKSON
CAPON BRIDGE
STEPHENS CITY
MIDDLETOWN
TOMS BROOK
BAKER
McCAULLEY
BAYARD
MT. STORM
BISMARCK
GREENLAND
SCHERR
FORMAN
MAYSVILLE
HARMAN
BEVERLY
COALTON
BELINGTON
KERENS
MONTROSE
MOORE STATION
PORTERWOOD
PLEASANT RUN
HAMBLETON
HENDRICKS
GILMAN
WHYTE
LEADSVILLE
CRYSTAL SPRINGS
HARDING
NORTON
HIGHLAND PARK
BENBUSH
COKETON
DOUGLAS
CANAAN HEIGHTS
OAK HILL
LAHMANSVILLE
OLD FIELDS
CUNNINGHAM
KESSEL
FISHER
FORT RUN
NEEDMORE
ARKANSAS
BEAN SETTLEMENT
CAPON SPRINGS
STAR TANNERY
MARLBORO
WHEATFIELD
LEBANON CHURCH
CLARY
ELK GARDEN
PIEDMONT
WEST VIRGINIA
MARYLAND
VIRGINIA
01-OCT-1994

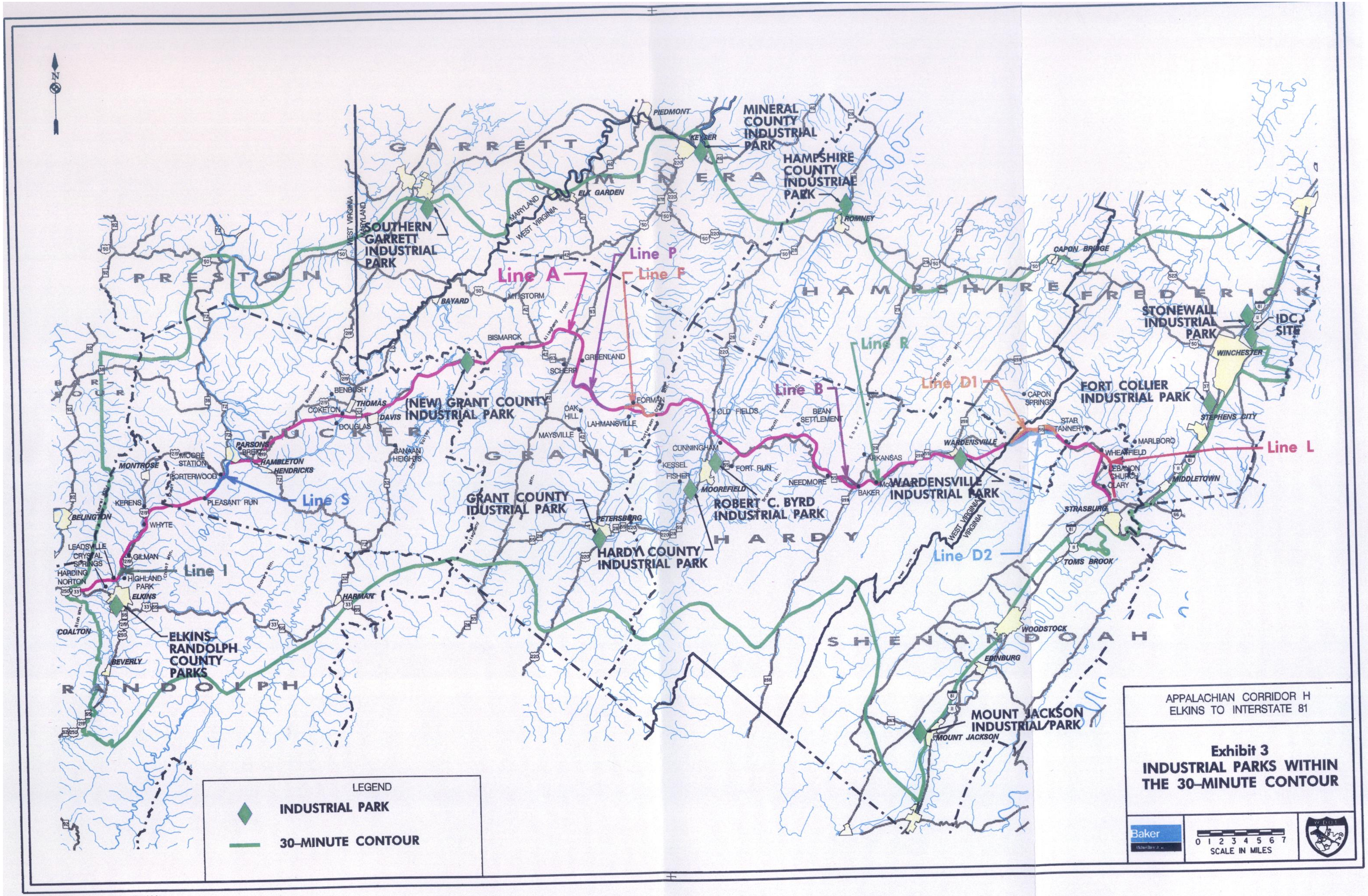


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TABLE 1
INDUSTRIAL PARKS WITHIN THE 30-MINUTE CONTOUR

NAME	PLACE	LOCATION	TOTAL		VACANT	
			Hectares	Acres	Hectares	Acres
Grant County Industrial Park	Petersburg, Wv	County 220/8(Airport Rd) South Of Petersburg	49	120	32	80
Hampshire County Industrial Park	Romney, Wv	North Of Romney On County 28/8	16	40	15	37
Hardy County Industrial Park	Moorefield, Wv	1/2 Mile South Of Moorefield On US 220	23	57	2	5
Wardensville Industrial Park	Wardensville, Wv	1/2 Mile North Of Wardensville On Wv 55 & 259	12	29	9	23
Mineral County Industrial Park	Keyser, Wv	Off County 46 On County 8	64	157	12	30
Elkins-Randolph County Parks	Elkins, Wv	Between 11th & 15th Street	22	55	16	40
Robert C. Byrd Industrial Park	Moorefield, Wv	1 Mile East Of Moorefield On Wv 55	29	71	29	71
(New) Grant County Industrial Park	Bayard, Wv	Near Tucker & Grant County Lines On Wv 93 Near Mt. Storm Power	40	100	40	100
Southern Garrett Industrial Park	Oakland, Md	2 Miles East Of Oakland On Md 135	36	90	20	50
Mount Jackson Industrial Park	Mount Jackson, Va	South Of Mt Jackson, 1 Mile Northwest Of I -81 And Va 263 Interchange	91	226	51	127
Stonewall Industrial Park	Winchester, Va	1/2 Mile West Of I-81, US 11 And Va 37 Interchange	219	540	142	350
IDC Site	Winchester, Va	13/4 Miles West Of I-81, Va 37 And Us 11 S	16	40	16	40
Fort Collier Industrial Park	Winchester, Va	1 And 1/2 Mile Southeast From I-81, US 11N, And VA 37 Interchange	136	335	69	170
		TOTALS	***753***	***1,860***	***483***	***1,193***

TABLE 2
EMPLOYMENT BY INDUSTRIAL PARK

NAME	EXISTING EMPLOYEES	ADDITIONAL EMPLOYEES
Grant County Industrial Park	275	675
Hampshire County Industrial Park	100	312
Hardy County Industrial Park	714	42
Wardensville Industrial Park	12	194
Mineral County Industrial Park	600	253
Elkins-Randolph County Parks	65	338
Robert C. Byrd Industrial Park	0	599
(New) Grant County Industrial Park	0	1,435
Southern Garrett Industrial Park*	1,022	422
Wv Total	***2,788***	***4,270***
Mount Jackson Industrial Park	437	1,072
Stonewall Industrial Park	1,600	2,954
IDC Site	0	338
Fort Collier Industrial Park	1,390	1,435
Va Total	***3,427***	***5,799***
Total	***6,215***	***10,069***

* Garrett County Was Included In The West Virginia Totals.

(2) Growth Industries

The growth in industrial parks is expected to be related to existing businesses and industries in the area. Data from economic development plans shows continued expansions of the following industries: poultry, agriculture, timber, and back-office production. Back-office production includes business, accounting and auditing firms and branch offices of larger corporations.

The poultry industry is expected to remain one of the main components of growth in the Corridor H area. This industry is one of the primary employers in the counties analyzed, with major facilities located in Moorefield and Baker: Wampler-Longacre, Hester Industries and Perdue. Interviews and discussions with Wampler, Hester and Perdue indicate that the addition of the four-lane Build Alternative would benefit their operations. Officials at Wampler indicated that the facility would increase the safety and efficiency of transporting products from the Moorefield plant (Price, 1994). At this time, however, no expansions have been announced due to the construction of Corridor H.

Agriculture in Hardy, Frederick and Shenandoah counties is projected to remain strong and includes products such as rabbits, apples and fish-farming (aqua-culture). Growth in aqua-culture is also expected in Tucker County (Bonner, 1994).

The timber industry may grow as a result of the Build Alternative. Existing lumber and wood products industries are involved in the cutting and processing of timber into chips, poles, pilings, lumber and processed wood products such as paneling. The primary market for these products is the construction sector. Growth is projected for this industry well into the future (Wise, 1992). The following plans include timber as part of their future economic expansions and marketing:

- Tucker County Comprehensive Plan
- Regional Development Plan, Region 8
- Regional Development Plan, Region 7
- Economic Adjustment Strategy for Hampshire County.

The economic plans of Tucker County, Regions 7 and 8, Hampshire County and Frederick County target growth in such services as back-office operations, accounting and auditing. A portion of this growth is expected to occur in the industrial parks.

c. Commercial Development

To predict commercial development around intersections and interchanges, a model (Hartgen et al., 1992) was employed that was developed to predict such growth on sections of Interstate 40 (I-40) in rural North Carolina. This model predicts the level of development, if any, that could occur in an area surrounding intersections and interchanges of new, rural multi-lane highways. The levels of development in this model are referred to as Stages. Stages range from Stage 0 (minimal development) to Stage 3B (truck stop) with the Stage level for rural intersections and interchanges being controlled or determined by the interaction of a set of variables. These variables are:

- volume of traffic on the existing cross route;
- visibility of the land surrounding the proposed intersection;
- distances to nearby communities or other intersections;
- availability or potential availability of infrastructure such as water and sewer services.

According to Hartgen et al.'s model, the following are the developmental Stages that can occur on land surrounding new intersections and interchanges on rural highways.

- Stage 0: minimal development
- Stage 1: residential; single family homes
- Stage 2A: light tourist services; 1 gas station, 1 small motel
- Stage 2B: economically competitive; 2-4 gas stations, 1-2 restaurants, 2+ motels
- Stage 2C: economic integration; 4+ gas stations, 5+ restaurants, 3+ motels, no residential, other businesses
- Stage 3A: heavy tourist; 6+ motels, 6+ restaurants, 3+ gas stations
- Stage 3B: truck stop.

The model was employed for intersections and interchanges for the Build Alternative. Thirteen were predicted to undergo development. Eight of the thirteen are predicted by the model to develop to Stage 2A characterized by light tourist services. Four were predicted to support heavy tourist services characterized by Stage 3A development and one was predicted to develop to Stage 2B, economically competitive.

Employment projections at each intersection were calculated using the average employment rates at similar businesses (e.g., gas stations, motels, restaurants). These employment rates were provided by the University of West Virginia's Regional Research Center. The total growth in employment due to predicted intersection and interchange commercial development would be approximately 1,250.

This job growth would be in the form of services geared almost entirely to tourism and recreation in the Corridor H area. The potential of linking the many recreation areas (discussed in the Socioeconomics Technical Report) by a four-lane facility represents access to new markets. The above job growth predictions focus on commercial enterprises at intersections and interchanges. The positive economic impact of the highway on the ski industry cannot be overlooked. A four-lane highway would expand the market area served by the existing ski facilities, making them more competitive with facilities in other parts of West Virginia and neighboring states. Officials at ski facilities in the Corridor H area did not have specific projections on potential growth of their businesses and corresponding new job potential, so that such growth *would be in addition to the 1,250 commercial jobs* predicted above.

In many respects, Corridor H has the potential to serve as a scenic byway. In the 1990 Scenic Byway Study, some aesthetic values associated with byways include vegetation such as forests and shrubland; agricultural patterns; panoramas; rock outcrops; and water bodies, such as lakes, rivers and wetlands (FHWA, 1990). These are all characteristics of Corridor H, regardless of the alternative selected. The combination of these features with the numerous recreation and historic tourism sites, and the promotion of tourism by every county in the study area suggests analysis as a scenic byway.

The analysis of the economic benefits from scenic byways is summarized in the 1990 study. However, since most scenic byways are new or newly designated, exact figures on the economic impacts are not yet available. Studies specifically focusing on the positive economic impacts of a scenic highway based on historic tourism were also not available. The US Travel Data Center, however, sampled 2,574 kilometers (1,600 miles) of scenic byways in nine states to determine economic impacts. In these states, there were 920 new jobs created that had a $9 million payroll and generated more than $2 million in state income tax and $500,000 in local taxes.

The jobs that may be produced due purely to the scenic qualities of a highway facility through the Corridor H area, particularly historic areas, would be related to the provision of additional tourism opportunities. These might include guided tours through the battlefields of the region and the need to add staff at certain points of interest to provide service to the traveling public. It is not possible to specifically predict this type of growth. Historical data resulting from the construction of a scenic byway does not exist. A strict per-linear distance calculation from the figures above would suggest 66 jobs could be created. However, future job growth and sales and wage tax benefits would vary across the project, depending on the scenic and historic potential of a specific area. These types of initiatives must be induced by local parties and guided by local and regional plans. Both the Build and the Improved Roadway Alternatives of Corridor H would provide an improved transportation system for access to these areas of interest. A prediction of job growth potential for scenic and historic tourism has not been calculated and any growth would be in addition to the figures shown for commercial development.

d. Residential and Related Service-Oriented Development

Residential and service-oriented development are interrelated. Residential development occurs as the result of industrial and commercial development. As new residential development occurs, service-oriented development grows to support it. In turn, additional residential development occurs due to the jobs created by the various support services. Service development includes such things as banking facilities, doctors' offices, real estate offices, and other professional services that offer support to people. (Service development that is predicted to occur as the result of predicted industrial growth, such as business, accounting and auditing firms is included within the industrial growth projections.)

The number of housing units required to support the projected increase of employment associated with industrial, commercial, and service-oriented development was calculated using data obtained from the US Census Bureau. The ratio of housing units to employee was applied to the total job growth projections to determine the number of housing units required. The results provide that as many as 15,637 new homes could be required. A method to predict the locations of these homes is discussed in the next section.

Single family residences were chosen as the housing unit in this analysis, as opposed to apartments or town houses, because they require more land per unit of housing (thus maximizing potential ecological impacts) and because single family homes are the housing unit of choice in the 30-Minute Contour. Land use requirements for housing were based on a lot size of approximately 0.8 hectare (2 acres) for each predicted single family residence. This lot size requirement was adopted because it is the minimum lot size that would accommodate an efficient septic system and was recommended by county and regional planners. For residential development projections in one area of Frederick County, Virginia served by public sewage, a typical lot size of 0.13 hectare (0.33 acre) was used.

A combination of two predictive models (discussed below) was used to predict the types and numbers of service-oriented facilities that could develop. Based on West Virginia figures for the average employment within such facilities, approximately 6,500 jobs could be created by the predicted service-oriented development. The land area required for such facilities, which traditionally locate near the residential growth areas, was calculated based on average size of such facilities.

e. Total Job Growth

A summary of the job growth results are provided by county in Table 3.

TABLE 3
TOTAL PREDICTED JOB GROWTH
BUILD ALTERNATIVE

County	Industrial	Commercial	Service-Oriented	County/State Totals
Garrett, MD*	422	0	297	719
Hardy	835	116	247	1,198
Hampshire	312	0	69	381
Grant	2,110	0	1,369	3,479
Tucker	0	301	158	459
Randolph	338	567	541	1,446
Mineral	253	0	165	418
WV Total	***4,270***	***984***	***2,846***	***8,100***
Frederick	4,727	0	3,080	7,807
Shenandoah	1,072	273	571	1,916
VA Total	***5,799***	***273***	***3,651***	***9,723***
Total	***10,069***	***1,257***	***6,497***	***17,823***

* Garrett County has been included in the West Virginia totals.

f. Determination of Raw Land

To predict land areas that could be developed for residential and service uses, it was necessary to determine the total land area that is feasible and practicable to develop. The GIS was utilized to overlay several layers of geographic data within the 30-Minute Contour. These features included United States Geological Survey land cover mapping (Anderson Level II), National Wetlands Inventory mapping, Soil Conservation Service soil mapping (slope data), USGS quadrangle mapping and Federal Emergency Management Agency mapping (floodplains). The GIS was then queried to identify tracts of land within the 30-Minute Contour that were free of the following features:

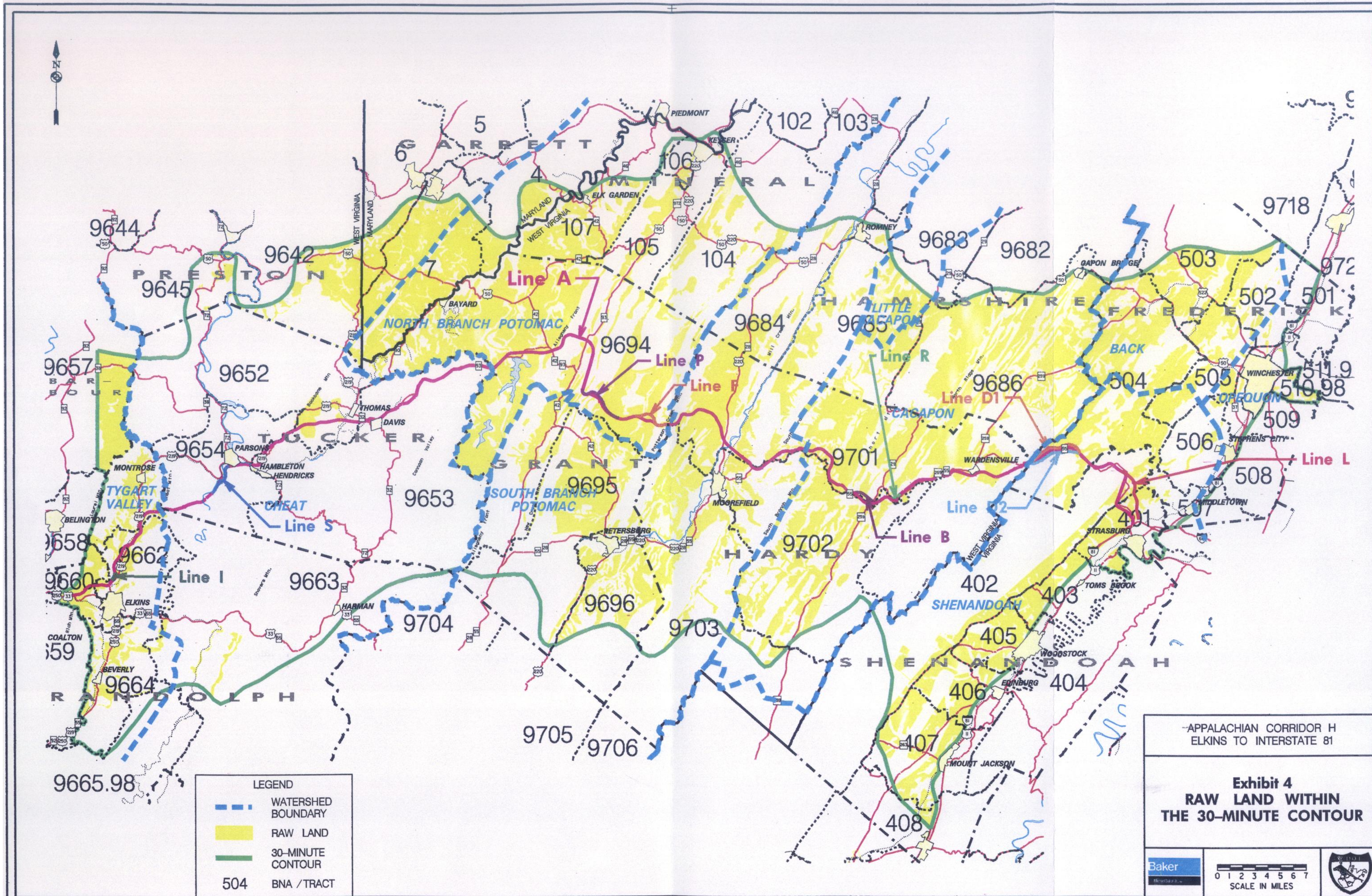
- 100-year floodplains
- slopes greater than 25%
- wetlands
- existing development
- public parks, other public facilities or National Forests.

The resulting areas were designated as *raw land* (Lapping, 1992) suitable for development (Exhibit 4). The total raw land area is approximately 212,300 hectares (525,000 acres). Through GIS queries, the existing land cover of raw land areas was determined to be 67% forested and 33% agricultural.

In order to predict locations of residential and service-oriented growth, two land use allocation odels were utiliz. These models use a variety of demographic data available from the US Census Bureau. Info tion concerning past and current development trends are comp ed by US Census Block Numbering Areas (BNA's) or Census Tracts. BNA's and Census Tracts are geographic areas of somewhat arbitrary size established by the US Census to track population trends and a variety of demographic parameters in rural areas of the country. BNA and Census Tract boundaries within the 30-Minute Contour are shown in Exhibit 4. The two models utilized were:

- The Mature Economic Region Land Allocation Model (MERLAM) developed by the Southwestern Pennsylvania Regional Planning Commission (1992) in part to identify potential growth areas in rural Southwestern Pennsylvania
- The Simplified Land Allocation Model (SLAM) developed by the Florida Department of Transportation (1991).

The basic tenet of these models is that certain features that are favorable for development, combined with recent development trends, determine future residential and service-oriented development. Table 4 provides a summary of housing unit allocation by BNA, county and watershed. A comparison of raw land requirements for residential and service-oriented development to the total raw land areas within each watershed concludes that sufficient raw land is available. These results are summarized in Table 5.



APPALACHIAN CORRIDOR H
ELKINS TO INTERSTATE 81
Exhibit 4
RAW LAND WITHIN THE 30-MINUTE CONTOUR
LEGEND
WATERSHED BOUNDARY
RAW LAND
30-MINUTE CONTOUR
504 BNA / TRACT
SCALE IN MILES
0 1 2 3 4 5 6 7
Baker
GARRETT
MINERAL
PRESTON
TUCKER
GRANT
HAMPSHIRE
FREDERICK
HARDY
SHENANDOAH
RANDOLPH
BARBOUR
NORTH BRANCH POTOMAC
SOUTH BRANCH POTOMAC
LITTLE CACAPON
CACAPON
BACK
OPEQUON
SHENANDOAH
TYGART VALLEY
CHEAT
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Line P
Line F
Line R
Line D1
Line D2
Line L
Line B
Line S
Line I
PIEDMONT
KEYSER
ELK GARDEN
ROMNEY
CAPON BRIDGE
BAYARD
THOMAS
DAVIS
PARSONS
HAMBLETON
HENDRICKS
MONTROSE
BELINGTON
ELKINS
COALTON
BEVERLY
HARMAN
PETERSBURG
MOOREFIELD
WARDENSVILLE
WINCHESTER
STEPHENS CITY
MIDDLETOWN
STRASBURG
TOMS BROOK
WOODSTOCK
EDINBURG
MOUNT JACKSON
MARYLAND
WEST VIRGINIA
VIRGINIA
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TABLE 4

PREDICTED HOUSING UNIT INCREASE BY WATERSHED AND COUNTY BUILD ALTERNATIVE

Watershed	County	BNA	Total Number of Existing Units in County	Housing Unit Increase	% Increase
Tygart Valley River	Randolph	9664	12,011	1,269	10.6%
Cheat River	Tucker	9652,9654	3,579	403	11.3%
	Garrett, MD*	6	8,974	631	7.0%
NB Potomac River	Mineral	105	6,803	367	5.4%
SB Potomac River	Grant	9696	4,873	3,052	62.6%
	Hardy	9702	6,542	180	16.1%
Cacapon River	Hardy	9702	---	871	---
	Hampshire	9686	10,009	335	3.3%
WV Total			***52,791***	***7,108***	***13.5%***
Shenandoah River	Shenandoah	402	16,547	1,681	10.2%
	Frederick	504	31,775	1,868	21.6%
Back Creek	Frederick	504	---	2,280	---
Opequon Creek	Frederick	510.98	---	2,700	---
VA Total			***48,322***	***8,529***	***17.7%***
Total			***101,113***	***15,637***	***15.5%***

* Garrett County has been included in the West Virginia totals.

TABLE 5

RAW LAND REQUIREMENTS TO SUPPORT RESIDENTIAL AND SERVICE-ORIENTED DEVELOPMENT BY WATERSHED FOR BUILD ALTERNATIVE

Watershed	RAW LAND									
	Available		Commercial Requirements		Residential Requirements		Service-Oriented Requirements		Remaining	
	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
Tygart Valley River	10,548	26,063	40	100	1,027	2,538	22	54	9,458	23,371
Cheat River	10,993	27,164	27	66	837	2,068	19	46	10,111	24,984
North Branch Potomac River	50,917	125,814	0	0	297	734	6	16	50,613	125,064
South Branch Potomac River	47,829	118,184	7	18	2,616	6,464	57	142	45,148	111,560
Cacapon River	46,706	115,410	2	4	976	2,412	11	27	45,718	112,967
Shenandoah River	27,711	68,474	25	62	2,873	7,098	68	169	24,745	61,145
Back Creek	14,902	36,823	0	0	1,845	4,560	56	138	13,001	32,125
Opequon Creek	2,715	6,708	0	0	364	900	23	58	2,327	5,750
Total	***212,322***	***524,640***	***101***	***250***	***10,835***	***26,774***	***263***	***650***	***201,122***	***496,966***

2. IMPROVED ROADWAY ALTERNATIVE INDUCED DEVELOPMENT

a. Industrial Development

Recent research indicates that limited growth could be expected from the construction of the IRA, due to some improved access to areas surrounding the corridor. A research study conducted in Indiana compared economic growth that occurred following construction of new multi-lane facilities to new two-lane facilities (Lombard, 1992). The study analyzed economic growth in both urban and rural counties throughout the state over a 10-year period from 1980 to 1990. Predictive models were developed based on economic growth occurring after highway construction. The model's dependent variables were total employment, service employment, and wage income. In the model, various independent variables were tested to determine their relationship to the economic development that had occurred. The two most significant independent variables were the density of total highway length per county (both two-lane and multi-lane) and the density of multi-lane highway length per county. In all cases in the Indiana study, the economic development that occurred following the addition of new two-lane facilities was a fraction of the development that occurred following the construction of new multi-lane facilities. In the case of total employment, the growth estimate associated with a new two-lane road was one-sixth that of the growth associated with a new multi-lane facility. Because the IRA is an existing two-lane road rather than a new two-lane road, it is reasonable to predict that less than one-sixth of the Build Alternative growth could be induced by the IRA. Several calculations were made using one-sixth to one-tenth of the 10,069 jobs projected for the Build Alternative. The results range from 1,678 to 1,007 jobs. These figures were compared to growth trends and found to be lower or comparable. Therefore, no additional industrial jobs are predicted based on the construction of the IRA.

b. Commercial Development

Commercial development in the form of restaurants and service stations would reasonably occur due to the construction of the IRA. The jobs associated with this development fall into the tourism category discussed for the Build Alternative, and would be predicted at nearly the same level, approximately 1,250. Included in this total would be the jobs created due to the possible re-opening of presently closed service stations and restaurants along the IRA. The summary of job growth by county is presented in Table 6.

c. Residential Development

The increase in commercial development alone would not be expected to induce additional residential development. The 1,250 jobs predicted are assumed to be taken by existing unemployed residents. Further, jobs associated with tourism are not of a wage level that would encourage movement of people into the area. The average weekly wage of these jobs is $200 less than that of industrial jobs (Virginia Employment Commission, 1993).

TABLE 6

TOTAL PREDICTED JOB GROWTH
IMPROVED ROADWAY ALTERNATIVE

County	Commercial
Randolph	567
Tucker	301
Hardy	116
WV Total	***984***
Shenandoah	273
VA Total	***273***
Total	***1,257***

B. SECONDARY IMPACT ASSESSMENT

1. LAND USE

a. Consistency With Comprehensive Plans

The impacts of secondary development within the counties in the 30-Minute Contour were also analyzed for consistency with their comprehensive plans. This development includes the industrial park development, commercial development, residential development, and service-oriented development, all of which are projected to occur due to the Build Alternative. This consistency analysis is directed at the Build Alternative. Development impacts for the Build Alternative are projected to be much greater than those associated with the IRA.

The only counties that have adopted zoning ordinances are Frederick and Shenandoah Counties in Virginia. Comprehensive plans have not been adopted in Randolph, Mineral, Grant, and Hardy Counties in WV and Garrett County, MD. However, Hardy does have a draft comprehensive plan and Mineral is in the process of preparing a draft comprehensive plan. Comprehensive plans were not evaluated for Barbour and Preston Counties since no growth due to Corridor H was projected to occur in these counties. Consistency with regional plans in West Virginia was also analyzed.

The Region Seven Development Plan, which includes Randolph and Tucker Counties, cites completion of Corridor H as the first transportation goal for the region. The Region Eight Development Plan, which includes Grant, Hardy, Hampshire, and Mineral Counties, also identifies the need for Corridor H to end the isolation caused by a lack of modern east/west highways. In both plans the lack of an east/west highway is identified as a cause for the lack of economic development. The secondary development predicted due to the Build Alternative of Corridor H is consistent with both of these regional plans for the area.

The Corridor H Development Model indicated increases in all types of development in Randolph County. This included 338 jobs at the industrial parks, 567 jobs due to intersection development, 1,269 new housing units, and 541 new service jobs. Most of this growth is projected to occur near Elkins. Randolph County has no zoning or comprehensive plans. Therefore, projected development and its effect on land use is not inconsistent with county plans.

Projected development in Tucker County was related to an increase in retail trade employment at intersections/interchanges. Projections include 301 new jobs at intersections, 403 new housing units, and 158 new service jobs. Tucker County has a comprehensive plan, which includes Corridor H as an element, therefore the projected development is consistent with Tucker County's Comprehensive Plan.

Grant County had projected increases in industrial park employment of 2,110 and service employment of 1,369. In addition, an increase of 3,052 housing units was projected to occur as part of the secondary development impact of the four-lane Build Alternative. Because Grant County does not have a comprehensive plan or zoning ordinance, this growth is not considered to be inconsistent with the county plan.

Hardy County is in the process of adopting a comprehensive plan. Corridor H is cited as a transportation investment in the draft plan (Hardy County, 1994). The Corridor H Development Model specified industrial park growth of 835 jobs, an increase in jobs at intersections/interchanges of 116, an increase of 1,051 residential units, and a service employment increase of 247. The draft comprehensive plan does not specify land uses in specific areas of the county, but rather identifies the need to support and maintain agricultural uses, to separate housing developments from commercial and industrial developments, and to concentrate commercial development near major transportation routes (Hardy County, 1994). The secondary growth associated with the Corridor H Build Alternative are not incompatible with these guidelines. Industrial park development is actively pursued in Hardy County and the intersection development can be accommodated. Increases in residential and residentially related service-oriented development can be accommodated without conflicting with the goals of the Draft Comprehensive Plan.

Hampshire County is projected to have industrial park employment growth of 312 jobs, 335 new housing units, and a service employment increase of 69. Hampshire County has enacted a subdivision ordinance but does not have an official zoning ordinance or comprehensive plan. Discussions with county planning officials verified that the growth projections and allocations of the Corridor H Development Model are consistent with planning efforts.

The development predicted to occur in Frederick County is due to full build out of its existing industrial parks. Development of these industrial parks is consistent with the county's Comprehensive Plan. Because recent residential development has occurred in BNA 504, and due to other favorable features of this area, the land use allocation model predicted further residential growth in this area at 4,148 units. The recent growth, and the growth projected by this study for BNA 504 are inconsistent with the Comprehensive Plan. The County Comprehensive Plan identifies this area as one that should remain rural and agricultural in character (Winchester, 1990). Implementation and enforcement of appropriate local land use controls may be necessary to assure that the location of residential development occurs in those areas designated for such use. Housing unit increases projected near Winchester, approximately 2,700, are consistent with the Comprehensive Plan.

The rate of residential development predicted to occur is consistent with the goals of Frederick County. The total increase in units averages about 370 per year over the twenty year period until 2013, an average increase of about 1% a year due to the Build Alternative. This 1% rate of growth is less than the moderate rate of growth of 4 - 5% identified as desirable by Frederick County (Winchester, 1990; Virginia Advisory Committee, 1993).

The location of predicted residential and commercial development (BNA 402) as determined by the allocation models employed is not consistent with Shenandoah County's Comprehensive Plan. The Shenandoah County Comprehensive Plan designates this BNA to be an area that should remain rural in character. The addition of the predicted 1,681 new housing units and intersection/interchange development in those areas would not be consistent with their rural character. As in Frederick County, Shenandoah County does have the available raw land to support the predicted development, however, it is the location of the predicted development that would need to be addressed in local land use controls. Job growth in Shenandoah County is predicted at 1,072 for industrial development, 273 for commercial development, and 571 for service-oriented development.

Growth is also projected to occur in the Mineral County, West Virginia and Garrett County, Maryland. Mineral County is in the process of preparing a comprehensive plan. Job growth in Mineral County includes 253 industrial jobs and 165 service jobs. Housing unit projections for Mineral County are at 367. Garrett County does not have planning regulations that cover the entire county and is currently updating its comprehensive plan. In interviews, Garrett County planners have indicated that the level of growth, about 631 residential units, 422 industrial jobs and 297 service jobs would likely be consistent with county plans (Jamison, 1994).

b. Land Use Impacts

Secondary land use/land cover impacts were determined by the GIS. The percentage of each land cover type was calculated for each BNA predicted to experience residential or service-oriented growth. These percentages were then applied to the total amount of land required for the specific form of development (e.g., commercial, residential, service-oriented) to determine the amount of each land cover type that would be impacted. Because the locations of industrial parks are known, land use impacts associated with them were analyzed specifically. The total amount of each land cover type predicted to be converted for the Build and Improved Roadway Alternatives is presented in Table 7. The ecological impacts associated with the conversion are discussed in the following subsections as they relate to that particular category of impact analysis (i.e., Vegetation and Wildlife, Wetlands and Streams).

TABLE 7
SUMMARY OF LAND COVER IMPACT
BY DEVELOPMENT TYPE

BUILD ALTERNATIVE

Development Type	Land/Cover Type	Watershed: Tygart Valley		Cheat		North Branch Potomac		South Branch Potomac		Cacapon		Shenandoah		Back		Opequon	
		Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
Commercial	Forest	27	68	19	46	0	0	0	0	2	4	10	25	0	0	0	0
	Farmland	13	32	8	20	0	0	0	0	6	14	14	35	0	0	0	0
	Developed	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Residential	Forest	750	1,853	477	1,179	211	521	1,674	4,137	713	1,761	1,350	3,336	1,569	3,876	244	603
	Farmland	277	685	360	889	86	213	942	2,327	263	651	1,523	3,762	276	684	120	297
Service	Forest	16	39	11	26	4	11	37	91	8	20	32	79	47	117	16	39
	Farmland	6	15	8	20	2	5	20	51	3	7	36	90	9	21	7	19
Total	Forest	793	1,960	506	1,251	215	533	1,711	4,228	722	1,784	1,392	3,440	1,617	3,993	260	642
	Farmland	296	732	376	929	88	218	962	2,378	272	673	1,573	3,887	285	705	127	316
	Developed	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0

IMPROVED ROADWAY ALTERNATIVE

Development Type	Land/Cover Type	Watershed: Tygart Valley		Cheat		North Branch Potomac		South Branch Potomac		Cacapon		Shenandoah		Back		Opequon	
		Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
Commercial	Forest	27	68	19	46	0	0	0	0	2	4	10	25	0	0	0	0
	Farmland	13	32	8	20	0	0	0	0	6	14	14	35	0	0	0	0
	Developed	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Total	Forest	27	68	19	46	0	0	0	0	2	4	10	25	0	0	0	0
	Farmland	13	32	8	20	0	0	0	0	6	14	14	35	0	0	0	0
	Developed	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0

(1) Industrial

Ten of the thirteen identified industrial parks are fully constructed, and partially occupied. The IDC Site in Winchester, VA has been fully constructed but is currently vacant. Full occupancy of these parks would have no additional land cover conversion impacts. The two remaining industrial parks are in various stages of development and are unoccupied. The Robert C. Byrd Industrial Park near Moorefield, WV is in its initial development phase. It has been surveyed and access roads and other infrastructure elements are under construction. This industrial park is situated on what was formerly pastureland. Prior to its development, a site review was held with the resource agencies (US Army Corps of Engineers, personal communication). No resources of concern were noted during that field view and industrial park development was begun. The new 40 hectare (100 acre) Grant County site is located north of WV 93 adjacent to Four Mile Run. Current land cover on this site is predominately mixed forest land. An approximately 2.3 hectare (5.5 acre) palustrine scrub-shrub wetland is present on the site as well as two intermittent tributaries to Four Mile Run.

(2) Commercial

Land use impacts due to commercial development were assessed by superimposing a one kilometer (3,280 ft) circle over each of the intersections and interchanges projected to develop. The percentage of each Anderson Level II land cover/land use type within this circle was then calculated. The land cover surrounding the interchanges/intersections predicted to develop is predominately agricultural or forest (Table 7) with a small amount of already developed or urban land.

The impacts to resources were refined by locating within the circle hypothetical occupancy sites for each of those facilities predicted to locate around the intersection. Required areal coverage for each facility (e.g., gasoline station, restaurant) was determined from data available regarding the average site size requirements for each such facility. Each of these hypothetical sites was superimposed on project mapping to determine the presence of sensitive natural resources (e.g., wetlands, streams, known cultural resources) and to determine if it would be possible to site predicted development to avoid these resources. Additionally, to present a worse case scenario, predicted development parcels were located immediately adjacent to the intersection in development mix patterns similar to those found at developed intersections. Results of this analysis are presented later in this report.

(3) Residential and Service-Oriented

By definition, raw land excludes sensitive natural resources (See Model Development above). Land cover that would be impacted by this development would therefore consist of forest land and agricultural land. A summary of impacts to those land cover types is shown in Table 7.

2. ECONOMICS

The predicted earnings potential due to job growth for the Build Alternative and the IRA is presented by county in Table 8. To determine the economic impact of predicted development, projections were made relative to real estate and income tax gains and losses. The real estate tax gains and losses were determined using the average tax rate assessed for each land cover type. Income taxes were calculated by assuming an average wage rate for employees in industrial and service oriented businesses within the 30-Minute Contour. These rates were then applied to the employment increases for each type of employment to determine income tax gains. Predicted tax losses and gains for the Build and Improved Roadway Alternatives are presented in Table 9.

3. PUBLIC WATER SUPPLY

a. Highway-Related Impacts

There would be no highway related secondary impacts to public water supplies for the Build or Improved Roadway Alternatives.

b. Development-Related Impacts

(1) Improved Roadway Alternative

Because there are no housing unit increases predicted under the IRA, there would be no impact on public water supplies. Further, there are no impacts to public water supplies associated with the commercial development predicted for the IRA. This is similar to the assessment below for the Build Alternative.

(2) Build Alternative

Portions of two of the raw land areas in West Virginia that are predicted to be areas of residential development are served by public water supplies. They are BNA 9664 around Beverly, WV in Randolph County, and BNA 9696 south of Petersburg, WV in Grant County. In both cases, there is sufficient capacity in the system to serve development that may take place within the systems' service areas. Some residential development is expected to take place outside the water system service areas and these housing units would rely on private water wells.

In Virginia, predicted residential development that would occur in BNA 510.98 east of Winchester, VA in Frederick County is served by a public water supply. The current public water system has adequate surplus capacity to serve the projected growth (Winchester-Frederick County Economic Development Commission, 1993).

TABLE 8

TOTAL PREDICTED ANNUAL WAGE EARNINGS

County	IRA	Build
Randolph	$10,363,626	$23,194,782
Tucker	5,402,649	7,233,447
Grant	0	63,856,996
Hardy	2,406,420	21,802,995
Hampshire	0	6,952,255
Mineral	0	8,087,212
Garrett, MD*	0	14,344,523
WV Total	***$18,172,695***	***$145,472,210***
Frederick	0	$224,655,488
Shenandoah	7,241,871	44,591,887
VA Total	***$7,241,871***	***$269,247,375***
Total	***$25,414,566***	***$414,719,585***

* Garrett County has been included in the West Virginia totals.

TABLE 9

PREDICTED TAX BENEFITS

IMPROVED ROADWAY ALTERNATIVE

County	Annual Land Tax Loss 1996-2013	Real Estate Tax Gain Residential 2001-2013	Real Estate Tax Gain Service/Retail 2001-2013	Net Annual Land Tax Gain/(Loss) 2001-2013	State Income Tax Gain 2001-2013	Annual Total Tax Benefit 2001-2013
Randolph	$500	N/A	$800	$300	$357,900	$358,200
Tucker	800	N/A	600	(200)	186,000	185,800
Grant	800	N/A	0	(800)	0	(800)
Hardy	1,400	N/A	200	(1,200)	84,700	83,500
Hampshire		N/A	0	0	0	0
Mineral		N/A	0	0	0	0
Garrett, MD*		N/A	0	0	0	0
WV Total	***$3,500***		***$1,600***	***($1,900)***	***$628,600***	***$626,700***
Frederick	$4,000	N/A	$0	($4,000)	$0	($4,000)
Shenandoah	2,700	N/A	1,900	(800)	346,100	345,300
VA Total	***$6,700***		***$1,900***	***($4,800)***	***$346,100***	***$341,300***
Total	***$10,200***		***$3,500***	***($6,700)***	***$974,700***	***$968,000***

BUILD ALTERNATIVE

County	Annual Land Tax Loss 1996-2013	Real Estate Tax Gain Residential 2001-2013	Real Estate Tax Gain Service/Retail 2001-2013	Net Annual Land Tax Gain/(Loss) 2001-2013	State Income Tax Gain 2001-2013	Annual Total Tax Benefit 2001-2013
Randolph	$1,000	$10,000	$1,200	$10,200	$801,000	$811,200
Tucker	2,600	3,800	800	2,000	249,000	251,000
Grant	3,600	50,600	2,300	49,300	2,249,000	2,298,300
Hardy	3,700	10,200	500	7,000	767,000	774,000
Hampshire		2,900	100	3,000	244,500	247,500
Mineral		17,800	800	18,600	287,000	305,600
Garrett, MD*		30,000	700	30,700	717,500	748,200
WV Total	***$10,900***	***$125,300***	***$6,400***	***$120,800***	***$5,315,000***	***$5,435,800***
Frederick	$11,300	$478,400	$16,000	$483,100	$11,154,500	$11,637,600
Shenandoah	6,300	102,700	3,600	100,000	2,131,000	2,231,000
VA Total	***$17,600***	***$581,100***	***$19,600***	***$583,100***	***$13,285,500***	***$13,868,600***
Total	***$28,500***	***$706,400***	***$26,000***	***$703,900***	***$18,600,500***	***$19,304,400***

* Garrett County has been included in the West Virginia totals.

Based on the assumption that industrial growth would occur within currently established industrial parks with infrastructure in place, it is assumed that adequate water supplies would be available to sustain that development or would be developed to support that development. For example, Moorefield, WV has recently completed an addition to its water treatment facility to meet its projected need of 4.8 million gallons per day. Currently the source of raw water, the South Fork River, is inadequate during periods of low flow to meet the capacity of the up-graded water treatment facility. Moorefield, in cooperation with the USDA Soil Conservation Service, is considering construction of a reservoir on Stony Run. If constructed, this reservoir would provide sufficient raw water to accommodate future predicted demands (USDA-SCS, 1994).

4. GROUNDWATER RESOURCES

a. Highway-Related Impacts

Under either the IRA or the Build Alternative, additional roadway construction would increase the amount of impervious cover in each of the watersheds. While this would increase stormwater runoff volumes and peak discharges, no long-term impact to the quantity of groundwater would be expected. The area covered by the highway pavement would be small in comparison to the overall land available for recharge.

Secondary impacts to groundwater involve contamination due to the operation of the highway, resulting from stormwater runoff and accidental spills. Stormwater runoff is related to the traffic volumes and is discussed in the Streams section of this report. Potential for groundwater contamination due to spills increases in karst terrain due to the rate at which surface waters reach the groundwater system. The IRA and the Build Alternative cross the same limestone unit near Greenland Gap, with traffic volumes for 2013 of 9,000 vehicles/day. This karst area was the subject of a detailed dye tracer study which is included in Section III of the SDEIS.

b. Development-Related Impacts

(1) Improved Roadway Alternative

Because there are no housing unit increases predicted under the IRA, there would be no impact groundwater resources due to private water wells.

(2) Build Alternative

Predicted residential and service-oriented development would generally occur in areas not supplied by a public water supply system. These homes and businesses would therefore have to rely upon wells for their water supply. Demand was calculated by multiplying the number of predicted housing units by an average daily usage of 567 liters (150 gallons). This figure was supplied by the West Virginia Department of Health. Utilizing a housing unit density of 125 single family units per square kilometer (1 unit per 0.80 hectare (2 acres)), water demand would equal approximately 70,000 liters per square kilometer per day.

Aquifer capacity (yield) data available for the 30-Minute Contour was available for the counties of Mineral, Grant, Hardy and Hampshire (Ward and Wilmoth, 1968; Hobba et al., 1972). Based on published information, it is reasonable to conclude that aquifers located in the other counties within the 30-Minute Contour would have a potential yield at least equivalent to those for which data are available. Yields in liters per day per square kilometer for those counties for which data are available range from 150,000 to 300,000.

Based on these data, the additional housing units predicted to occur as the result of development would not adversely impact groundwater resources within the 30-Minute Contour.

5. WILDLIFE HABITAT

a. Highway-Related Impacts

(1) Forest Fragmentation and Biodiversity

Forest fragmentation due to road construction could create edge habitat that would be exploited by a number of plant and wildlife species. 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. This was an attempt to define the core area available for area sensitive species after effects of nest predation, brood parasitism and competition (associated with edge habitats) were considered (Temple and Cary, 1988). While these edge effect constraints may influence the distribution of area sensitive species, this does not preclude these areas from being utilized by a variety of other wildlife species (Adams and Geis 1982,1983).

Table 10 summarizes the changes in the number of forest patches less than 150 ha (370 ac) available for area sensitive indicator species after edge effect constraints were considered (see *Vegetation and Wildlife Habitat Technical Report* for a more detailed discussion). These impacts are associated with both the Build and Improved Roadway Alternatives. 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 prevent these areas from being used 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 impacts associated with edge effects of Line A, an 18% increase from the estimated original forest impacts. Approximately 3,530 ha (8,720 ac) could be influenced by the IRA, a 9% increase from the estimated original forest impacts. Both figures represent nearly a 1% loss of regional forest lands for breeding use by the forest interior neotropical migrant indicator species.

(2) Wildlife Mortality

(a) Literature review

The most direct 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 ROW's 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.

TABLE 10
SECONDARY IMPACT AFFECTS ON CREATED FOREST PATCHES COMPARED TO MINIMUM AREAL BREEDING REQUIREMENTS OF NEOTROPICAL MIGRANT INDICATOR SPECIES

MINIMUM AREAL BREEDING REQUIREMENTS MET (# OF SPECIES)	PATCH SIZE (HA)	# OF PATCHES CREATED	
		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

Several studies have documented the effects of interstate 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;
- roads appeared to act 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) having high population densities.

Michael (1975) conducted a study in Cooper's Rock State Forest in northern West Virginia to measure the impact of Appalachian Highway 48 (Corridor E) on wildlife populations. This area is dominated by deciduous upland forest with vegetative and vertebrate species similar to that found in the present study area. The major results of this study were:

- the majority of birds and mammals 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. That is, it is related to the total number of individuals per species present within the area.

(b) Conclusions

The construction of the 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 in 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, that exist within the project watersheds. Because wildlife mortality has been found to be density dependent, species killed in greatest numbers would be those attracted to right-of-way habitat with high population densities. Density dependent population regulators tend to remove those members of a population who represent a population surplus without removing any members of the core population. Density dependent regulators have been shown to have no negative consequences for a species, or for that segment of a population of that species occupying optimum habitat (Errington 1963, Pearson 1966, Krebs 1978). 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 (1982) 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 (1982) found that 76 percent of road wildlife mortality occurred on four lane interstate highways. Line A would be expected to follow these observed results.

(3) Isolation of Populations and Genetic Diversity

Oxley et al. (1974) speculated that four lane highways and their adjacent rights-of-way are barriers to small forest mammals as effective as a body of water twice as wide. Adams and Geis (1982) also "found some evidence that roads, particularly large ones, inhibit movement of some small mammal species" and that the significance of this "barrier effect" to populations of those species is not known. However, Ferris et al. (1978) concluded that highways are not more than partial barriers to small mammal (e.g., mice, voles, shrews) movements and that this effect is lessened by the presence of culverts. In addition, they and others (McCartney et al., 1994) found that medium sized mammals (e.g., raccoons and woodchucks) utilized culverts, thus circumventing the "barrier effect" of the highways. Burke and Sherburne (1982) in their report on I-95 wildlife interactions in northern Maine state that, "Clearly the effects of the highway as a physical barrier to movement, particularly of small mammals, are not understood".

Even if all movement across the highway was curtailed, it seems unlikely that the genetic diversity of populations of wildlife on either side of the highway would decline. The mammalian species represented within the 30-Minute Contour are generalized species. Such species have great genetic diversity, generally random breeding patterns, relatively large populations and are capable of exploiting a large range of environments. Because of these characteristics, populations of these species are virtually ubiquitous throughout the eastern United States. Therefore, even with the construction of the Build Alternative or the IRA, large gene pools for those species represented within the 30-Minute Contour would continue to exist on both sides of the highway and no diminution of that genetic diversity for those species would occur.

b. Development-Related Impacts

(1) Habitat Unit Loss - Improved Roadway Alternative

Development related to the IRA involves commercial enterprises at intersections and interchanges. The required land area for this development was presented earlier in this report. 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 11.

(2) Habitat Unit Loss - Build Alternative

Total hectares required for predicted 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 12. For this calculation all development related impacts are presented in the aggregate. That is, intersection/interchange, residential and service oriented development were combined by land cover type to determine the total number of habitat units predicted to be lost because of predicted development requirements.

TABLE 11
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 River	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 River	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 12
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 River	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 River	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. WETLANDS

a. Highway-Related Impacts

(1) Introduction

Secondary impacts discussed here are those that occur as the result of the construction and operation of the project. These effects may be the immediate consequences of road construction, or they may be a result of the road's long-term operation. The effects of highway construction may be more likely to occur in wetlands than in uplands because wetlands are the landscape units that receive, retain, and discharge surface water and groundwater (Southerland, 1993). Secondary impacts can affect wetlands through changing the vegetation communities, erosion and sediment deposition, or altering water regimes and water quality. The majority of these impacts are temporary in nature and their severity can be mitigated through the use best management practices.

(2) Erosion and Sedimentation

Wetland water quality could be affected by temporary erosion and sedimentation caused by earth moving activities. Shuldiner *et al.* (1979) report that highway construction is a major source of sediment loads in surface waters, and sediment loads from highway construction during an average storm can be 10 times greater than that from cultivated land and 200 times greater than that of grassed and forest land. Construction activities within the wetland itself can cause large amounts of organic and mineral matter to be suspended in the surrounding water. Runoff from cleared lands or highway fill is also a source of inorganic matter that could enter wetlands. This could decrease overall wetland productivity by increasing water turbidity, thereby lowering the amount of light available for photosynthesis. Deposition of sediment within wetlands could raise the surface elevation of the wetland, leading to eventual drop in the water table and loss of the wetland. Excess sediment also could smother certain plant species.

Data analysis determined that 3% of the impacted wetlands for the Build Alternative contained submerged aquatic vegetation that could be susceptible to the above impacts. Further analysis revealed that within these wetlands, the submerged vegetation was a small component of the overall wetland vegetative community. The dominant existing emergent plants that surround these submerged species would likely act as a vegetative buffer to reduce runoff and "trap" suspended solids. The employment of proper erosion and sedimentation control practices should reduce and/or minimize these impacts.

(3) Hydrological

Changes in water levels and water flow regimes are a potential effect of highway construction and operation. Movement of groundwater could be slowed by placement of impervious fills or compression of the substrate. This effect could cause ponding of water on the upstream side of the road and drying of the downstream side of the road. Channelization of water flows in a wetland due to placement of culverts also could cause lowering of the water table. The reverse could also occur - greater water levels could occur if water is directed into a wetland from an outside source. Many wetland plant species are sensitive to the amount and level of water that occurs in the wetland. In some cases changes in water levels could cause minor alterations in the vegetation community composition, and in other cases, the changes could be dramatic.

Data analysis for the Build and Improved Roadway Alternatives determined that highway construction restricted the placement of culverts to existing streams, and as such, would not impact wetland vegetation.

Alteration of flooding patterns (timing and flow volume) can impact wetland productivity and vegetative community structure. Flooding provides periodic inputs of needed nutrients into wetlands. Drier conditions accelerate decomposition of dead plant material and these added nutrients encourage rapid growth. Thus, loss of flooding could cause reduced wetland productivity and changes in wetland community structure and composition.

During wetland field investigations, an assessment was made of potential sources of wetland hydrology. Twelve percent of the delineated wetlands were solely dependent on seasonal flooding for their hydrology. Of these, eight were within 100' of the construction limits. These wetlands could be susceptible to alterations in flood patterns due to construction activity.

Potentially harmful and toxic materials can be associated with stormwater runoff (Dupuis and Kobriger, 1985). These materials may include nitrogen, phosphorus, metals, salts, petroleum products, and pathogenic bacteria. However, it has been found that stormwater runoff from rural highways with traffic volumes less than 30,000 vehicles per day causes minimal to no impact on the aquatic environment. Projected traffic volumes for the year 2013 for the Build Alternative ranged from 1,000 to 23,000 vehicles per day with an average volume of 9,000 with the IRA traffic volumes being less. At these traffic volumes, the above effects would be minimal.

b. Development-Related Impacts

As discussed above, all industrial parks except one have already been constructed or are currently under construction. The one proposed industrial park site north of WV 93 and adjacent to Four Mile Run contains a 2.3 hectare (5.5 acre) palustrine scrub-shrub wetland. Development of this site could encroach upon that wetland as well as impact Four Mile Run.

Intersection/Interchange development analysis revealed that such development could occur without encroaching upon any wetland resources, for the Build and Improved Roadway Alternatives.

Because the definition of raw land excludes wetlands and because sufficient raw land is available to support all predicted residential and service-oriented development, it is possible that this projected development could occur without wetland impacts.

7. STREAMS: HIGHWAY-RELATED IMPACTS

This section deals solely with highway-related secondary impacts, following a brief statement regarding development-related secondary impacts to streams. Secondary impacts associated with industrial development would not be expected in twelve of the thirteen industrial parks identified. The remaining park is not yet constructed and could impact a perennial stream, Four Mile Run, and two of its tributaries. The park is adjacent to WV 93 in Grant County near Mount Storm Lake. This park could be designed to avoid significant impacts to the stream. Commercial development at intersections could also be planned and designed to avoid impacts to streams. Residential development cannot be definitively located beyond the BNA predictions and as such, impacts to streams cannot be adequately assessed.

a. Erosions and Sedimentation: Effects and Mitigation

The combination of steep slopes, erodible soils, extensive excavation, clearing, and grading would result in a high potential for erosion and sedimentation. Controlling potential erosion from the construction area and subsequent sedimentation in local streams is a major concern.

A variety of substrate types is important in maintaining a productive aquatic habitat. Boulders, cobble, and gravel with relatively little sand, silt, and clay create an optimal substrate for fish and invertebrates. Sedimentation of streams during and after construction of the project could adversely impact both aquatic invertebrates and fishes by altering the existing substrate. When sedimentation of the stream results in the silt content of the substrate exceeding 15 percent, trout populations can be reduced by 50 percent (Hunter, 1991).

Sedimentation can have acute and chronic effects on aquatic invertebrates and fish. Suspended sediment concentrations must be very high (above 20,000 ppm) to cause mortality in adult fish by clogging the gill filaments and preventing normal water circulation and aeration of blood. However, abrasion damage to gills begins to occur at sediment concentrations as low as 200 ppm (Welsch, 1991). Low concentrations can cause behavior changes and disrupt normal reproduction by covering spawning areas and preventing the emergence of fry.

The effects of silt (suspended particulate matter) has also been reported to be a limiting factor in the distribution and density of invertebrate organisms (Bartsch, 1916; Ellis, 1936; National Technical Advisory Committee, 1968; Luedtke and Brusven, 1976; Marking and Bills, 1980; Brzezinski and Holton, 1981; Gray and Ward, 1982; Buikema et al., 1983; Cowie, 1985; Duncan and Brusven, 1985; Garie and McIintosh 1986; Aldridge et al., 1987; Dewalt and Olive, 1988; Wolcott and Neves, 1990; Hogg and Norris, 1991; Corkum, 1992; Layzer and Anderson, 1992; Houp, 1993). Filter feeding organisms utilize minute cilia on the surface of their gills to collect food particles. Silt particles clog the cilia which in turn reduces food ingestion and, depending on the silt load and sensitivity of the organism, can lead to suffocation. Silt impacts the colonization and distribution of invertebrates by modifying the benthic habitat. As silt settles out of the water column, the rate of accretion can be greater than the escape rate of many invertebrates that are less mobile or sedentary in nature. The modification in substrates as a result of sedimentation excludes many invertebrate species that utilize the interstitial zones of cobbel/gravel stream beds.

For each section of highway designed, a comprehensive erosion and sedimentation control plan would be implemented to minimize impacts. The erosion and sedimentation plans would include best management practices (BMP's) as described in the WVDOT DOH *Erosion and Sedimentation Control Manual* (1993) and *Standard Specifications Road and Bridges (1993).* In Virginia, the construction of the project would adhere to Virginia's Stormwater Management Regulations (1990) and VDOT's *Road and Bridge Specification*, as well as the *Virginia Erosion and Sedimentation Control Handbook (1993).* To ensure that the erosion and sediment control plan would be adhered to during the construction phase, routine inspections in the field would be conducted. Temporary erosion and sediment controls which would be used during construction include the following:

<u>Vegetative Soil Stabilization Methods:</u> Seeding and mulching would be performed on a continual basis to reduce the potential for erosion from cut and fill slopes, haul roads, waste sites and borrow pits during the construction phase. Clearing and grading would be minimized to allow natural vegetation to serve as erosion control. Those areas that are cleared and graded would be stabilized by planting fast-growing annual plant species.

Water Conveyance And Energy Dissipation: Erosion would be reduced by utilizing structures which slow the flow of water and reduce its ability to create erosion. These structures would include temporary berms, slope drains, temporary pipes, contour ditches, check dams and ditch checks.

Clear Water Diversion: Relatively sediment-free stormwater runoff would be intercepted and diverted around the construction site. Clear water diversions would reduce the amount of stormwater flowing across and through the construction site, thus reducing erosion and minimizing the amount of stormwater runoff requiring treatment.

Sediment Retention Structures: Sediment barriers and sediment basins would be used to reduce the amount of eroded sediment carried by stormwater runoff from the construction site. Sediment barriers, such as straw bales and silt fencing, would be used along the toe of slope and other areas where sheet flow would be intercepted. Concentrated runoff would be routed to sediment basins and traps before being redirected to a stream below the construction site. The channels utilized to transport the sediment-laden stormwater runoff would be lined with properly anchored erosion resistant materials so as not to create additional erosion problems.

Stream Bank Protection: Construction in and/or near streams would require additional erosion control measures to minimize stream bank erosion and sedimentation. Typically, this requires limiting construction activities within streams to periods of low flow; establishing temporary bridge or culvert crossings of streams for construction equipment; stockpiling excavated material outside the floodplain; limiting clearing of stream bank vegetation; and placing silt fencing along streams.

After construction of the facility is completed, permanent erosion control measures would be instituted. These measures would include stabilizing cut and fill slopes, shoulders, medians, and any other areas of exposed soils as well as drainage swales and ditches. Stabilization could be established with perennial vegetation or the use of non-erosive materials (i.e. riprap, geotextiles, etc.). Establishing a permanent vegetative cover (grass, shrubs, and trees) capable of preventing erosion may require considerable site preparation including seeding, transplanting, fertilization, mulching, watering, and, on steep slopes, the use of natural or synthetic matting. The location of permanent discharge points for stormwater should be designed to dissipate streamflow velocity and prevent erosion into the receiving stream.

b. Highway Pollutants

After construction of the project, major sources of pollutants include vehicles, dustfall, and precipitation (Charbeneau et al., 1993). A variety of factors (e.g., traffic volume and type, local land use, and weather patterns) affect the type and amounts of pollutants. Additionally, roadway maintenance practices such as sanding, deicing, and application of herbicides on highway right-of-ways, also can act as sources of pollutants. Table 13 lists the types of potential contaminants associated with roadway development. From this list, deposition of pollutants from vehicles (both direct and indirect) is the largest source of pollutants during most of the year, while deicing salts (sodium chloride and calcium chloride) and abrasives are the largest source of pollutants during periods of snow and ice (Gupta et al., 1981). The rate of deposition and subsequent magnitude of these pollutants in highway runoff are site specific and affected by: traffic characteristics, highway design, maintenance activities, surrounding land use, climate, and accidental spills.

Highway pollutants are removed from the highway through a number of mechanisms which include stormwater runoff, wind, vehicle turbulence, and the vehicles themselves. The effects of highway runoff on streams are variable and depend on the length of time since the last storm event, traffic volume, natural surface winds, the quantity of stormwater runoff delivered to the stream, volume of flow in the stream, and the duration of the storm event (Charbeneau et al., 1993). The most important factor contributing to the accumulation of pollutants from highway operation and maintenance is the build up of fine particulate matter. Many toxic compounds such as heavy metals and hydrocarbons adhere to fine particles and are easily transported by stormwater runoff to nearby streams. The accumulation of particulate matter on a highway is also proportional to the amount of traffic on the highway. However, vehicle turbulence also can remove solids and other pollutants from highway lanes and shoulders (Kerri et al., 1985; and Asplund et al., 1980) which complicates the relationship between traffic volume and pollutant concentrations in runoff.

Highway runoff may adversely affect water quality through acute (i.e. short-term) loadings (i.e. storm events) and through chronic effects as a result of long-term accumulation and exposure. Research on rural highways similar to the project indicates few substantial effects from highway runoff are apparent for highways with an Average Daily Traffic (ADT) of less than 30,000 vehicle per day, and that toxic effects are limited to urban highways with high ADT's (>50,000 ADT) (Maestri et al., 1981). Driscoll et al. (1990) concluded that runoff concentrations are two four times higher for highways that are subject to ADTs > 30,000. Dupuis and Kobriger (1985) reported that there were no apparent water quality impacts during storm events on benthic invertebrates. Based on the volume of traffic predicted for the project (23,000 vehicles per day), it is anticipated that there would be no measurable differences in water quality on receiving streams.

TABLE 13
COMMON HIGHWAY RUNOFF CONSTITUENTS AND THEIR PRIMARY SOURCES

Constituent	Primary Sources*
Particulates	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Leaded gasoline (auto exhaust), tire wear (lead oxide filler material), lubricating oil and grease, bearing wear
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guardrails, etc.), moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fugicides and insecticides applied by maintenance operations
Cadmium	Tire wear (filler material), insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline (exhaust) lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Bromide	Exhaust
Cyanide	Anticake compound (ferric ferrocyanide, Prussian Blue or sodium ferrocyanide, Yellow Prussiate of Soda) used to keep deicing salt granular
Sodium, Calcium	Deicing salts, grease
Chloride	Deicing salts
Sulphate	Roadway blends, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate
Polychlorinated Biphenyls	Spraying of highway right-of-ways, background atmospheric deposition, PCB catalyst in synthetic tires
Pesticides Pathogenic bacteria (indicators)	Soil, litter, bird droppings and trucks hauling livestock and stockyard waste
Rubber	Tire wear
Asbestos	Clutch and brake lining wear

* Source: Kobriger, 1984

c. Mitigation of Highway Pollutants

Even though the impact on water quality from highway stormwater runoff is predicted to be minimal based on the ADT projections, mitigation measures designed to control storms producing less than 2.5 centimeters or 1 inch of rainfall would control nonpoint pollution discharges for approximately 90 percent of the storms each year. The majority of pollutant loads from a storm are delivered by a relatively small percentage of the runoff volume during the initial stages of the storm. Mitigation measures in the final design should address the control of this "first flush" and the removal of heavy metals and other pollutants which tend to adhere to sediment particles.

Two methods have been shown to be highly effective in removing pollutants from runoff (Masestri et al, 1981). The first is the use of vegetated surfaces (grass) to manage highway stormwater runoff pollution which capitalizes on the natural capability of vegetated surfaces to reduce runoff velocity, enhance sedimentation, filter suspended solids, and increase infiltration. Secondly, the use of wet detention basins which maintain a permanent pool of water are capable of highly effective pollutant removal principally through sedimentation. These methods have been found to be the most effective in removing a significant percentage of the pollutant load from stormwater runoff (Table 14).

In Virginia, the project would be subject to Virginia's *Stormwater Management Regulations* (1993). The goal of these regulations is to inhibit the deterioration of the aquatic environment by instituting a stormwater management program that maintains both water quantity and quality equal to or better than that prior to construction. The regulations require detaining the first 1.3 cm (0.5 in) of rainfall. Numerous studies have shown that the greatest concentrations of highway pollutants are contained within the first flush of a storm event. By requiring the detainment of the first 1.3 cm (0.5 in) of rainfall, the water quality of receiving streams would not be subjected to this initial pulse. In West Virginia, there are no requirements for permanent management of highway stormwater quantity or quality.

To control stormwater runoff during the operation of the highway, the proper management of chemicals used for highway maintenance is an important element in minimizing water quality impacts. Proper application and storage of deicing chemicals, pesticides and herbicides would minimize the introduction of these pollutants into surface waters.

d. Aquatic Habitat: Impacts and Mitigation

As described in previous sections, impacts to streams include alterations in stream hydrology, geometry, and the degradation of water quality. These impacts could impact the stream's capacity to provide habitat suitable for aquatic life, including game and non-game fish, amphibians, and invertebrates.

TABLE 14
EFFECTIVENESS OF STORMWATER MITIGATION MEASURES

POLLUTANT	WET DETENTION BASIN	GRASS SWALES AND BUFFER STRIPS
Suspended Sediment	80-90%	50-60%
Phosphorus	50-60%	10-15%
Nitrogen	30-40%	5-10%
Lead	70-80%	45-55%
Zinc	40-50%	25-30%
Copper	40-50%	30-35%

Source: Virginia Stormwater Management Regulations (1993)

Impacts to the aquatic environment change with time and space. Spatially, the movement of aquatic invertebrates and fish within streams is important to the colonization of portions of streams temporarily disturbed during construction and to the natural colonization of undisturbed streams (Lancaster, 1990). During periods of low stream flow, movement of fish and aquatic invertebrates along a stream to areas of deeper water is necessary.

Colonization of stream substrate by aquatic invertebrates comes from four major sources: downstream drift, upstream movement, vertical movement from deep within the substrate and aerial movements of adults. The contribution of each source of recruitment varies for each taxa (e.g. caddisflys move with the drift). William and Hynes (1976) found that for the organisms sampled by their traps, 41% came from downstream drift; 18% from upstream movement along the substrate, 19% from vertical movement through the substrate and 28% from aerial deposition of eggs by adults. It was also discovered that an additional source of colonization was due to movement of adults between streams.

Many aquatic invertebrates exhibit a daily drift downstream, generally occurring near dusk. Aquatic invertebrates which exhibit downstream drift including various taxa of the following: Oligochatea, Amphipoda, Isopoda, Ephemeratera, Plecoptera, Odonata, Hemiptera, Diptera, Coleoptera, Hydracarina, and Mollusca (Hynes, 1970). Drift can be divided into broad and overlapping categories (Waters 1961,1962a, 1962b, 1965; as cited by Pearson and Kramer 1972):

- Constant drift due to normal accidental dislodgment;
- Behavioral drift due to active response by organisms;
- Drift due to catastrophic events (e.g. floods, toxics, low streamflows).

Aquatic invertebrates appear to enter the drift both actively and passively. When food resources become scarce, aquatic invertebrates actively enter the drift to find suitable feeding areas. Aquatic invertebrates may also actively enter the drift to avoid predation or passively due to the loss of a limb after a predatory attack (Williams and Levens, 1988).

Drift has been shown to be a major contributing source of colonization of disturbed areas (42%-82%) as reported by various researchers in Lock and Williams, 1981). Colonization of disturbed areas solely by drift required from 2-4 weeks to several years (Lock and Williams, 1981).

Although Williams and Hynes (1976) reported an average of 18% of organisms were recruited from upstream movement along the substrate, this percentage varied greatly depending on the species in question. Some Ephemeroptera (mayflies) move as much as 1.6 km upstream (Lock and Williams, 1981). In many cases however, upstream movement is equivalent to less than 5 percent of the downstream drift.

Many species, particularly during early life stages, are now known to move vertically into the gravel and cobble substrate to depths of at least 100 cm. Organisms located deep within the substrate are protected from short-term disturbances such as temperature changes, streamflow fluctuations, and release of toxics or sediments. Movement vertically, horizontally, and laterally within the substrate can contribute substantially to the colonization of disturbed streams. Populations inhabiting deeper zones within the substrate are important in colonizing streams which may be temporarily impacted by the project.

Disturbed areas can also be colonized by adult insects depositing eggs into the stream or substrate. The adults of many species move upstream before depositing their eggs, which may compensate for downstream drift of immature aquatic invertebrates. Upstream movement of adults have been documented in Tricoptera, Plecoptera, Ephemeroptera, and Simuliidae. Some caddisflies undertake a definite upstream migration estimated at 2-3 km. (Pearson and Kramer, 1972). The importance of adult deposition of eggs for colonization varies based on the location of the stream within the watershed. Headwater streams are more dependent on adult deposition than are streams located lower in the watershed. In headwater streams, adult recruitment can lead to restoration of the trophic structure of a disturbed stream within two years, although the taxa may differ from pre-construction conditions due to the lack of taxa with poor dispersal abilities such as some stoneflies (Wallace et al, 1986).

Although a majority of the colonization of disturbed portions of streams would be from movement of aquatic invertebrates within the same stream, movements between streams by adults can also contribute to the colonization. Taxa with strong dispersal capabilities as adults include Odonata, Simuliidae, Culicadae, and various Coleoptera, Hemiptera, and Tricoptera. Many adult Ephemeroptera, Tricoptera, Chronimidae and Plecoptera are weak fliers and are unlikely to contribute substantially to colonization by actively moving between streams.

Bridging avoids permanent impacts to aquatic habitat, but enclosures and relocations would have temporary and permanent impacts. Many of the general, specific and construction period minimization measures previously discussed would avoid and minimize impacts to the aquatic habitat provided by the streams crossed by the project.

The project would require bridging, enclosing and relocating a number of streams, each of which would have different secondary impacts on the aquatic habitat of a stream. The use of bridges to cross 39 streams avoids impacts to the aquatic habitat of those streams.

Enclosures (e.g. pipes and box culverts) would have temporary and permanent impacts on aquatic habitat. Streams would be temporarily diverted or dammed while the pipe or culvert is constructed. A portion of the streams immediately adjacent to the construction of the enclosure would be disturbed during construction. Once construction is completed and the construction site stabilized, normal colonization processes would repopulate disturbed portions of the streams. Counter sinking the enclosure below the level of the streambed would allow upstream and downstream movement of aquatic invertebrates and fish within the stream, thus maintaining natural colonization processes. The placement of a culvert under a large amount of fill which effectively block stream valleys may impede the upstream movement of adult insects. This would likely impede only a portion of the adult population which hatch downstream of the crossing. Those adults which emerge upstream of the culvert and those which are capable of flying over the fill would not be affected.

If proper mitigation measures are implemented, the relocation of stream channels should not detrimentally impact the movement of aquatic invertebrates or fish in areas where an acceptable ratio of pools and riffles are established. Based on the identified areas where secondary development is expected to occur (intersections and industrial parks) the ecological importance of such disturbances is minimal due to the relative diversity, abundance, analyzed biotic integrity, and existing habitat of these identified streams.

e. Riparian Habitat

The project would impact the terrestrial environment immediately adjacent to stream corridors. The productivity of a stream, its water quality, and aquatic habitat, is affected by the type of riparian habitat along its banks and associated floodplain.

Overland surface runoff conveys nutrients (i.e., particulate organic matter (POM), particulate inorganic matter (PIM), dissolved organic matter (DOM), and dissolved inorganic matter (DIM)), into streams thereby affecting aquatic habitat and water quality. Forested riparian buffer strips adjacent to streams substantially reduce the impacts of overland surface runoff on receiving streams by removing sediment and other suspended solids from overland surface runoff. As a result of this filtering action, silt-clogging material does not buildup in the interstitial regions within the substrate of a stream. In addition, the biological oxygen demand (BOD) of the stream is also reduced. A major source of pollutant in agricultural areas is phosphorus. Phosphorus adheres to small size particles and is transported into streams through overland runoff. The filtering action of a forested riparian buffer strip can result in a reduction of approximately 80% of the phosphorus in overland runoff, thus greatly reducing phosphorus loading to streams (Welsch, 1991).

In addition to filtering, forested riparian buffer strips can intercept and transform pollutants into less toxic compounds. For example, the most common form of nitrogen, nitrate, is soluble in surface and groundwater. The amount of nitrogen in runoff and shallow groundwater can be reduced by as much as 80% after passing through a riparian forest (Welsch, 1991). Nitrate concentrations are reduced through the processes of plant uptake, nitrification and de-nitrification. Some estimates indicate that 25% of the nitrogen removed by forested riparian buffer strips is assimilated in tree growth which may be stored for extended periods of time. Forested riparian buffer strips can also retain and transform pesticides and herbicides into less toxic compounds (Welsch, 1991).

Forested riparian buffer strips also influence other factors which contribute to the quality of aquatic habitat for fish and macroinvertebrates. One factor, water temperature, is a function of both air temperature and solar radiation. The optimal conditions for streams supporting cold water fish (e.g. trout, dace) is a water temperature of 8 to 15 degrees C and approximately 75% shading (Hunter, 1991). The loss of forested riparian buffer strips can result in an increase in water temperature. The increase in water temperature reduces the dissolved oxygen concentration within the water and also increases the basal metabolic rate (i.e., the demand for oxygen at a resting state) of fish. First through third order streams typically comprise about 85% of the total length of running waters in a watershed (Welsch, 1991). Because of their small ratio of streamflow to shoreline, these streams are particularly vulnerable to increased water temperature due to loss of forested riparian buffer strips.

Forested riparian buffer strips enhance habitat structure by stabilizing undercut stream banks which provide habitat for a variety of aquatic organisms. Forested riparian buffer strips also contribute large woody debris (limbs, trunks, stumps) to the stream system. Large woody debris creates dams and jams in the stream, forming pools which serve many purposes. Sand and silt can be temporarily stored in these pools, which may otherwise be deposited in spawning areas. Organic material can be trapped behind log dams providing the aquatic invertebrate community with greater food resources. The woody material itself is consumed by some aquatic invertebrates and provides attachment sites for many other species. Debris provides refugees from predators and periods of high flows.

Riparian vegetation also provides a source of organic material (leaves, twigs, bark, seeds) to the stream and serves as the base of the detrital food chain. This material is consumed by a variety of aquatic invertebrates which are a primary source of food for other organisms. In small first order mountain streams, input of organic material (DOM and PIM) from the riparian forest accounts for the majority (75%) of the productivity of the stream.

Lastly, forested riparian buffer strips provide suitable habitat for terrestrial wildlife. Stream corridors are often used as travel routes and foraging areas by many species of wildlife.

Within the project area, most of the smaller, mountainous first order streams possess a riparian forest composed of hardwoods (oaks, yellow birch, maples, and sycamore), while steeper stream valleys with cooler and moister microclimate support hemlock and rhododendron. Along relatively flat second and third order stream valleys within the project area, much of the valley bottom has been converted to agricultural use, resulting in the complete loss of a forested riparian buffer strip or one that is reduced to a narrow fringe along the stream banks. Many of the existing roadways in the study area are located along streams, thus reducing the abundance of riparian habitat.

Any construction near streams would result in some level of impact to the existing riparian habitat. The greatest potential for impact would be along streams which have well developed riparian forests. Construction along stream valleys could not be avoided, but impacts to riparian forests were minimized where possible by placing the alignments a minimum of 23 meters (75') up slope of the stream. To quantitatively determine impacts of the project to existing riparian forest buffers, the following study was conducted.

(1) Methodology

GIS analysis identified parallel limits of highway construction within 30 meters (100') of existing perennial streams for both the IRA and Build Alternative. This parallel limit was used as a reference for identifying potential encroachments within 23 meters (75') of ripiarian buffers for both the IRA and Line A. Construction of this nature would encroach upon the existing riparian buffer. This would produce a parallel strip of land, varying in width, between the construction limits and the existing perennial streams.

Croonquist and Brooks (1993) suggested that protecting a forested corridor at least 25 meters (80 ft.) wide on each bank provides feeding, resting, or migrating corridors for sensitive species including forest interior neotropical migrants birds. Welsch (1991) determined that a minimum width of 23 meters (75') of forested buffer is required to protect water quality and aquatic habitats. Based on the above literature, the average width and vegetative cover type within each resultant 23 meter (75') buffer strip were determined to assess potential wildlife utilization and highway runoff impacts associated with parallel stream construction. The nearest stream sampling station and its associated Biotic Rank was identified for each resultant buffer strip to provide a quantitative assessment of stream conditions within the impact area. The Biotic Rank for each sampling location is calculated by comparing stream community, population, and functional parameters to the closest reference or "relatively undisturbed" station. Biotic Rank values range from A, non-impaired, to a low of D, severely impaired. This information was used in the development of minimization, avoidance, and mitigation measures.

(a) Estimated Impacts - IRA

Table 15 presents a summary of the impact to riparian buffers under the IRA. The IRA would impact 59 riparian buffers paralleling 9,463 meters (31,045 feet) of first, second, and third order perennial streams (Table 16). Riparian buffers less than 23 meters (75 feet) are less capable of providing water quality and wildlife benefits. A majority of these narrower riparian buffers (86%) would contain either forest, shrub and brush, or emergent wetlands thus providing some benefits for wildlife and water quality. Agricultural and herbaceous rangeland would comprise the remaining 14% and would be of limited water quality and wildlife value (Figure 1). The Cheat River regional project watershed would contain the largest number and length of riparian buffer zone impacts (Table 15). Seventy three percent of the riparian buffer zones impacted bordered streams categorized as non-impaired or moderately impaired (Biotic Rank of A or B). The water quality and aquatic communities of these streams may be more susceptible to construction induced runoff than streams with lower categorical rankings (Biotic Rank C or D). The IRA would impact almost five times the length of riparian buffer as would Line A.

(b) Estimated Impacts - Line A

Table 17 presents a summary of the impact to riparian buffers under Line A. Line A would impact 19 riparian buffers paralleling 1,739 meters (5,792') of 24 first, second, and third order perennial streams (Table 18). Seventy nine percent of these buffers would be either forested, shrub and brush, or emergent wetlands and would provide some benefits for wildlife and water quality. Agricultural land would comprise the remaining 21% and would be of limited water quality and wildlife value (Figure 1). The Cheat River regional project watershed would contain the greatest number of riparian buffer zone impacts, while the South Branch of the Potomac River regional project watershed would contain the greatest length (Table 17). Stream BI rankings associated with these riparian zones ranged from non-impaired (A) to severely impaired (D). Sixty three percent of the riparian buffers less than 23 m bordered streams categorized as impaired or severely impaired (Biotic Rank of C or D). The water quality and aquatic communities of these streams may be less susceptible to construction induced runoff than streams with higher categorical rankings (Biotic Rank A or B).

TABLE 15
SUMMARY OF IMPACTS TO RIPARIAN BUFFER ZONES: IRA

Regional Project Watershed	Local Project Watershed	Perennial Streams	Stream Order	Length of Parallel Construction Within 23 m (75') of Stream*		Number of Riparian Buffers Impacted
				Meters	Feet	
Tygart Valley River	Leading Creek	trib. Leading Creek	1	27	89	1
		Wilmoth Run	2	142	466	3
		Leading Creek	3	197	643	6
Cheat River	Shavers Fork	Haddix Run	1	472	1,548	2
		trib. Shavers Fork	1	113	372	1
		Haddix Run	2	1,252	4,106	8
		Haddix Run	3	1,049	3,441	8
	Black Fork	Roaring Run	1	203	666	1
		trib. Beaver Creek	1	309	1,015	2
		trib. Slip Hill Mill Run	1	216	710	1
		Roaring Run	2	422	1,386	4
		Beaver Creek	3	36	119	1
S. Branch Potomac	Main Channel	Dumpling Run	2	404	1,324	1
		Fort Run	2	362	1,187	1
Cacapon River	Skaggs Run	trib. Skaggs Run	1	174	572	2
	Baker Run	trib. Long Lick Run	1	155	507	1
		trib. Baker Run	1	197	646	1
		Ba[illegible] Run	3	650	2,131	4
	Central Cacapon	Lost River	3	772	2,533	4
	Slate Rock Run	trib. Sine Run	1	230	756	1
		trib. Slate Rock Run	1	1,280	4,201	2
Shenandoah River	Cedar Creek	Duck Run	2	801	2,627	4
Total				**9,463**	**31,045**	**59**

* Based on Proposed Limits of Construction

Figure 1
RIPARIAN BUFFER ZONE ENCROACHMENT
IRA & Line A COMPARISON
Riparian Buffer Zone < 23 meters (75')

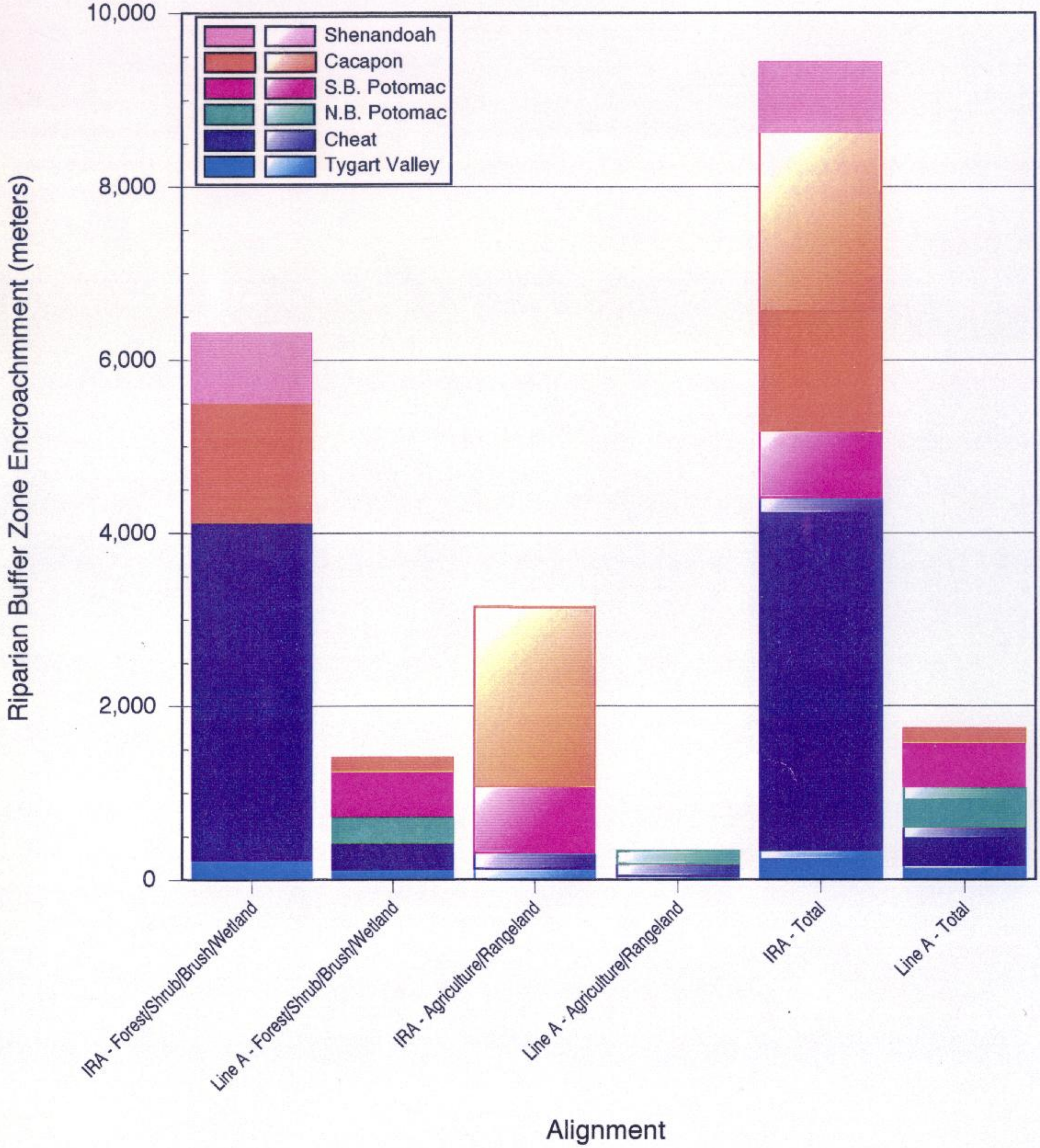


TABLE 16
RESULTANT RIPARIAN BUFFER ZONE < 23 METERS (75')1
IRA

Associated Reference Station	Regional Project Watershed	Local Watershed	Stream Name	Stream Order	Stream Length		Riparian Buffer Land Use	Biotic Integrity (%)	Biotic Rank2	Habitat Score
					Meters	Feet				
PS201	Shenandoah	Cedar Creek	Duck Run	2	22	73	Forest	60	B	112
PS202	Shenandoah	Cedar Creek	Duck Run	2	214	703	Forest	60	B	112
PS204	Shenandoah	Cedar Creek	Duck Run	2	243	796	Forest	87	A	48
PS204	Shenandoah	Cedar Creek	Duck Run	2	322	1055	Forest	87	A	48
PC303	Cacapon	Slate Rock Run	trib. Sine Run	1	230	756	Forest	100	A	79
PC2300	Cacapon	Slate Rock Run	trib. Slate Rock RUn	1	959	3146	Forest/Agriculture	80	A	86
PC2300	Cacapon	Slate Rock Run	trib. Slate Rock RUn	1	322	1055	Forest/Agriculture	80	A	86
PC413	Cacapon	Central Cacapon River	Lost River	3	15	50	Rangeland	80	A	120
PC413	Cacapon	Central Cacapon River	Lost River	3	676	2218	Rangeland	80	A	120
PC401	Cacapon	Central Cacapon River	Lost River	3	40	130	Forest	47	C	97
PC401	Cacapon	Central Cacapon River	Lost River	3	41	135	Forest	47	C	97
PC501	Cacapon	Baker Run	trib. Baker Run	1	197	646	Forest/Agriculture	73	B	67
PC503	Cacapon	Baker Run	Baker Run	3	194	637	Forest/Agriculture	93	A	89
PC2500	Cacapon	Baker Run	Baker Run	3	46	150	Agriculture	80	A	103
PC2500	Cacapon	Baker Run	Baker Run	3	152	500	Agriculture	80	A	103
PC2500	Cacapon	Baker Run	Baker Run	3	257	844	Agriculture	80	A	103
PC2502	Cacapon	Baker Run	trib. Long Lick Run	1	155	507	Forest	80	A	88
PC2504	Cacapon	Skaggs Run	trib. Skaggs Run	1	139	456	Forest/Rangeland	67	B	87
PC2504	Cacapon	Skaggs Run	trib. Skaggs Run	1	35	116	Forest/Rangeland	67	B	87
PSB2605	SBPR	Main Channel	Dumpling Run	2	404	1324	Agriculture	0	D	60
PSB2602	SBPR	Main Channel	Fort Run	2	362	1187	Agriculture	0	D	52
MC1103	Cheat	Black Fork	trib. Beaver Creek	1	172	563	Forest/Wetland	60	B	63
MC1208	Cheat	Black Fork	Beaver Creek	3	36	119	Forest	27	C	68
MC1111	Cheat	Black Fork	trib. Beaver Creek	1	138	452	Forest/Wetland	40	C	57
MC3303	Cheat	Black Fork	trib. Slip Hill Mill Run	1	216	710	Forest	27	C	66
MC3306	Cheat	Black Fork	Roaring Run	2	75	246	Forest	53	B	117
MC3305	Cheat	Black Fork	Roaring Run	1	203	666	Forest	67	B	111
MC3308	Cheat	Black Fork	Roaring Run	2	258	849	Forest	93	A	124
MC3308	Cheat	Black Fork	Roaring Run	2	55	179	Forest	93	A	124
MC3308	Cheat	Black Fork	Roaring Run	2	34	112	Forest	93	A	124
MC1400	Cheat	Shavers Fork	trib. Shavers Fork	1	113	372	Forest/Shrub	67	B	120
MC3403	Cheat	Shavers Fork	Haddix Run	3	119	389	Forest/Shrub/Agriculture	60	B	108

TABLE 16 (CONT.)
RESULTANT RIPARIAN BUFFER ZONE < 23 METERS (75')1
IRA

Associated Reference Station	Regional Project Watershed	Local Watershed	Stream Name	Stream Order	Stream Length		Riparian Buffer Land Use	Biotic Integrity (%)	Biotic Rank2	Habitat Score
					Meters	Feet				
MT3504	Cheat	Shavers Fork	Haddix Run	3	199	652	Forest/Shrub/Agriculture	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	3	155	508	Forest/Shrub/Agriculture	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	3	73	241	Forest/Shrub/Agriculture	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	3	261	857	Shrub/Wetland	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	3	80	264	Shrub/Wetland	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	3	101	330	Shrub/Wetland	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	3	61	200	Shrub/Wetland	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	166	547	Shrub/Wetland	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	157	516	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	154	505	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	47	154	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	21	68	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	43	140	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	13	42	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	2	650	2134	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	1	459	1506	Forest/Shrub	67	B	96
MT3504	Cheat	Shavers Fork	Haddix Run	1	13	42	Forest/Shrub	67	B	96
MT3503	Tygart	Leading Creek	Leading Creek	3	58	189	Forest/Agriculture	47	C	76
MT3503	Tygart	Leading Creek	Leading Creek	3	30	97	Forest/Agriculture	47	C	76
MT3503	Tygart	Leading Creek	Leading Creek	3	38	125	Forest/Agriculture	47	C	76
MT3503	Tygart	Leading Creek	Leading Creek	3	15	48	Forest/Agriculture	47	C	76
MT3503	Tygart	Leading Creek	Leading Creek	3	19	61	Forest/Agriculture	47	C	76
MT3502	Tygart	Leading Creek	Leading Creek	3	37	123	Agriculture	73	B	77
MT1511	Tygart	Leading Creek	Wilmoth Run	2	71	232	Shrub/Brush	20	D	53
MT1511	Tygart	Leading Creek	Wilmoth Run	2	15	50	Shrub/Brush	20	D	53
MT1511	Tygart	Leading Creek	Wilmoth Run	2	56	184	Shrub/Brush	20	D	53
MT3603	Tygart	Leading Creek	trib. Leading Creek	1	27	89	Agriculture/Wetland	20	D	76
Total					9,463	31,045				

1 Based on Welsch, 1991, Croonquist and Brooks, 1993

2 Biotic Rank Determined from Biotic Integrity Scores:
A = > 79%
B = 50-79%
C = 21-49%
D = < 21%

TABLE 17
SUMMARY OF IMPACTS TO RIPARIAN BUFFER ZONES: LINE A

Regional Project Watershed	Local Project Watershed	Perennial Streams	Stream Order	Length of Parallel Construction Within 23 m (75') of Stream*		Number of Riparian Buffers Impacted
				Meters	Feet	
Tygart Valley River	Leading Creek	Pearcy Run	2	46	153	1
		Leading Creek	3	123	411	4
Cheat River	Black Fork	trib. Beaver Creek	1	29	95	1
		Pendleton Creek	2	172	573	1
	Shavers Fork	trib. Shavers Fork	1	123	411	1
		Pleasant Run	2	15	51	1
		Pleasant Run	3	59	195	1
		Shavers Fork	3	48	160	1
N. Branch Potomac	Patterson Creek	trib. Patterson Creek	1	84	279	1
		trib. N.B. Patterson Creek	1	227	756	2
		M.F. Patterson Creek	3	146	485	1
S. Branch Potomac	Anderson Run	Toombs Hollow Run	2	515	1,715	2
Cacapon River	Skaggs Run	Skaggs Run	2	152	508	2
Total				**1,739**	**5,792**	**19**

TABLE 18
RESULTANT RIPARIAN BUFFER ZONES < 23 METERS (75')1
LINE A

Associated Reference Station	Regional Project Watershed	Local Watershed	Stream Name	Stream Order	Stream Length		Riparian Buffer Land Use	Biotic Integrity (%)	Biotic Rank2	Habitat Score
					Meters	Feet				
PNB800	NBPR	Patterson Creek	trib. Patterson Creek	1	84	279	Forest	0	D	34
PNB808	NBPR	Patterson Creek	trib. N.B. Patterson Creek	1	150	500	Agriculture	20	D	51
PNB808	NBPR	Patterson Creek	trib. N.B. Patterson Creek	1	77	256	Shrub/Brush	20	D	51
MC1111	Cheat	Black Fork	trib. Beaver Creek	1	29	95	Forest	40	C	57
MC1402	Cheat	Shavers Fork	trib. Shavers Fork	1	123	411	Agriculture	7	D	37
PC513	Cacapon	Skaggs Run	Skaggs Run	2	82	274	Shrub/Brush	60	B	86
PC513	Cacapon	Skaggs Run	Skaggs Run	2	70	234	Shrub/Brush	60	B	86
PSB707	SBPR	Anderson Run	Toombs Hollow Run	2	419	1,398	Forest	60	B	89
PSB708	SBPR	Anderson Run	Toombs Hollow Run	2	95	317	Forest	60	B	89
MC1212	Cheat	Black Fork	Pendleton Creek	2	172	573	Wetland	20	D	86
MC1505	Cheat	Shavers Fork	Pleasant Run	2	15	51	Agriculture	33	C	84
MT1603	Tygart	Leading Creek	Pearcy Run	2	46	153	Agriculture	27	C	76
PNB907	NBPR	Patterson Creek	M.F. Patterson Creek	3	146	485	Forest	73	B	93
MC1400	Cheat	Shavers Fork	Shavers Fork	3	48	160	Shrub/Brush	67	B	120
MC1503	Cheat	Shavers Fork	Pleasant Run	3	59	195	Forest	87	A	104
MT3602	Tygart	Leading Creek	Leading Creek	3	21	69	Forest	47	C	91
MT3602	Tygart	Leading Creek	Leading Creek	3	25	83	Forest	47	C	91
MT3602	Tygart	Leading Creek	Leading Creek	3	56	185	Forest	47	C	91
MT3602	Tygart	Leading Creek	Leading Creek	3	22	74	Forest	47	C	91
Total					1,739	5,792				

1 Based on Welsch, 1991, Croonquist and Brooks, 1993

2 Biotic Rank Determined from Biotic Integrity Scores: A = > 79%
B = 50-79%
C = 21-49%
D = < 21%

(c) Alignment Comparison

An alignment comparison of riparian impacts within Biotic Rank categories by regional project watershed is summarized in Table 19. The IRA would impact 43 riparian buffers paralleling 7,899 m (25,909') of streams categorized as non-impaired or moderately impaired (Biotic Rank A or B), while Line A would impact 7 riparian buffers paralleling 909 m (3,014'). The water quality and aquatic communities of these streams may be more susceptible to construction induced runoff than streams with lower categorical rankings (Biotic Rank C or D).

The Cheat River regional project watershed has the greatest number of riparian impacts for both the IRA and Line A (28 vs. 6). The greatest length of IRA riparian impact also occurs in this watershed (4,072 m, 12,330'), while the North Branch of the Potomac River regional project watershed contains the greatest length of riparian impact for Line A (457 m, 1,384').

Within both the Cacapon and Shenandoah River regional project watersheds, the IRA would impact a greater number and length of riparian buffer zone than would Line A. Both the Cacapon and Shenandoah River regional project watersheds contain sensitive water resources such as the Lost River, Baker Run and Duck Run. The loss of forested riparian buffers could result in an increase in water temperature and a reduction of the dissolved oxygen concentration. This could negatively affect existing aquatic organism populations, including the native brook trout (*Salvelinus fontanalis*) population in Duck Run.

(3) Mitigation

Where possible, alignments were developed to avoid riparian habitat areas. However, some encroachment upon the riparian buffer zone of perennial streams is unavoidable. One possible mitigation strategy would be to make design modifications during final design that would provide a minimum riparian buffer of 23 m (75'). A commitment could also be made to re-vegetate areas that are disturbed during the construction process within 23 m (75') of perennial streams. Several existing riparian buffers could also be improved through mitigation measures designed to enhance wildlife and/or water quality functions. Presently, 525 m (1,750') of perennial stream is bordered by an agricultural or disturbed land riparian buffer. This land use provides limited water quality benefits or wildlife habitat value. A riparian buffer zone management plan could be developed to plant tree and shrub species that would both increase sedimentation/nutrient reduction capabilities and provide more productive habitat for a variety of wildlife species. Where practical, additional ROW could be purchased for long reaches of parallel construction in agricultural areas. Riparian corridors in these areas could be fenced off to reduce livestock damage and promote natural revegetation.

TABLE 19

SUMMARY OF RIPARIAN IMPACTS BY WATERSHED: IRA AND LINE A

Regional Project Watershed	Number of Riparian Impacts in Each Biotic Rank Category								Length of Riparian Impacts in Each Biotic Rank Category (Meters)							
	IRA				Line A				IRA				Line A			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Tygart Valley River	0	1	5	4	0	0	5	0	0	37	160	169	0	0	170	0
Cheat River	3	22	3	0	1	1	2	2	347	3,335	390	0	59	48	44	295
N. Branch Potomac	0	0	0	0	0	1	0	3	0	0	0	0	0	146	0	311
S. Branch Potomac	0	0	0	2	0	2	0	0	0	0	0	766	0	514	0	0
Cacapon River	10	3	2	0	0	2	0	0	3,006	371	81	0	0	152	0	0
Shenandoah	2	2	0	0	0	0	0	0	565	236	0	0	0	0	0	0
Total	15	28	10	6	1	6	7	5	3,918	3,979	631	935	59	860	214	606

8. CULTURAL RESOURCES

Highway-related impacts to cultural resources include effects due to increased noise or potential visual impacts which have been considered in the direct impact assessment contained in the *Cultural Resources Technical Report*. The assessment of development-related secondary impacts to cultural resources is provided below. This section begins with a discussion of the methodology used in this analysis, followed by the results.

a. Methodology

Development-related secondary impacts to cultural resources have been assessed in three ways:

- Identification of any significant resources that are within 305 meters (1,000 feet) of the alternatives and falling within raw land areas predicted for residential and service-oriented development. These resources would be considered as undergoing potentially heavy impact;
- Identification of resources falling within intersection areas predicted for commercial development. These resources would be considered as undergoing potentially heavy or moderate impact, depending on the distance from the intersection and the nature of the resource;
- Identification of existing roads that are predicted to experience substantial increases in average daily traffic and associated noise impacts to any cultural resources;
- Archaeological sites identified by WVDCH as potentially experiencing secondary impacts due to proximity to the construction area or that may experience other secondary effects.

b. Development-Related Impacts: Build and IRA

There were no cultural resources identified that fall into the raw land areas predicted for residential and service-oriented development as described above. This would apply only to the Build Alternative as no residential development is predicted under the IRA.

The assessment of secondary impacts to cultural resources due to predicted commercial development is identical under both the Build and Improved Roadway Alternatives. Eight resources (Table 20) were identified that meet the constraints discussed above. Additionally, the WVDCH identified 46 resources (Table 20) that may be subject to secondary impacts from construction (borrow sites or work areas) or other development: 23 for the Build Alternative and 23 for the Improved Roadway Alternative. However, sufficient area exists for induced development that could avoid secondary impacts to significant cultural resources. Accordingly, secondary impacts, where projected, while constituting an Effect have not been deemed to be an Adverse Effect within the meaning of 36 CFR Part 800.5.

Investigation of substantial increases in average daily traffic showed that the IRA, when compared to the No-Build Alternative, resulted in differences of up to 7,000 vehicles/day (County 3/3) quadrupling the existing volumes. In most cases, the same route under the Build Alternative would experience a slight increase or a reduction in average daily traffic (ADT). Increases equal to or greater than 3,000 vehicles per day between the No-Build and the IRA and between the No-Build and Build Alternatives are presented in Table 21. Based on noise analysis investigations, six of the roads under the IRA (County 3/3, WV 55 Baker, WV 55 State Line, WV 93, US 219 Parsons, and US 219 Montrose) would experience noticeable increases in noise levels when compared to the No-Build Alternative. Of these, County 3/3 and WV 55 State Line would be considered moderate noise impacts. Under the Build Alternative, there would be no noticeable noise increases, with two of the roads experiencing a noticeable decrease in decibel level from existing conditions. While all cultural resources within the 30-Minute Contour have not been identified, it can be concluded that resources along the roads noted above could experience an Effect, possibly Adverse, under the Improved Roadway Alternative.

Consideration was given to the potential adverse impacts to which the historic district of Capon Springs might be exposed through project activity. While the authors appreciate the concerns of the Capon Springs management and owners, no objective evidence in the form of traffic models or other studies have come to their attention which would suggest that the project in its various forms would have a demonstrable Effect or Adverse Effect upon the Capon Springs National Register property. Factors mitigating against a finding of Effect or Adverse Effect include the lack of proximity of the property to the project area, and the "buffer zone" of approximately 5,000 acres owned by Capon Springs that surround the core property.

TABLE 20
PREDICTED SECONDARY IMPACTS TO CULTURAL RESOURCES

BUILD AND IMPROVED ROADWAY ALTERNATIVES: SITES PROXIMAL TO PREDICTED COMMERCIAL DEVELOPMENT	
RESOURCE NO.	RESOURCE TYPE & ELIGIBILITY
01-01	Prehistoric Site (PE)
01-03	National Gable Front & Wing Residence (PE)
02-04	National I-House (PE)
80-01	Queen Anne Residence (CE);
80-02	Pre-Railroad Tidewater Residence (CE);
142-01	Craftsman Side Gabled Residence (CE)
191-01	National Gable Front & Wing Residence (CE)
IBK-01	Historic Domestic Site (CE)

SITES IDENTIFIED BY WEST VIRGINIA DIVISION OF CULTURE AND HISTORY			
BUILD ALTERNATIVE		IMPROVED ROADWAY ALTERNATIVE	
RESOURCE NO.	RESOURCE TYPE & ELIGIBILITY	RESOURCE NO.	RESOURCE TYPE & ELIGIBILITY
35-03	Historic Domestic Site (CE)	29-01	Open Air Lithic Scatter (CE)
40-02	Historic Domestic Site (CE)	38-13	Prehistoric Civil War (CE)
42-02	Historic Domestic Site (CE)	44-01	Prehistoric Open Site (CE)
43-01	Quarry/Reduction Site (CE)	44-02	Historic Domestic Site (CE)
44-01	Base Camp (CE)	48-01	Prehistoric Open Site (CE)
44-02	Historic Domestic Site (CE)	163-01	Porterwood Mill (CE)
44-03	Historic Domestic Site (CE)	188-01	Prehistoric Open Site (CE)
44-04	Open Air/Lithic Surface (CE)	188-02	Prehistoric Open Site (CE)
58-03	Base Camp/Hunting Station (CE)	188-03	Prehistoric Open Site (CE)
108-03	Base Camp (CE)	189-01	Prehistoric Open Site (CE)
108-04	Base Camp (CE)	189-02	Prehistoric/Revolutionary War (CE)
109-01	Camp (CE)	IBK-04	Prehistoric/French and Indian War (CE)
117-01	Historic Domestic Site (CE)	IBK-08	Historic Farm Site (CE)
157-05	Prehistoric Site (CE)	IGG-02	Surveyor's Camp Site (CE)
164-02	Prehistoric Site (CE)	IMO-65	Prehistoric Open Site (CE)
164-03	Prehistoric Site (CE)	IMO-66	Prehistoric Open Site (CE)
182-02	Historic Domestic Site (CE)	IMO-72	Prehistoric Open Site (CE)
182-03	Historic Domestic Site (CE)	IWD-60	Historic Commercial Site (CE)
182-05	Camp (CE)	IWD-62	Prehistoric Open Site (CE)
182-06	Camp (CE)	IWD-64	Prehistoric Open Site (CE)
189-01	Transient Camp (CE)	IWD-67	Prehistoric Open Site (CE)
IBK-08	Historic Farmstead Remains (CE)	IWD-68	Prehistoric Open Site (CE)
IBK-11	Prehistoric Base Camp (CE)	IWD-69	Prehistoric Open Site (CE)

TABLE 21
2013 AVERAGE DAILY TRAFFIC VOLUMES FOR ROADWAYS PROJECTED TO EXPERIENCE AN INCREASE OF OVER 3000 VEHICLES

ROUTE	NUMBER OF LANES	ALTERNATIVES		
		NO-BUILD	IMPROVED ROADWAY	BUILD
Grant County 3/3	2	2,000	9,000	2,000
I-81	4	51,000	52,000	55,000
WV 32	2	7,000	13,000	5,000
VA 37	4	21,000	20,000	25,000
WV 55 @ Baker	2	3,000	9,000	1,000
WV 55 @ State Line	2	3,000	10,000	1,000
WV 93	2	3,000	9,000	4,000
US 17	4	47,000	47,000	52,000
US 50	4	17,000	15,000	24,000
US 219 Parsons	2	4,000	10,000	2,000
US 219 Montrose	2	4,000	11,000	1,000

III. CUMULATIVE IMPACT ANALYSIS

A. INTRODUCTION

Cumulative impacts are those impacts "which result from the incremental consequences of an action when added to other past and reasonably foreseeable future actions" (40 CFR 1508.7). Analysis of a project's cumulative impacts is a requirement of the National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality's NEPA regulations (40 CFR 1508). However, the subject has received limited treatment in the assessment of highway projects (Bank, 1992). In 1992, the FHWA issued a position paper which states, "to fulfill the general NEPA mandate of environmentally sensitive decision making, the FHWA and States must develop and use techniques to incorporate secondary and cumulative impact issues in the highway project development process" (Bank, 1992).

Cumulative impact assessments should consider the relationships between natural environmental components and how these individual components function as integral parts of a larger system. Studies should focus on the functional relationships of resources within larger systems. To properly evaluate cumulative effects on natural resources, the value of the resources in a watershed or regional ecosystem must be determined based on their relative contribution to the functioning of the entire landscape system (Preston and Bedford 1988, Whigham et al., 1988, Leibowitz et al., 1992). Southerland, in his report to the EPA entitled *Evaluation of Ecological Impacts from Highway Development* (1993), recognizes the need to put impacts in a broader and more meaningful ecological context when he states, "Although in some cases the ecological impacts may be limited to the highway corridor (e.g., 91 meters or 300 feet in width), impacts will often extend to the watershed or ecological region." To facilitate the analyses of cumulative impacts of this highway project in a broader ecological context, a watershed approach was adopted. For a more detailed discussion of the project watersheds, please see Section N of the SDEIS. Exhibit 2 depicts the regional project watersheds, and Back and Opequon Creek watersheds within the 30-Minute Contour.

B. CUMULATIVE IMPACT ANALYSIS -- APPROACH

The analyses of cumulative impacts that may occur as the result of construction of either the Build Alternative or the Improved Roadway Alternative (IRA), have in some areas been divided into three categories:

- those that are related to the overall additive effect of direct impacts;
- those that are related to the overall additive effect of direct and secondary impacts;
- those that are related to the development of foreseeable future actions.

Additive direct impacts are discussed by watershed in the various subject Technical Reports. Direct impacts were cumulatively totaled over broad environmental systems (watersheds) to allow comparisons between these systems. Leibowitz et al. (1992) suggest that an estimate of the value provided by a function (i.e. wildlife habitat) within a landscape watershed should be considered relative to other watersheds within the area of interest. A comparison of impacts to wildlife habitat and wetlands by watershed is summarized below.

Cumulative impacts related to the additive effect of combining direct and secondary impacts are summarized for wildlife habitat and wetland resources below. Secondary impacts can be considered "incremental consequences of an action" and should be added to "past actions" (direct impacts) to assess cumulative impacts.

Cumulative impacts related to the development of foreseeable future actions was limited to known Federal actions that are currently ongoing or are in the formulative stages of study. Five Federal actions were identified and impacts associated with these actions are discussed below.

C. CUMULATIVE IMPACT ASSESSMENT

1. WETLANDS

a. Additive Direct Impacts

Additive direct impact to wetlands by watershed are summarized in Table 22 for both the Improved Roadway and Build Alternatives. The IRA in West Virginia would cumulatively impact 63 individual wetlands, comprising 8.22 ha (20.32 ac), an encroachment area representing 0.07% of the predicted wetland area for the West Virginia Watersheds. The IRA in Virginia would cumulatively impact 17 individual wetlands, comprising 0.47 ha (1.14 ac), an encroachment area representing 0.18% of the predicted wetland area for the Virginia Watershed.

Line A in West Virginia would cumulatively impact 158 individual wetlands, comprising 14.92 ha (36.86 ac), an encroachment area representing 0.12% of the predicted wetland area of the West Virginia Watersheds. Line A in Virginia would cumulatively impact 7 individual wetlands, comprising 0.33 ha (0.82 ac), an encroachment area representing 0.13% of the predicted wetland area of the Virginia Watershed.

TABLE 22
WETLAND IMPACTS BY WATERSHED

Watershed		#	Hectares	Acres	% of Predicted Watershed Wetland Area
Tygart Valley River	Line A	17	2.00	4.95	1.29
	IRA	17	1.02	2.53	0.66
Cheat River	Line A	91	7.77	19.19	0.09
	IRA	27	4.88	12.06	0.05
North Branch Potomac River	Line A	10	3.38	8.35	0.18
	IRA	10	1.68	4.15	0.09
South Branch Potomac River	Line A	10	0.80	1.98	0.24
	IRA	8	0.56	1.39	0.17
Cacapon River	Line A	17	0.97	2.39	0.03
	IRA	1	0.08	0.19	0.02
West Virginia Total	Line A	158	14.93	36.86	0.12
	IRA	63	8.23	20.32	0.07
VA- Shenandoah River	Line A	7	0.33	0.82	0.13
	IRA	17	0.46	1.14	0.18

Leibowitz et al., (1992) presented three general categories of wetland functions that should be considered when evaluating cumulative impacts: habitat functions that provide support for wetland dependent species, including food, shelter, and breeding sites; water quality functions including water quality improvement, nutrient cycling and supply; and hydrologic functions such as flood attenuation and moderation of hydrologic flow. These functions are considered below.

Wildlife wetland habitat was assessed using the USFWS Habitat Evaluation Procedure (HEP). This procedure is discussed in detail in the *Vegetation and Wildlife Habitat Technical Report.* Overall, wetland habitat contributed less than 1% to the calculated HU total. The wetlands impacted appear to be of seasonal importance, providing limited breeding and feeding habitat during the spring and early summer. The majority of wetlands impacted for both Alternatives were relatively small palustrine emergent communities. As such, they did not provide vegetative habitat components in the quantities necessary to yield appreciable HU's for the chosen evaluation species. While small wetlands can play an important role in the population dynamics of many wetland associated small mammal, bird, amphibian, and insect species, the removal of this wetland area would not have a measurable cumulative effect on these wildlife populations within the regional project watersheds.

In addition, wetland mosaic patterns are an important feature for wetland associated species. Researchers have found that the approximate maximum migration distance for aquatic breeding amphibians, small birds, and small mammals is 1,000 m (3,280) (Gibbs, 1993). Gibbs also found that small wetlands (less than 4 ha, 10 acres) play an important role in the population dynamics of many wetland associated species by reducing interwetland distances, thereby increasing the probability of successful dispersal and increasing the number of individuals dispersing among patches within the wetland mosaic. Over 90 % of the delineated wetlands met this size criteria. Alteration of the existing wetland mosaic pattern could result in wetlands becoming "isolated" (greater than 1,000 m, 3,280 ft, from the nearest wetland) which could impact the population dynamics of wetland associated species. GIS analysis examined the existing wetland mosaic pattern of the field investigated wetlands. Four percent (20) of the existing delineated wetlands were determined to be isolated based on the above definition. The average minimum distance between existing wetlands was 240 m (790 ft).

Construction of the Build Alternative (Line A) could potentially isolate one (1) additional wetland by creating an inter-wetland distance greater than 1,000 m. Overall, the average minimum distance between wetlands would increase by 20 m to 260 m (850 ft). This increase in average minimum distance is not considered an impediment to those species present. Construction of the IRA similarly would isolate one small (< 0.5 hectare) wetland. Construction of either alternative would therefore not alter the current wetland mosaic pattern present.

A functions and values evaluation for each delineated wetland was conducted using the Wet 2.1 computer program. In summary, the WET 2.1 program assigns qualitative probability ratings to wetland functions and values including groundwater recharge, floodflow alteration, sediment stabilization, sediment/toxicant retention, and nutrient removal/transformation. All watershed wetlands generally had high to moderate functional probability values for the above functions. Of the wetlands impacted, 25% were predicted to lose their ability to perform the above functions. These wetlands averaged approximately 0.08 ha (0.2 ac) in total size and would likely have had limited functional capabilities. The cumulative impact of this wetland loss on watershed wetland functional values would be minimal considering the relatively small size of the impacted wetlands, and the relatively small percentage of total watershed wetlands they comprise (less than 1%).

b. Additive Direct and Secondary Impacts

The combination of direct and secondary impacts yielded a slight increase in wetland impact area due to secondary industrial park development. A 2.3 ha (5.5 ac) palustrine scrub/shrub community could potentially be impacted by the development of a new Grant County industrial park located in the North Branch of the Potomac River regional project watershed. This would represent an increase of 26% for wetland impacts associated with the IRA and a 15% increase of wetland impacts associated with Line A. However, for both Alternatives, this increased wetland impact area is less than 1% of the total predicted wetland area within the North Branch of the Potomac River regional project watershed. The loss of this wetland could impact floodflow alteration, sediment stabilization, sediment/toxicant retention, and nutrient removal/transformation functions within the immediate area. However, any development that removed equivalent wetland would be required to replace this acreage through compliance with Federal and state wetland regulatory guidelines. Proper design of the wetland replacement site should replace and possibly enhance lost functions and values.

c. Development of Foreseeable Future 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. Because sufficient raw land is available within the regional project watersheds to support predicted development (Table 5), encroachment on wetlands to support that development would not be necessary.

Five Federal actions and potential wetlands impacts associated with these actions were identified:

- Moorefield, WV, in cooperation with the USDA's Soil Conservation Service, is considering construction of a reservoir on Stony Run to provide sufficient raw water to accommodate future predicted demands (USDA-SCS, 1994);
- Moorefield, WV, in cooperation with the Corps of Engineers, is considering construction of levees along the South Fork South Branch Potomac River to provide flood protection (COE, 1990);
- the effort to establish the Canaan Valley National Wildlife Refuge;
- the continued multiple resource use management of the George Washington National Forest (USDA, FEIS George Washington National Forest, 1993);
- and the continued multiple resource use management of the Monongahela National Forest (USDA, FEIS Monongahela National Forest, 1986).

Table 23 summarizes the potential wetland impacts due to the above five Federal actions. Only the Moorefield floodwall project would involve future wetland impacts within the South Branch of the Potomac River watershed. Approximately .8 ha (2 ac) of forested wetlands would be removed by the construction of this project. Mitigation measures include land acquisition and planting of .8 ha of bottomland hardwood species to replace wetland functions and values lost (COE, 1990). The proposed Canaan Valley National Wildlife Refuge would protect the largest wetland complex in both West Virginia and the central and southern Appalachians (wetland complex over 3,400 ha in size). Both National Forests have prepared Final Environmental Impact Statements that propose no wetland impacts for the immediate future. State and Federal regulatory agencies would be consulted if proposed changes to forest management plans or objectives would impact wetlands.

2. WILDLIFE HABITAT

a. Additive Direct Impacts

Additive direct impacts to wildlife habitat (as measured by Habitat Units lost) by watershed are summarized in Table 24 for both the Improved Roadway and Build Alternatives. The IRA would cumulatively result in the loss of 2,968 HU's in West Virginia and 164 HU's in Virginia. Line A would cumulatively result in the loss of 6,145 HU's in West Virginia and 809 HU's in Virginia. Habitat Units lost in both Alternatives is less than 2% of the HU's found within the regional project watersheds.

Potential forest fragmentation due to direct impacts was assessed within the 30-Minute Contour. Table 25 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 (see the *Vegetation and Wildlife Habitat Technical Report* for a more detailed discussion). Based on the analysis of 1"=1000' scale photointerpreted mapping, a cumulative 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 neotropical migrant indicator species minimum breeding area requirements (Table 25), 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 forest habitat within the above mapped area and consequently less than 1% of the forest habitat within the 30-Minute Contour. 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.

A total of 1,585 ha (3,916 ac) of existing land would be altered due to construction of Line A. 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 affects 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.

A total of 780 ha (1,925 ac) of existing land would be altered due to construction of the IRA. 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.

TABLE 23
CUMULATIVE WETLAND AND WILDLIFE IMPACT ASSESSMENT MATRIX FOR FORESEEABLE FUTURE FEDERAL ACTIONS WITHIN 30-MINUTE CONTOUR

	WILDLIFE HABITAT IMPACTS	WETLAND IMPACTS	BIODIVERSITY IMPACTS	MITIGATION/ MANAGEMENT PLANS
FLOODWALL - MOOREFIELD, WV	Over 90% of impacts to cropland or urban land (21 ac)	1.9 acres forested wetlands	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	None, no wetlands identified in feasibility study	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 largest wetland complex in West Virginia and the central and southern Appalachians.	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	None proposed	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	None proposed	Plan to promote populations of management indicator species, including threatened and endangered species.	Comprehensive land and resource management plan

TABLE 24
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 25A
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 25B
FOREST PATCHES CREATED BY CONSTRUCTION ALTERNATIVES 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

b. Additive Direct and Secondary Impacts

The combination of direct and secondary impacts yielded an increase in HU's lost by the evaluation species due to predicted secondary development (Table 26). Predicted secondary development is an aggregate of intersection/interchange, residential and service-oriented development. The Shenandoah River regional project watershed would have the greatest cumulative loss of HU's, while the North Branch of the Potomac River regional project watershed would have the least. This calculated loss is based on a 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.

Long term cumulative effects of wildlife mortality due to collisions with motor vehicles has not been thoroughly researched. Over time, wildlife killed in greatest numbers would be those species with high population densities that are attracted to right-of-way habitat, such as edge associated birds, and small/medium sized mammals. Because research has shown that this mortality is density dependent, individuals killed represent a population surplus and as such, no long term effect on overall wildlife populations is expected.

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 were discussed previously. Table 23 summarizes the potential wildlife habitat impacts due to the above five 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 ac) of high habitat value trees and shrubs to replace 32 HU's 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 HU's/forested acre (based on SDEIS HEP study), this project would result in the loss of 203 HU's. However, the creation of open water habitat and 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.

TABLE 26
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***

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 which address the habitats 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.

3. STREAM SYSTEMS

The additive effects of direct impacts to stream systems has been evaluated on a watershed basis in the *Streams Technical Report*. The following assessment deals with the additive effects of direct and secondary impacts to streams.

With respect to streams and rivers, the significance and magnitude of potential cumulative impacts are closely associated with existing surface water conditions. A variety of studies have demonstrated the degradative influence of agricultural and urban land use on the diversity of fishes and other biota of streams (Larimore and Smith, 1963; Ragan and Dietemann, 1975; Klein, 1979; Goldstein, 1981; Karr et al., 1985; Scott et al., 1986; Steedman, 1988). The abiotic and biotic processes involved in stream degradation are often complex and reflect the types of human activities within a watershed (Steedman, 1988).

It is estimated that 70-90% of the waterways in the eastern United States have been drastically altered by human activities (Brinson et al., 1981; Swift, 1984; Hunt, 1985). It is clear that streams and rivers are a reflection of surrounding watershed land use. What is less obvious and in need of further investigation, is whether biotic communities respond to incremental changes within a watershed over time (Schindler, 1987; Karr, 1987). If biotic communities do behave predictably, then they are a suitable tool for measuring long-term cumulative effects at the watershed scale to that of a reference watershed.

The riparian zone, as defined by Hunt (1985), is the zone between rivers, wetlands, and adjacent uplands. This zone, which was previously discussed in this report, has the potential to buffer the stream channel from point and non-point sources of pollution. Recent studies have focused on the dynamics between terrestrial landscape patterns and its influence on a stream system's biotic diversity, which may serve as an indicator of an environment's "health". For example, streams and rivers within watersheds that are subject to agricultural, industrial, and commercial use would require a greater degree of developmental pressure to "significantly" alter the biotic communities established as a result of prior watershed development. Conversely, watersheds that are undeveloped and forested, are sensitive to developmental pressure and require less watershed degradation to alter biotic communities. The degree of biotic change is debatable as it relates to its ecological significance. A "significant" impact or alteration is defined here as a disturbance that permanently alters or degrades a stream system from which incomplete recovery is the result of such a disturbance. For example, if a stream possesses an average Biotic Integrity (BI) rank of "A", which assumes a great deal of similarity to its regional reference station, then the reduction in BI rank to "C" is of significance. However, if the stream is already impacted relative to its reference station (for example a BI rank of "C") then a greater degree of watershed degradation would be required before that particular stream assemblage would be altered such that it would receive a BI rank of "D". This is due to the broad ecological tolerance of species associated with degraded ecosystems.

In order to identify areas where such watershed degradation may potentially occur, a cumulative watershed impacts analysis was conducted. The analysis utilized in this study included baseline stream data (Rapid Bioassessment Protocol II results), basic water quality results, review of predominant local project watershed use, and a review of published information on spatial and temporal changes in community structure as a result of catastrophic events. The goal of this analysis was to predict, with some level of confidence at both the local project watershed scale and the regional project watershed scale, the magnitude and ecological importance of cumulative impacts as a result of the construction and operation of the project on surface water resources.

a. Methodology

In order to predict the significance or magnitude of an impact attributable to the construction and operation of the project, a clear understanding of baseline surface water conditions is required. The project traverses two ecoregions, both of which include "impacted" and "non-impacted" local project watersheds. Therefore, the project would have markedly different impacts to local project watersheds based on the particular local project watershed traversed.

Streams and rivers in the project area are systems that are subject to seasonal catastrophic events (i.e. flood events). Floods frequently "reset" macrophytic, macroinvertebrate, and fish communities by scouring biota out of long reaches of stream channels (Bilby, 1977; Gray and Fisher, 1981; Fisher et al., 1982, Kimmerer and Allen; 1982; Fisher 1983; Molles, 1985; Matthews, 1986; Harvey, 1987; Power and Stewart, 1987; Erman et al., 1988; Power, 1992). Large regional storm events trigger flooding of rivers in different watersheds such that watershed systems with different community structures and habitat quality are reset simultaneously. Also of importance is the fact that organisms in flood-prone streams and rivers have had long histories of exposure to floods and are constituted of species, many with short generation times, that can recover quickly (Power, 1992).

Similar to flooding, a number of streams within the project area are subject to organic and inorganic enrichment from allochthonous (terrestrial) sources (AMD, fertilizers, stockpiled poultry manure, cattle excrement, pesticides, herbicides) that consequently impact surface and ground water quality, aquatic habitat, and the metabolism of aquatic organisms. In addition to allochthonous sources, autochchthonous (in-stream) sources such as increased BOD as a result of detrital breakdown and siltation of interstitial zones, impact the types and diversity of macroinvertbrates that are capable of inhabiting a stream.

The elasticity or resiliency of a stream system to physical and biological disturbances is a complex and dynamic issue. Streams are systems that are both spatio-temporal and seasonal by nature. As Power (1992) points out, most natural communities exhibit a sharp drop in densities of organisms as a result of major disturbances (e.g., floods, fire, landslides). However, as communities recover, community structure and accrual of trophic level biomass may reflect historical accident, differential dispersal capabilities, and population growth rates of early colonizing species or those residual species that survived the period of disturbance. In this study, the degradation of a stream system was measured by its relative similarity to the regional reference stations as detailed in the *Streams Technical Report*.

For each stream system, land use, total habitat assessment scores, and BI ranks were identified. Exhibits 5 through 14, located at the end of Cumulative Impact Assessment, detail baseline stream conditions and land use data for the IRA and Line A. Color codes were used to distinguish differences between streams with differing BI ranks. For streams that possessed more than one sample point, BI ranks were averaged. Streams that were subject to AMD were identified with a separate color code.

b. Leading Creek Local Project Watershed

The Leading Creek project watershed system is subject to a number of anthropogenic pollutants. As a group, the average BI rank was 0.38 or a ranking of "C". This watershed exhibited a significant association (Pearson Correlation, adjusted squared multiple $r = 0.81$; Bartlett chi-square Statistic, $p < 0.001$; Appendix B) between total habitat assessment score and BI rank. This association suggests that there is a positive association between total habitat quality and the biotic integrity of this stream system. Because no defined functional relationship exists between these two parameters, it is assumed that other variables such as non-point source pollutants, geomorphology, and land use (as examples), also affect both parameters independently. As Exhibit 5 illustrates, the main-stem of Leading Creek is of moderately impaired water quality, with a number of its nonforested third order tributaries having severely impaired water quality.

Land use within the Leading Creek local project watershed is dominated by cattle grazing and agriculture. However, there are several wetland systems associated with the floodplain of Leading Creek. These forested and scrub-shrub wetlands enhance the water quality of Leading Creek by performing a variety of wetland functions (e.g., sediment trapping, flood flow alteration and retention, nutrient transformation). It is important to note that third order streams that emanate from within forested regions are of higher water quality than those that flow through agricultural zones (Exhibit 5). This relationship generally holds true for the entire project area between both ecoregions. Baseline conditions for this stream system indicate that Leading Creek is a stressed system. Evidence of severe flooding, low quality first order tributaries, uncontrolled agricultural runoff of fertilizers, animal excrement, and siltation are the predominant sources of pollutants. It is also assumed that fecal coliform levels within this watershed are high. Fecal coliforms, which are bacteria that inhabit the intestines of birds and mammals, are released into the environment through feces.

Projected cumulative impacts as a result of the construction and operation of either the IRA or Line A would not measurably alter baseline surface water quality within the Leading Creek local project watershed. This is based on the nature and history of on-going cumulative impacts (e.g., deforestation, conversion to grazing and agricultural production) within this watershed. The institution of sound watershed management practices would greatly enhance Leading Creek's potential as a warm water fishery and it's water quality to down stream users (Tygart River).

c. Shavers Fork Local Project Watershed

The Shavers Fork local project watershed within the vicinity of the IRA and Line A alternative is dominated by deciduous and mixed forests. As Exhibit 6 illustrates, the IRA would bridge Shavers Fork in the town of Parson in an area that is extensively developed. The IRA would follow US 219 adjacent to Haddix Run, a tributary that possesses both good riparian and aquatic habitat. In contrast, Line A would cross Shavers Fork upstream of the IRA within an undeveloped agricultural area. Line A would then traverse the Pleasant Run watershed, which is identified as a trout stream possessing excellent riparian habitat.

The IRA would have negligible impacts to the habitat and biotic integrity of Shavers Fork. Foreseeable cumulative impacts as a result of the IRA would include deforestation and increased sediment loads to Haddix Run. Additional development within this watershed is not anticipated. Haddix Run has been previously disturbed as a result of the construction and operation of US 219. However, the IRA could significantly reduce the biotic integrity of Haddix Run as a result of direct and secondary impacts. This is based on the proximity, number, and location of cuts adjacent to Haddix Run, which would alter surface water hydrology, water temperature, and would result in a loss of aquatic habitat due to sedimentation and encroachment into the floodplain of Haddix Run.

Line A would also have negligible impacts to the habitat and biotic integrity of Shavers Fork. It is believed that Line A could impact Pleasant Run for similar reasons as those outlined for Haddix Run. Although Line A would impact marginal riparian areas, Line A would require substantial deforestation and cuts on a regionally steep slope paralleling the entire length of Pleasant Run.

As a group, the average BI rank for the Shavers Fork local project watershed was 0.59 or a ranking of "B". This watershed also exhibited a significant positive association (Pearson Correlation, adjusted squared multiple $r = 0.906$; Bartlett chi-square statistic, $p = 0.025$; Appendix B) between total habitat assessment score and BI rank. Unlike the Leading Creek local project watershed, the Shavers Fork local project watershed is composed primarily of forest (Exhibit 6). All stream systems within this local project watershed are of moderate to high water quality and habitat value. Within this local project watershed, only Pleasant Run is reported to contain trout. Shavers Fork is stocked, but not within the vicinity of the project.

d. Black Fork Local Project Watershed

As a group, the average BI rank fore the Black Fork local project watershed was 0.59 or a ranking of "B". This watershed also exhibited a significant positive association (Pearson Correlation, adjusted squared multiple $r = 0.759$; Bartlett chi-square statistic, $p = 0.001$; Appendix B) between total habitat assessment score and BI rank. This local project watershed is composed of stream systems (North Fork of the Blackwater River, Long Run, Big Run, Pendleton Creek, Blackwater River, and Beaver Creek) with differing water quality. Within this local project watershed large portions of the watershed have been subjected to deep and surface coal mining. As Exhibit 7 illustrates, these areas include drainage areas for Beaver Creek, the North Fork of the Blackwater River, Pendleton Creek, Long Run and Middle Run.

The Black Fork River possessed a BI ranking of "C" within the vicinity of Parsons. Based on existing land use within this local watershed, it is anticipated that no significant cumulative impacts would be attributed to construction of either the IRA or Line A for this river.

Roaring Run, a native trout stream that received an average BI ranking of "B", would be impacted by construction of either the IRA or Line A. However, the IRA would impact this stream system to a greater degree than Line A. This local watershed is composed of forest, agricultural, and rangeland within its mid to lower basin and entirely forested near its headwaters. Aside from the construction and operation of the project, no additional alterations to this watershed are anticipated.

No significant cumulative impacts are anticipated for stream systems within the Monongahela National Forest (Big Run, Tub Run, Long Run, and Middle Run, North Fork Blackwater River). This is based on planned avoidance measures to minimize physical encroachments of stream channels and forested riparian buffer zones and the impact of AMD on the North Fork Blackwater River, and sections of Middle and Long Run. AMD has significantly impacted these stream systems (Exhibit 7).

No additional cumulative impacts are expected to occur within this local project watershed as a result of construction and operation of either alignment alternative. This is based on baseline surface water conditions of Pendleton Creek (BI rank = "C"), lack of foreseeable future development, existing land use adjacent to Pendleton Creek, and the proposed location of alignment crossings within this watershed.

Beaver Creek and a majority of its tributaries (Exhibit 7) received BI ranks of "C". Both the IRA and Line A parallel Beaver Creek and WV 93. The vast majority of Beaver Creek flows through exposed mine spoil areas, newly reclaimed areas, and large wetland systems (e.g., Elder Swamp). Many of the intermittent and perennial tributaries to this stream system showed evidence of AMD. Based on existing surface water quality and riparian habitat quality, no significant reduction in BI ranking is anticipated for this stream system. This stream system is significantly degraded to that of its reference stream. Additionally, in most instances, when the IRA and Line A diverge from WV 93, WV 93 is positioned between Beaver Creek and the IRA and Line A.

In summary, cumulative impacts as a result of the construction and operation of the facility could potentially impact five primary stream systems within the Black Fork local project watershed. These stream systems include the Black Fork River, North Branch of the Blackwater River, Pendleton Creek, and

Beaver Creek. However, based on existing water quality, local project watershed land use and the projected ancillary development (or lack of) within these local watersheds, it is concluded that only Roaring Run may be subject to a significant reduction in BI rank relative to reference stations as a result of either alignment alternative.

e. North Branch of the Potomac River Regional Project Watershed

This regional project watershed is divided into two local project watersheds which include the Stony River local project watershed and the Patterson Creek local project watershed (Exhibit 8). Suspected sources of pollution in the North Branch of the Potomac River include sediment runoff from agriculture, timbering, oil and gas exploration, and coal refuse piles. Acid mine drainage, primarily from abandoned mines also poses a major problem, but is generally limited to the drainage of the Stony River and Abrams Creek.

As a group, the Stony River local project watershed, possessed an average BI rank of 0.39 or a ranking of "C". This watershed did not exhibit a significant association between total habitat assessment score and BI rank (Exhibit 8). No measurable cumulative impacts are anticipated within this local project watershed as a result of the project.

As a group, the Patterson Creek local project watershed possessed an average BI rank of 0.55 or a ranking of "B". This watershed also exhibited a significant positive association (Pearson Correlation, adjusted squared multiple $r = 0.79$; Bartlett chi-square statistic, $p < 0.001$; Appendix B) between total habitat assessment score and BI rank (Exhibit 9). No measurable cumulative impacts are anticipated within this local project watershed as a result of the project.

f. South Branch of the Potomac River Regional Project Watershed

Existing land use within the South Branch of the Potomac River regional project watershed is dominated by deciduous forests, cropland, and pasture. Although the water quality of the South Branch is considered excellent and is renowned for its smallmouth bass (*Micropterus dolomieui*) fishery, a number of its tributaries within the regional project watershed are impacted by non-point source pollution associated with agriculture, cattle, swine, rabbit, poultry, and forestry production. Of growing concern is the effect of the poultry industry on ground and surface waters (USFWS, 1994; Constantz, 1990; Ritter, 1986; Ritter and Chirnside, 1987) and fecal coliform levels which may exceed clean water standards (Water Resources Board, 1990). Problems associated with expansion of this industry include floodplain disruption, silt and fecal contamination from improper disposal of poultry manure, and contamination from the improper disposal of dead poultry.

Results of the stream analysis indicate that small forested headwater streams are marginally productive with respect to macroinvertebrate diversity and density, yet are of high habitat and ecological value to the South Branch. However, many of these streams eventually flow through poultry, pasture, and grazing lands that are subject to non-point source pollution. These streams have been identified in Exhibits 10 and 11 and include the upper reaches of Toombs Hollow, long reaches of Walnut Bottom, Anderson Run, Dumpling Run, and Fort Run.

Baseline conditions for this regional project watershed indicate that it is a stressed system. Current and projected land use and lack of watershed management practices have led to a significant degradation of surface water resources in the lower reaches of streams within this local project watershed. Therefore, additional cumulative impacts to surface water resources as a result of the construction and operation of the project would be inconsequential when compared to that of existing land use impacts. Cumulative impacts to surface water resources would continue within this regional project watershed with or without construction of the facility. As is the case with Leading Creek, implementation of sound watershed management practices and restoration of forested riparian buffers would improve (i.e., increase in BI rank) baseline surface water resources.

As a group, the Anderson Run local project watershed possessed an average BI rank of 0.59 or a ranking of "B" (Exhibit 10). However, this watershed did not exhibit a significant association between total habitat assessment score and BI rank. The Main Channel of the South Branch local project watershed possessed an average BI rank of 0.27 or a ranking of "C". This watershed exhibited a significant positive association (Pearson Correlation, adjusted squared multiple $r = 0.68$; Bartlett chi-square statistic, $p = 0.001$; Appendix B) between total habitat assessment score and BI rank. The Clifford Hollow local project watershed possessed an average BI rank of 0.80 or a ranking of "A" (Exhibit 11). This watershed did not exhibit a significant association between total habitat assessment score and BI rank because of the small sample size (2 samples). No measurable cumulative impacts are anticipated within this local project watershed as a result of the project.

g. Cacapon River Regional Project Watershed

The Cacapon River regional project watershed can be divided into two distinct river systems. Those that drain into the Lost River (upstream of WV 55 bridge crossing) and those that drain into the Middle Cacapon River (beginning near Wardensville, WV).

The Cacapon River's water quality varies significantly depending on location and water level (Constantz et al., 1993). Both the Lost River and Middle Cacapon River sections receive non-point source pollutants and have been identified by Constantz et al. (1993) as being relatively more polluted than other stream reaches further downstream in the basin. It is also known that fecal coliform levels within this watershed are high, and depending upon the season, exceed state water quality standards (Constantz et al., 1993). Many of the non-point source pollution problems that plague the South Branch of the Potomac River were observed in the upper reaches of the Lost River basin and its tributaries. However, as a whole the Lost/Cacapon River system is in relatively "good" health (Constantz et al., 1993). The streams analysis performed for this study support those of Constantz et al. (1993). Furthermore, this report also identifies a number of tributaries to both stream systems within this regional project watershed that are either severely degraded or of excellent water quality.

With respect to foreseeable cumulative impacts, a number of impacts have already been identified as concerns for this regional project watershed. They include population growth, growth of the poultry industry, and multiple dam construction. The construction of the project may encourage growth in the region and the poultry industry. The third projected impact (multiple dam construction) would permanently alter the Lost/Cacapon River system. Dams constitute the "death" of a free-flowing river in that they turn a river into a series of navigation pools, whereby species that require shallow flowing water and riffles would be extirpated from the river system. For example, many daces, darters, macroinvertebrates, and freshwater mussel could be lost.

Skaggs Run local project watershed possessed an average BI rank of 0.54 or a ranking of "B" (Exhibit 12). This watershed did not exhibit a significant association between total habitat assessment score and BI rank. Skaggs Run is located at the western edge of the Cacapon watershed and drains toward the North River, a major tributary to the Cacapon River north of the project area. Skaggs Run flows through a combination of mixed forest and agricultural land. The construction and operation of either the IRA or Line A is not expected to induce cumulative impacts within this local project watershed. Presently this local project watershed is already subject to nonpoint source pollution from poultry, cattle, and crop production.

The Baker Run local project watershed possessed an average BI rank of 0.77 or a ranking of "B". This watershed includes Baker Run, Long Lick Run, Camp Branch, Parker Hollow Run, and Bears Hell Run. This watershed exhibited a significant positive association (Pearson correlation, adjusted squared multiple $r = 0.96$; Bartlett chi-square statistic, $p = 0.016$; Appendix B) between total habitat assessment score and BI rank. Both proposed alignments generally parallel Baker Run from its confluence with the Lost River to its headwaters (Exhibit 12). Construction of the project could facilitate cumulative impacts to surface waters within this local project watershed by increasing the expansion of livestock and poultry production and the ensuing changes in habitat associated with these industries.

The Central Cacapon River local project watershed possessed an average BI rank of 0.58 or a ranking of "B". This watershed did not exhibit a significant association between total habitat assessment score and BI rank. This was due to several first order stream samples possessing high total habitat assessment scores but low Biotic Integrity scores. These headwater streams are located on steep forested slopes and are naturally low in macroinvertebrate diversity and density (Exhibit 12). The IRA and Line A would follow the Lost River north of WV 55 (from Hanging Rock to WV 55 bridge crossing), however, there would be no physical impacts to the river channel or its riparian buffer zone (this also includes Sauerkraut Run, a wild trout stream). As Exhibit 12 illustrates, the majority of this local project watershed is forested, adjacent to George Washington National Forest, and not conducive to floodplain development. Therefore, no foreseeable cumulative impacts to this local project watershed would be attributed to construction of either alternative.

The Waites Run local project watershed possessed an average BI rank of 0.76 or a ranking of "B" (Exhibit 13). This watershed exhibited a significant positive association (Pearson Correlation, adjusted squared multiple $r = 0.98$; Bartlett chi-square statistic, $p = 0.002$; Appendix B) between total habitat assessment score and BI rank. Both Waites Run and Trout Run are stocked trout streams that drain into the Middle Cacapon. Both these streams are productive coldwater fisheries. One foreseeable cumulative impact as a result of constructing either alternative would be an increase in fishing pressure on these streams. However, this impact is a positive economic/recreation impact for Wardensville.

Lastly, the Slate Rock Run local project watershed (Exhibit 13) possessed an average BI rank of 0.73 or a ranking of "B". This watershed did not exhibit a significant association between total habitat assessment score and BI rank. Because this local project watershed is located within the George Washington National Forest, no cumulative impacts are anticipated.

h. Shenandoah River Regional Project Watershed

The Shenandoah River regional project watershed, which is wholly within Virginia, is composed of deciduous and mixed forests, cropland, and pasture. Streams potentially impacted within this local project watershed include Duck Run, Eishelman Run, Turkey Run, Zanes Run and Mulberry Run. The headwaters of Town Run are located along the eastern end of the project area. As Exhibit II-10 illustrates, the Duck Run and Cedar Creek watersheds are dominated by forest while tributaries to Turkey, Mulberry, and Town Run are dominated by farmland. For sub-watersheds that are dominated by agriculture and cattle production, existing impacts include low quality first order tributaries, organic loading from fertilizers and animal excrement, and siltation. Duck Run, which is protected as an Outstanding State Waters resource, and a headwater tributary to Paddy Run, are native trout streams. Cedar Creek, which is stocked under VA's put-and-take program, is listed on the Nationwide Rivers Inventory. These sub-watersheds are more sensitive to watershed degradation than those currently impacted by agricultural development (Mulberry Run and Town Run).

As a group, the Cedar Creek local project watershed possessed an average BI rank of 0.54 or a ranking of "B". This watershed did not exhibit a significant association between total habitat assessment score and BI rank. Cumulative impacts could occur within the Duck Run local project watershed. Although this watershed is wholly within the George Washington National Forest, there is the potential for aquatic habitat degradation a result of deforestation, increased surface water temperature, and alterations in surface flow. It is speculated that consistent water chemistry, baseline flow, and low water temperature are important reasons Duck Run can maintain native trout throughout the year. Both the IRA and Line A (including Option Alignments) would traverse a large portion of the Duck Run watershed (see the Alignment and Resource Location Plans, Sheets 67 and 68). The IRA would require more encroachments to Duck Run while Line A and Option Alignments would require substantial cuts and deforestation. These impacts are discussed in the Environmental Consequences Section of this report.

No additional significant cumulative impacts to surface waters are anticipated within this regional project watershed based on existing land use and baseline aquatic habitat conditions.

i. Foreseeable Future Federal Actions

The Canaan Valley Wildlife Refuge is a preservation measure, and as such, is a positive impact to the stream systems and aquatic habitat in this portion of the Cheat River Watershed. Stony Run Dam would impact the flora and fauna of the Stony Run watershed. However, these impacts are not associated with those of direct or secondary nature due to the proposed project, and are not expected to have a combined effect on the watershed. The Moorefield floodwall project would have temporary impacts on the aquatic habitat within the South Branch channel but would have no long term effects. Therefore, no cumulative impacts of this action are anticipated. The Monongahela and the George Washington National Forests adhere to Best Management Practices in the preparation of erosion and sedimentation control plans.

j. Conclusions

Highway-related secondary impacts would be due to riparian buffer zone encroachment and deforestation. Under the IRA, three stream systems would experience such impacts: Haddix Run and Roaring Run in the Cheat River watershed, and Duck Run in the Shenandoah River Watershed. Under the Build Alternative, Pleasant Run and Roaring Run in the Cheat River watershed and Duck Run would experience secondary impacts. It is not anticipated that these impacts would measurably affect the Cheat River or the Shenandoah River watersheds. In summary the overall Biotic Integrity ranking of the local project watersheds within the Cheat River and the Shenandoah watersheds was "B", moderately impaired. In view of this ranking, the impacts anticipated are not expected to reduce the BI to rank "C". Additionally, riparian buffer zone encroachments can be mitigated, along with the ability to further minimize the lengths of buffers less than 23 meters (75 feet) during final design.

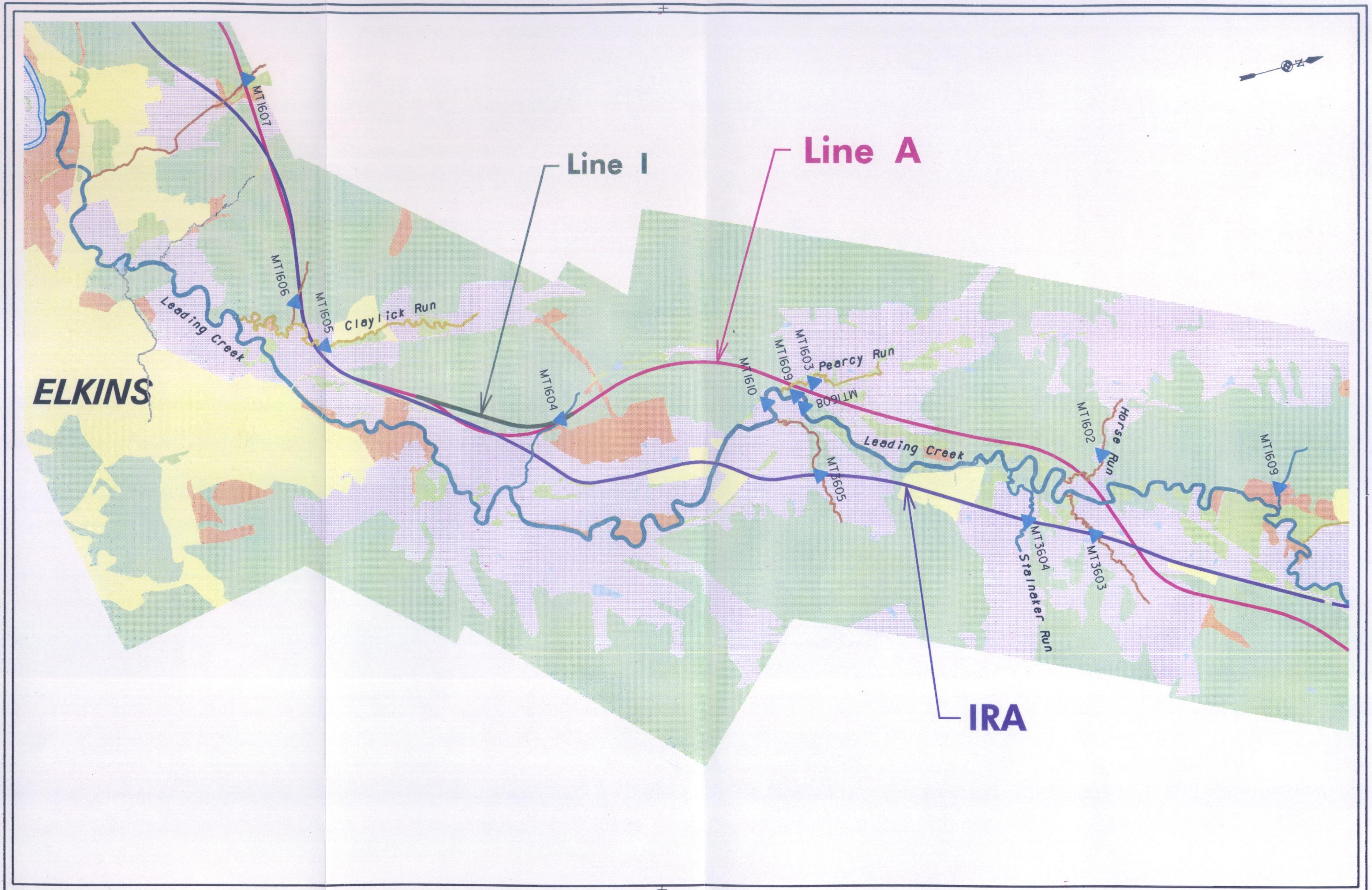
Roaring Run would experience the additive effects of direct and secondary impacts under the Build Alternative based on total enclosures and deforestation, respectively. No stream under the IRA would experience measurable cumulative effects due to direct and secondary impacts.

The only identified potential development-related impact to streams is associated with the Grant County Industrial Park and Four Mile Run. This impact could be avoided during site planning efforts of the park. A study of the direct impacts in the North Branch of the Potomac River watershed indicates that cumulative effects in this watershed would be minimal. The BI of the streams studied in this regional project watershed are ranked as "C", impaired and "B", moderately impaired, for the Stony River and Patterson Creek watersheds. Existing land use and minimal predicted residential development are not expected to reduce the Biotic Integrity to "C".

4. CULTURAL RESOURCES

The additive effects of direct impacts on cultural resources have essentially been quantified in the *Cultural Resources Technical Report*. The evaluation system used in order to make a Determination of Effect on a given resource consisted of the "addition" of physical, visual and auditory effects. Inasmuch as this system also evaluated secondary impacts, this technique has also considered the additive effects of direct and secondary impacts to cultural resources.

Relative to the cumulative impact on cultural resources based on the five foreseeable future actions, all such actions are subject to the same scrutiny as the project in accordance with Section 106 of the National Historic Preservation Act. Further, the Canaan Valley Wildlife Refuge is in itself a preservation measure and would not impact cultural resources. The Stony Run Dam is located such that potentially effected resources would not constitute additional effects to those identified by the proposed action. Site identification, determinations of eligibility, and mitigation measures for potential effects on cultural resources relative to the Moorefield Floodwall Project are currently underway. Further, the results of these efforts served as background information and basis for the predictive settlement pattern model discussed in the *Cultural Resources Model Test Report*. The management plans for the Monongahela and the George Washington National Forests would primarily involve potential effects to archaeological resources on federal lands. It is not possible at this time to determine whether or not Forest Service activities would affect, in some cumulative fashion, the resources also affected by the proposed action.



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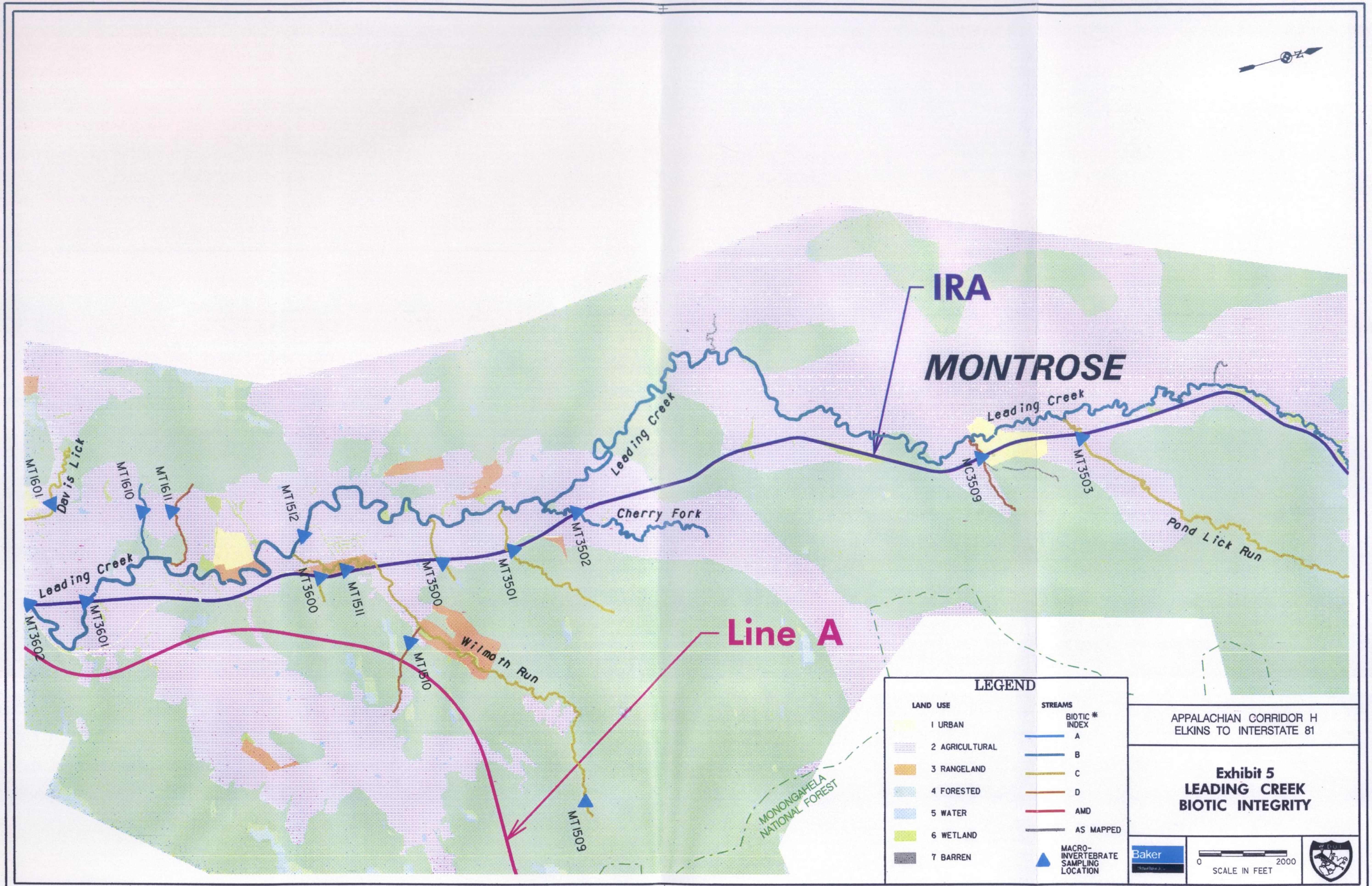

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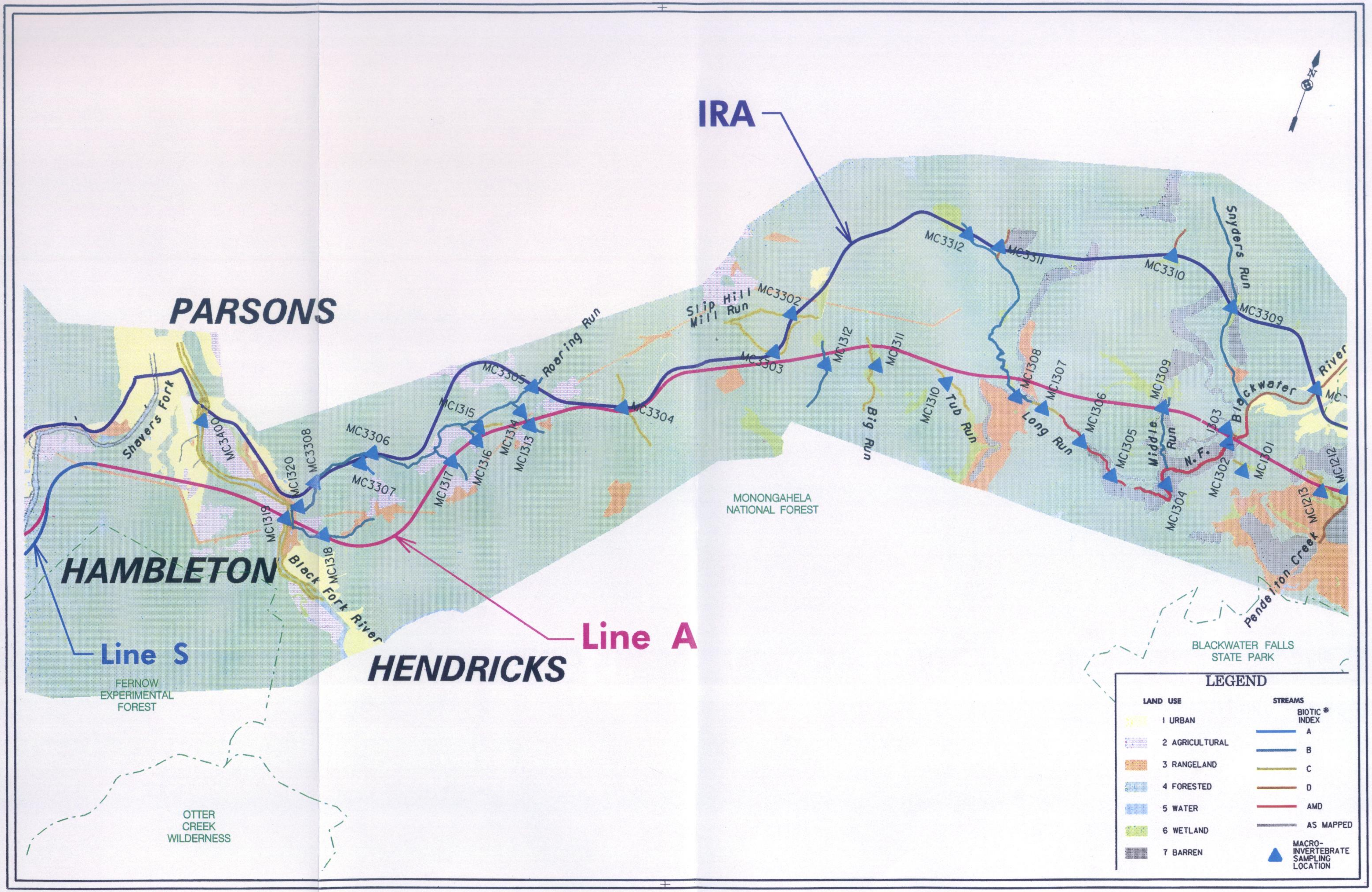

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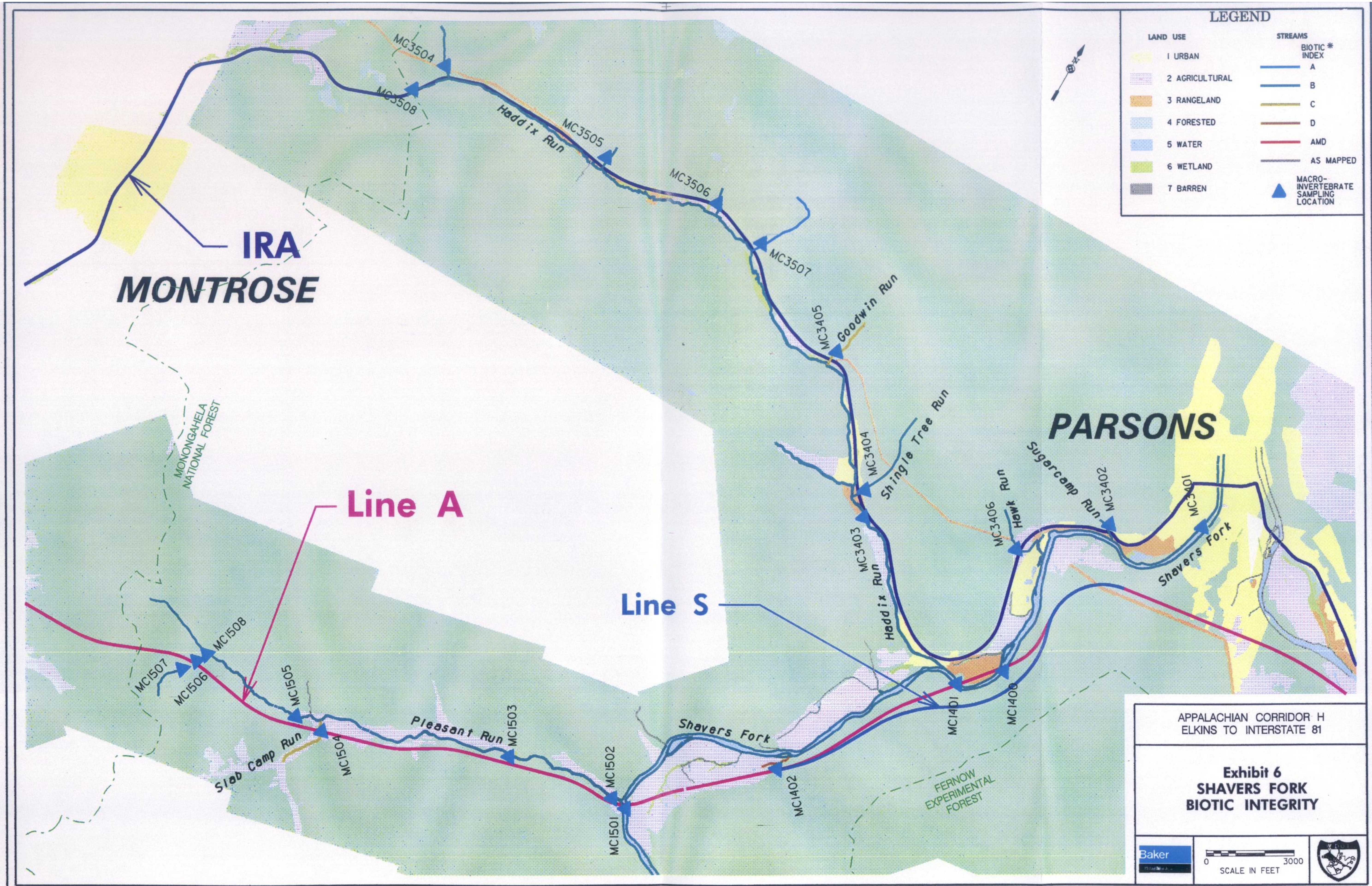

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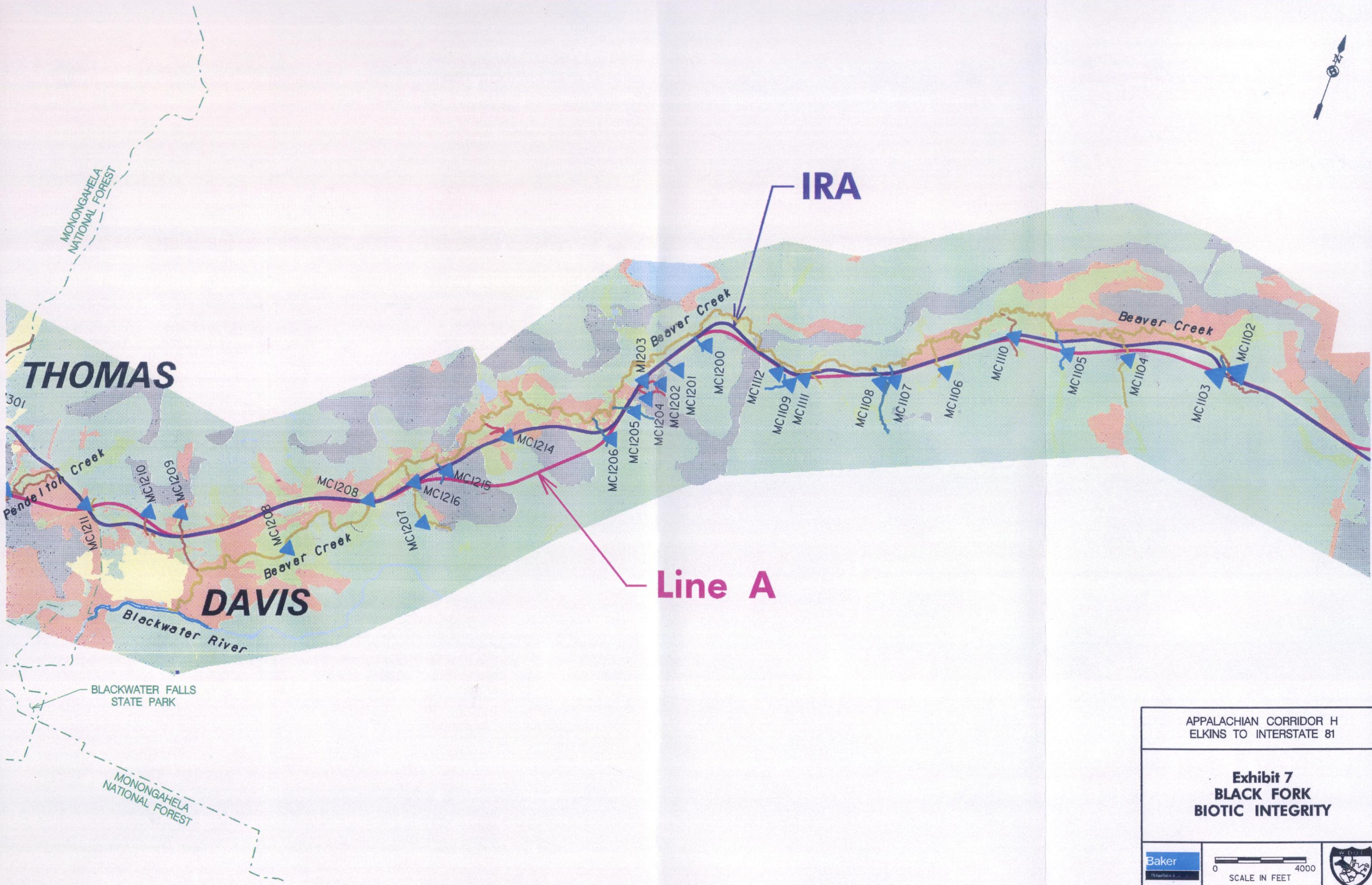

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Exhibit 7
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BIOTIC INTEGRITY

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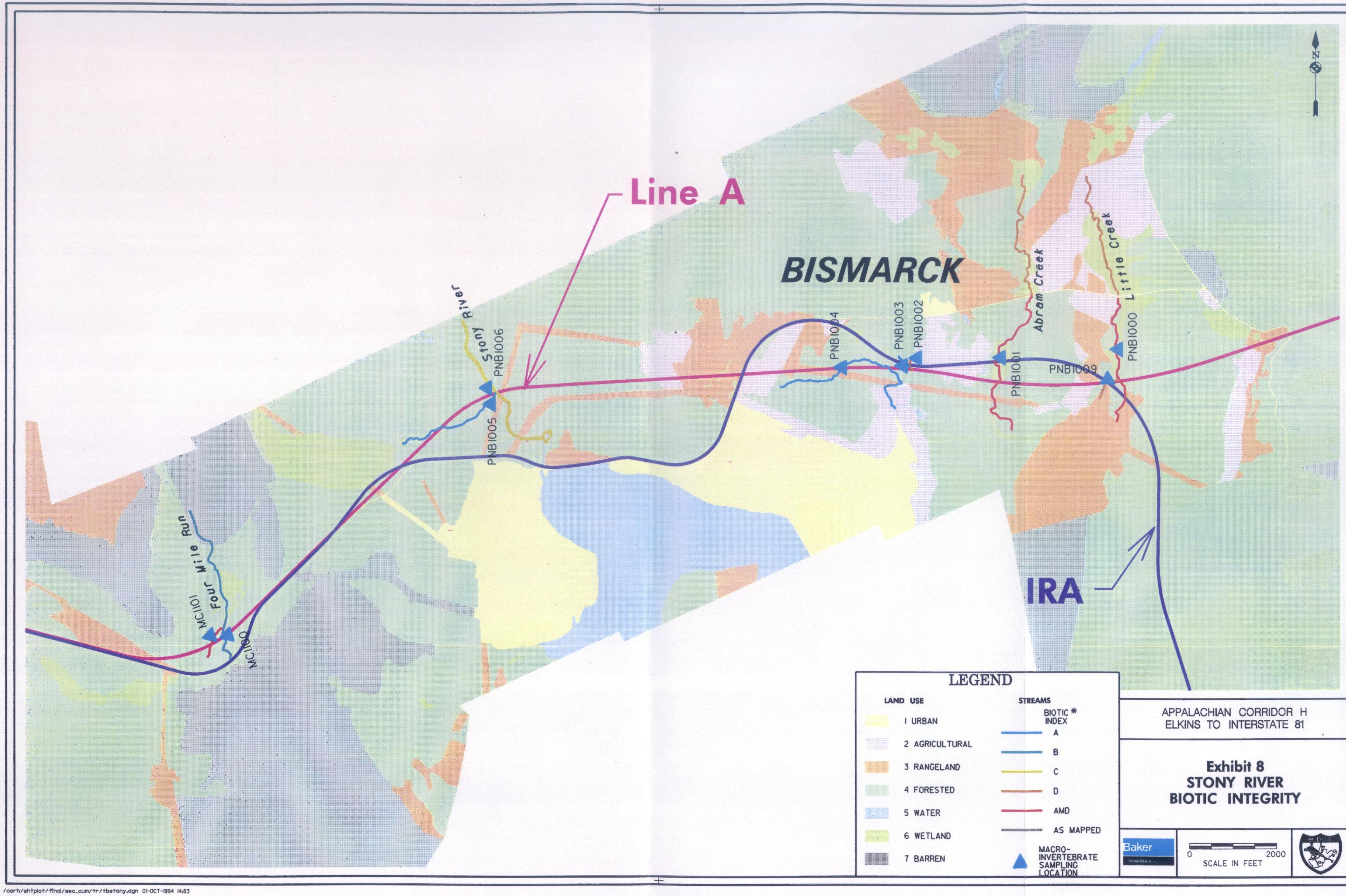
Line A
BISMARCK
Stony River
Abram Creek
Little Creek
Four Mile Run
PNB1006
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PNB1009
MC1101
MC1100
IRA
LEGEND
LAND USE
1 URBAN
2 AGRICULTURAL
3 RANGELAND
4 FORESTED
5 WATER
6 WETLAND
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STREAMS
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A
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Exhibit 8
STONY RIVER
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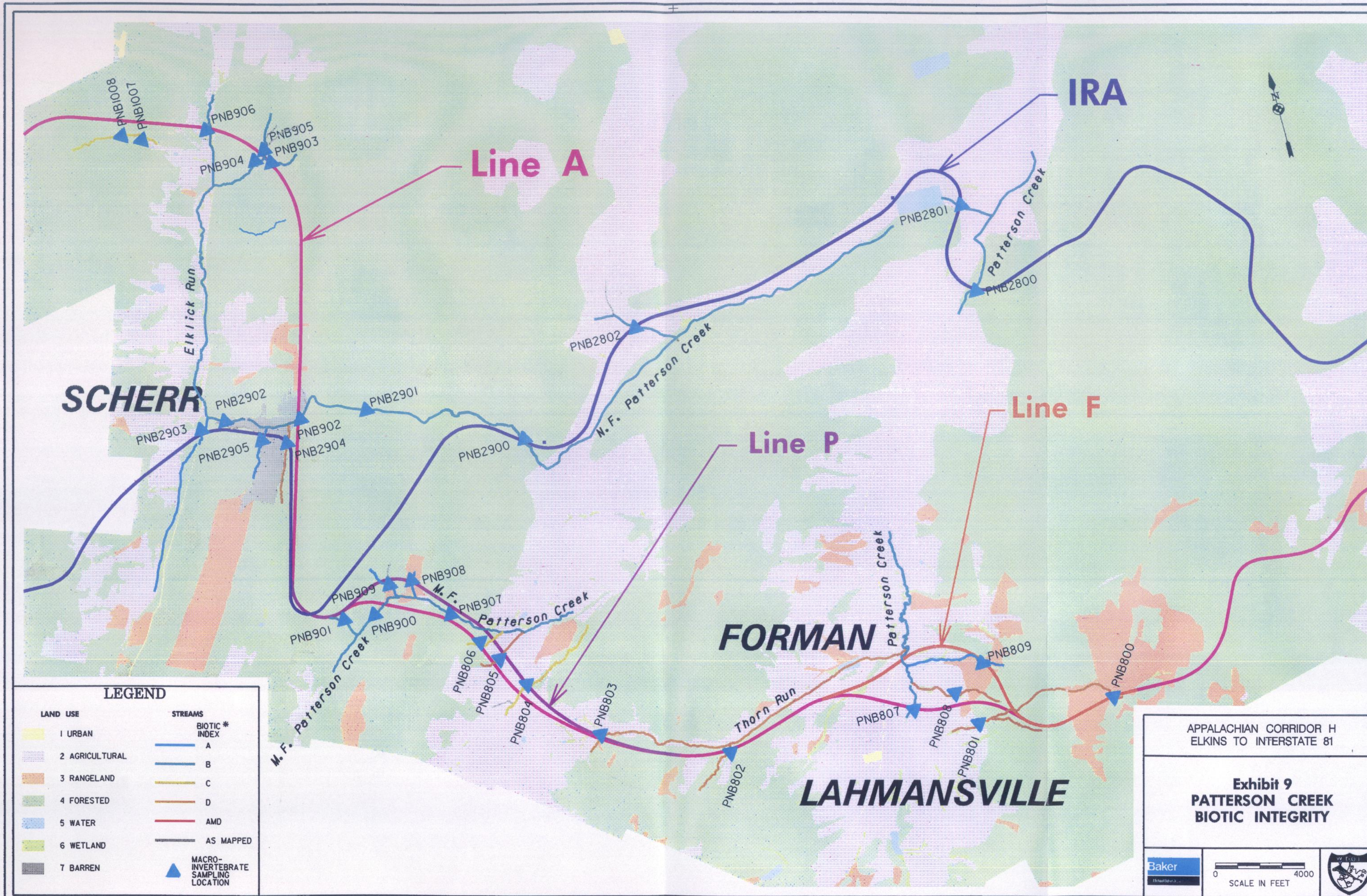

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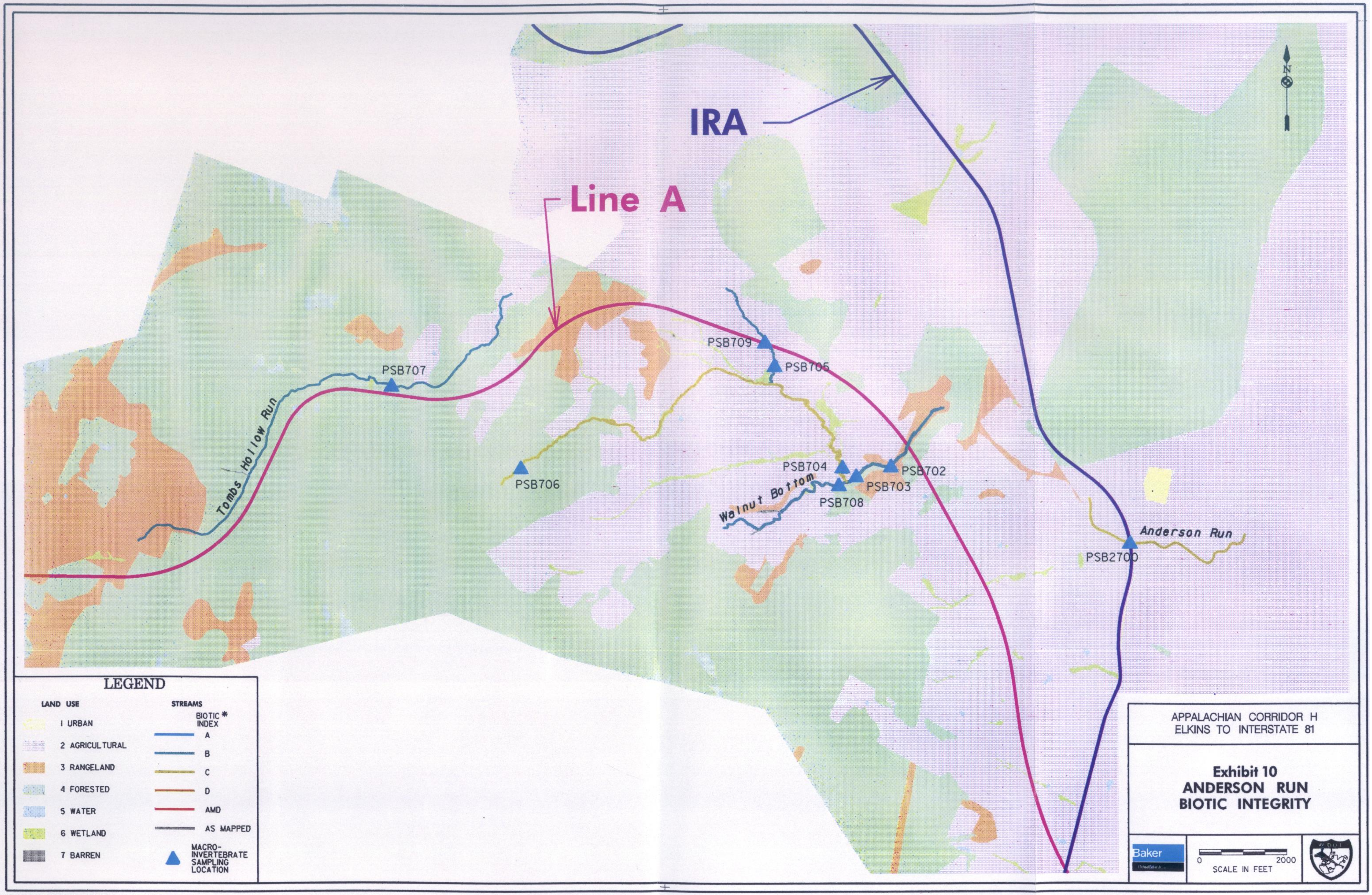

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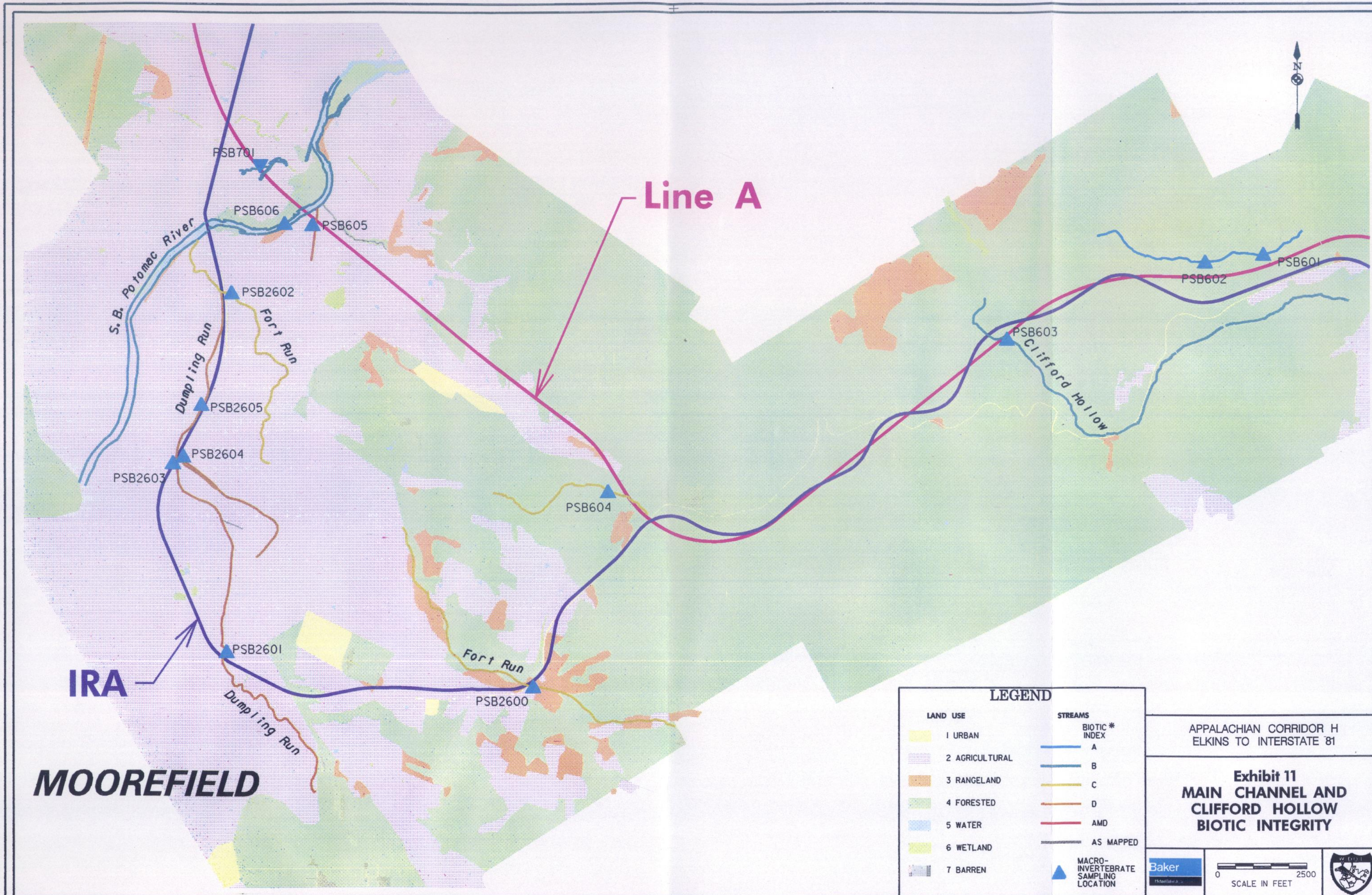

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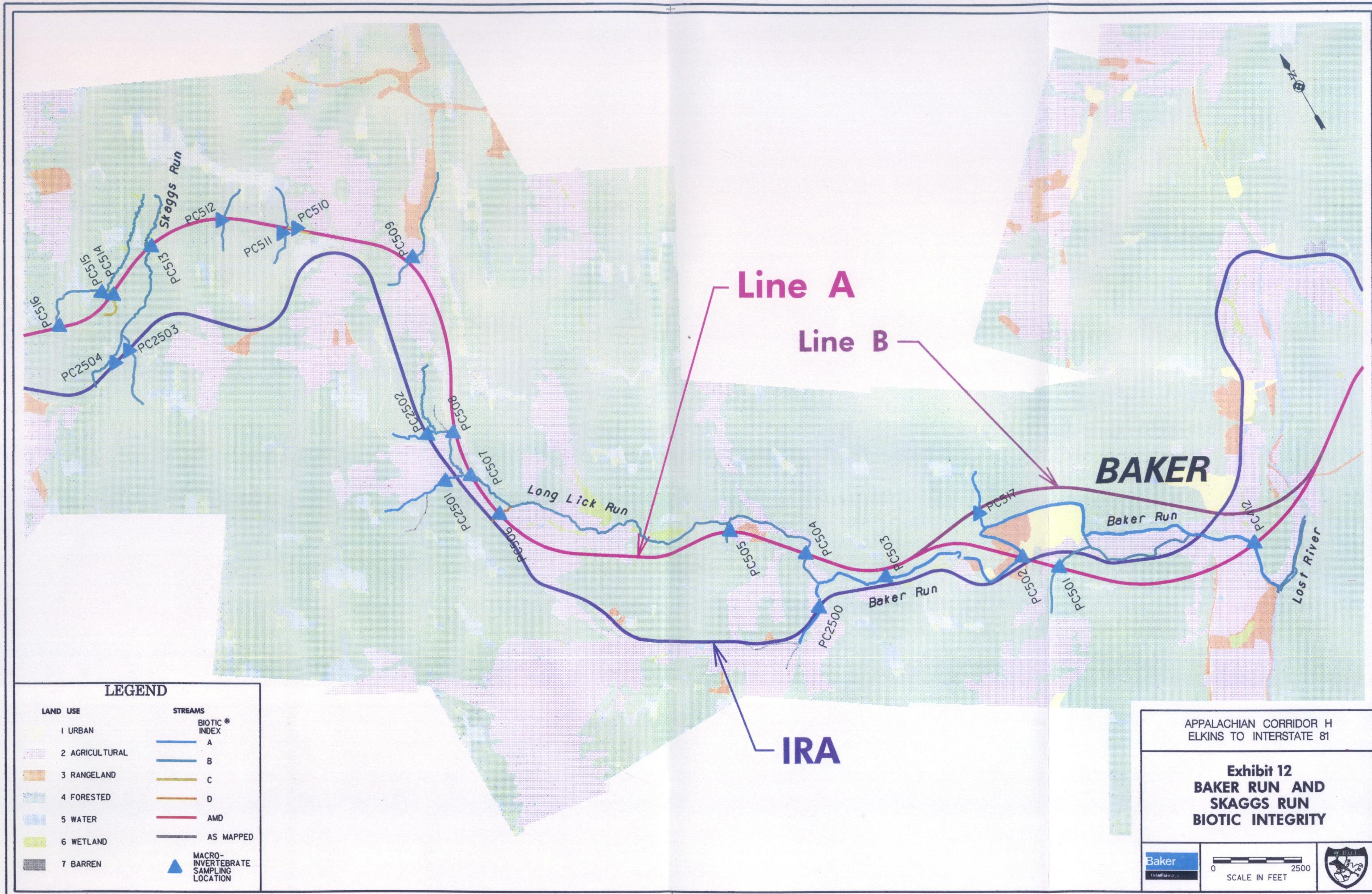

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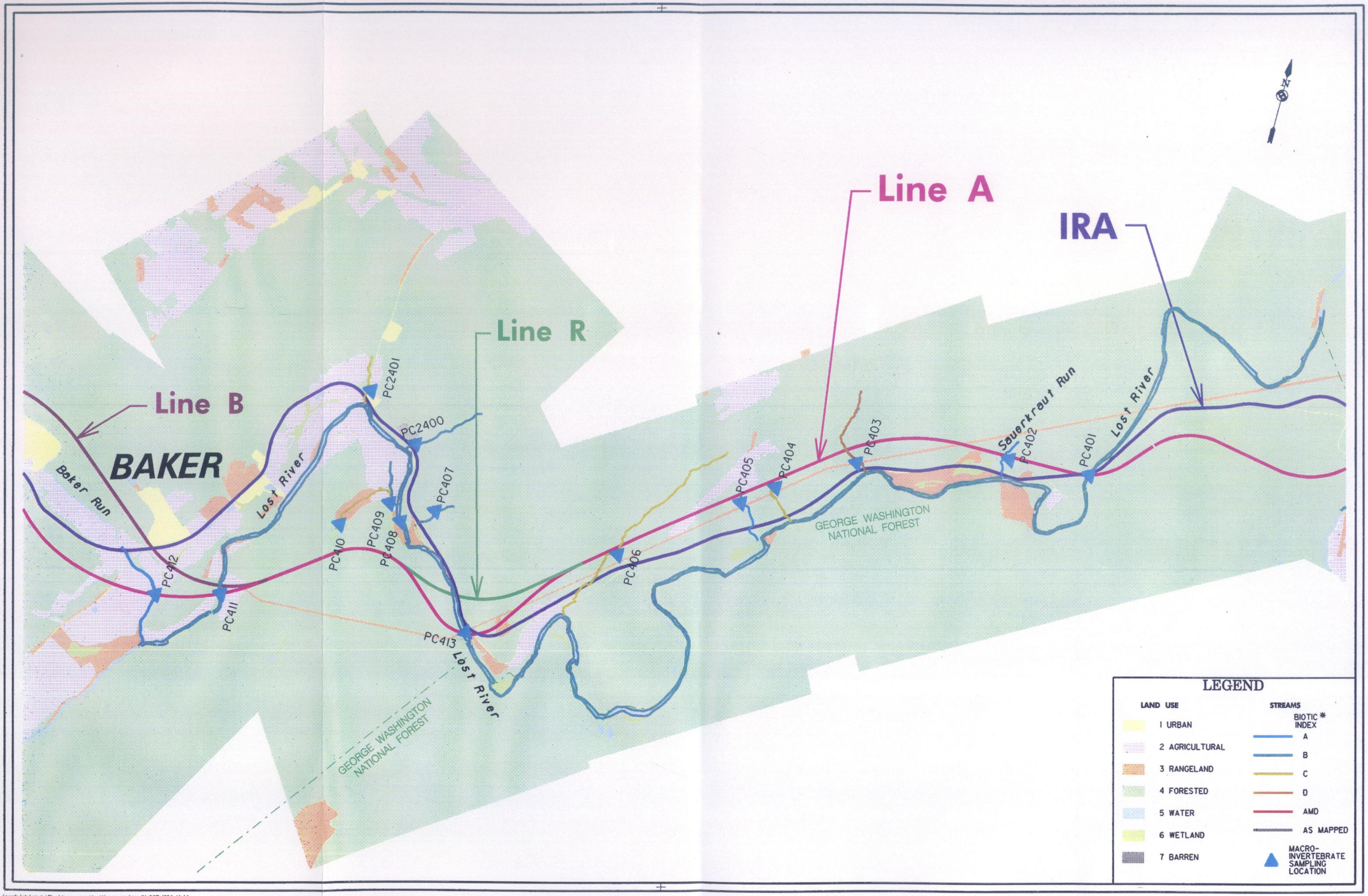

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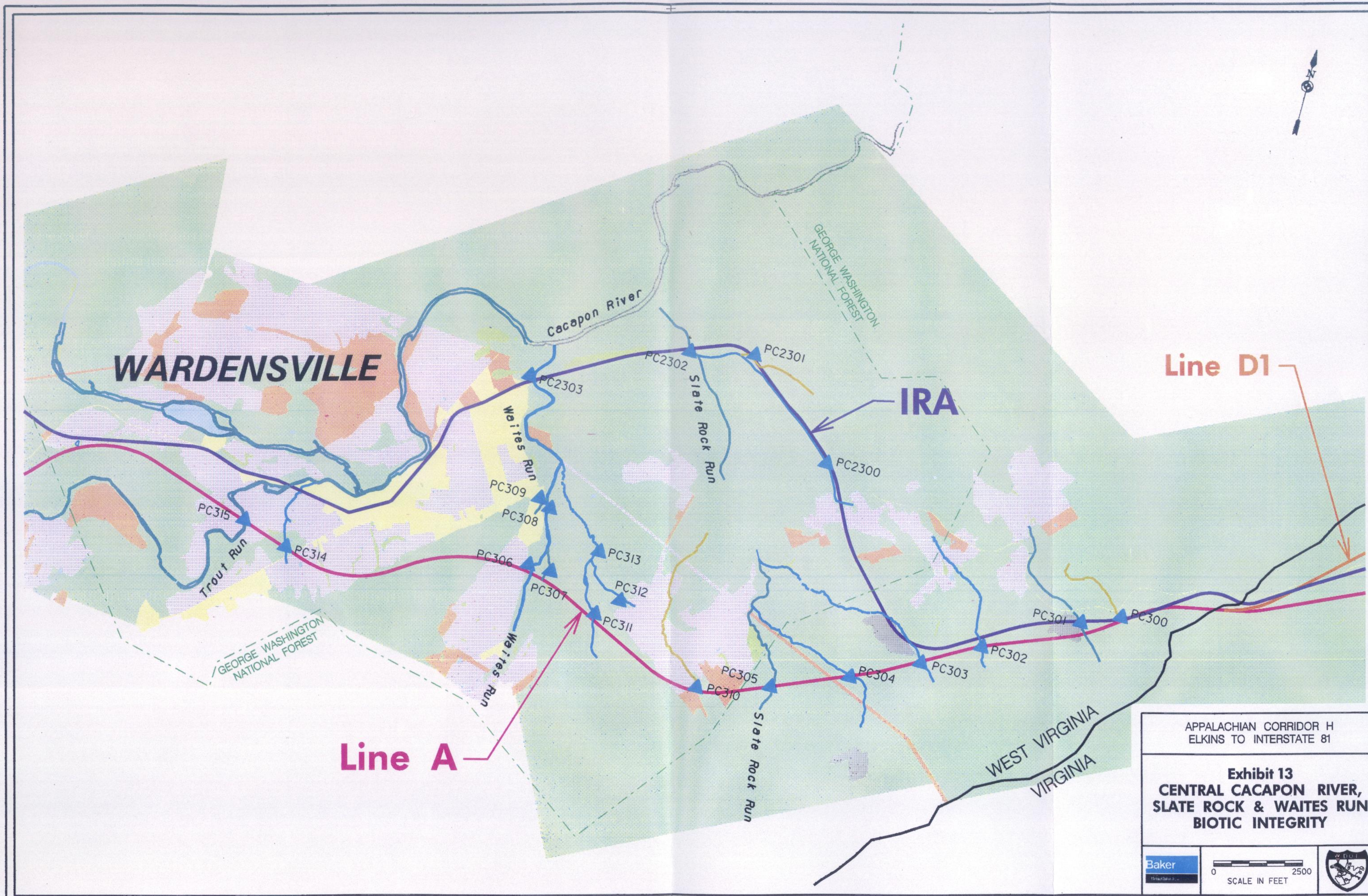

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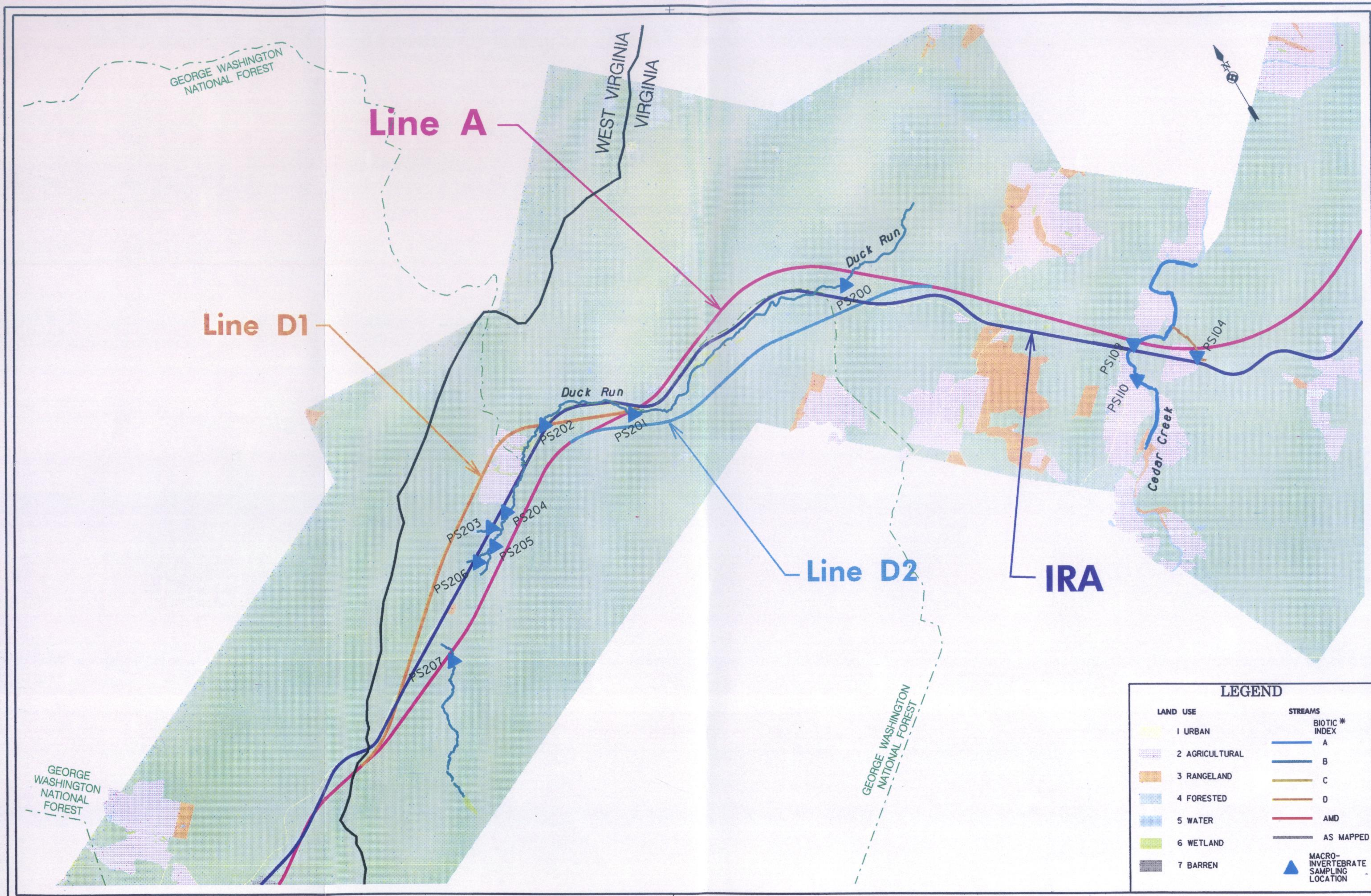
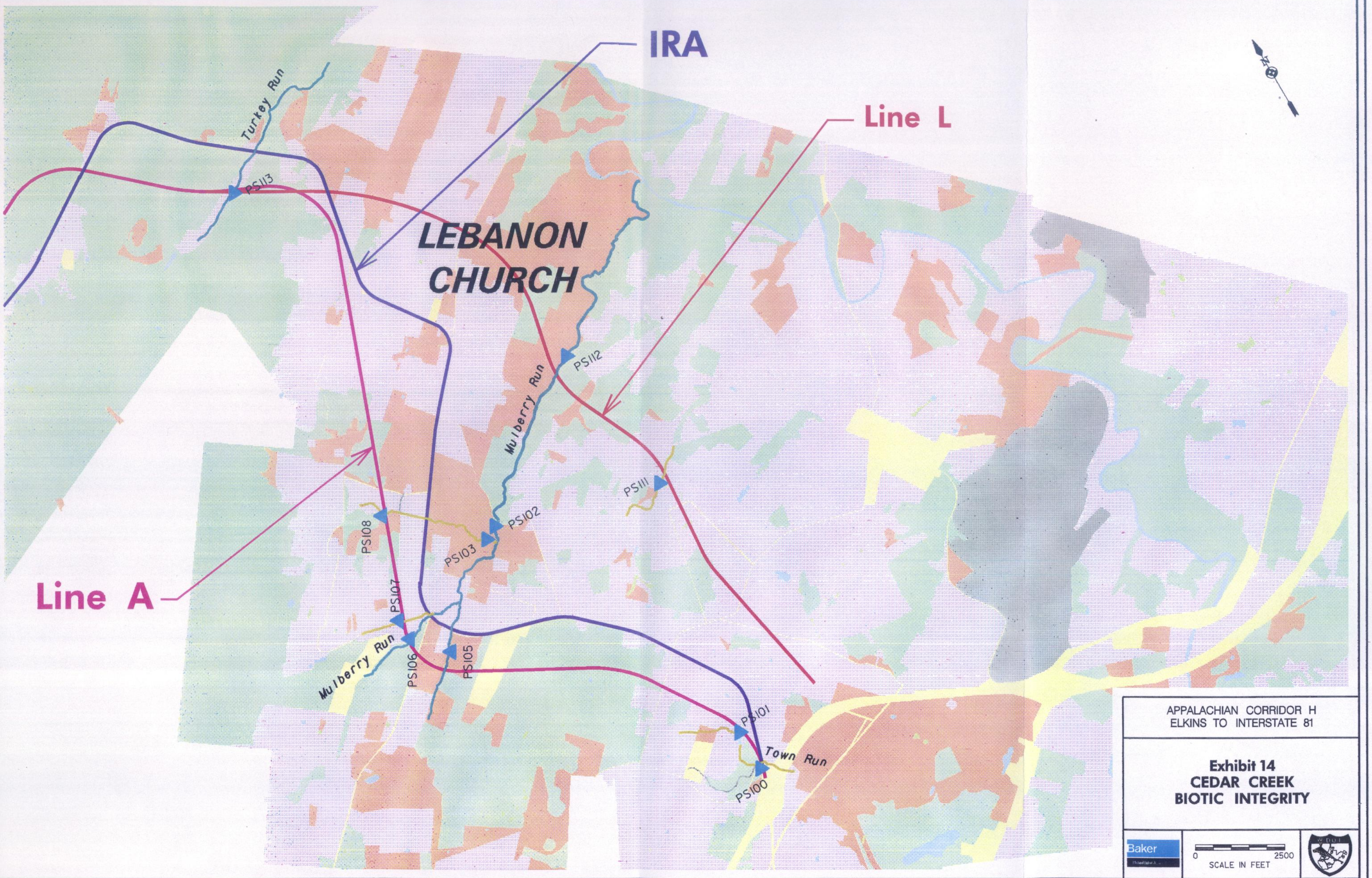


GEORGE WASHINGTON NATIONAL FOREST
WEST VIRGINIA
VIRGINIA
Line A
Line D1
Line D2
IRA
Duck Run
Cedar Creek
PS200
PS201
PS202
PS203
PS204
PS205
PS206
PS207
PS109
PS110
PS104
LEGEND
LAND USE
1 URBAN
2 AGRICULTURAL
3 RANGELAND
4 FORESTED
5 WATER
6 WETLAND
7 BARREN
STREAMS
BIOTIC* INDEX
A
B
C
D
AMD
AS MAPPED
MACRO-INVERTEBRATE SAMPLING LOCATION
/corh/shtplot/final/seo_cum/tr/tbcedar2.dgn 01-OCT-1994 14:46



APPALACHIAN CORRIDOR H
ELKINS TO INTERSTATE 81

Exhibit 14
CEDAR CREEK
BIOTIC INTEGRITY

/corh/shtplot/final/sea_cum/tr/tbcedar.dgn 01-OCT-1994 14:46

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