ROUTE 29

CORRIDOR STUDY

CITY OF CHARLOTTESVILLE AND ALBEMARLE COUNTY

TECHNICAL MEMORANDUM
FOR ENVIRONMENTAL IMPACT STATEMENT

AIR QUALITY ANALYSIS

6029-002-122, PE 100

U.S. Department of Transportation
Federal Highway Administration
and
Virginia Department of Transportation

April 1990

AIR QUALITY ANALYSIS

TECHNICAL MEMORANDUM FOR ENVIRONMENTAL IMPACT STATEMENT

ROUTE 29 CORRIDOR STUDY

STATE PROJECT: 6029-002-122, PE 100

FEDERAL PROJECT: F-

FROM: ROUTE 250

TO: NORTH FORK RIVANNA RIVER

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

REGION 3

AND

VIRGINIA DEPARTMENT OF TRANSPORTATION

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I. INTRODUCTION

Federal Regulations which implement the Clean Air Act of 1970, amended in 1977, and the National Environmental Policy Act of 1969, require that air quality be considered in the preparation of environmental documents for federally funded highways. The Clean Air Act also required that air quality standards be established for criteria pollutants and that all states implement plans to attain and maintain these standards. The U.S. Environmental Protection Agency has promulgated National Ambient Air Quality Standards (NAAQS) for six atmospheric pollutants: Carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, particulates, and lead. Transportation projects should be designed so that they do not cause violations of the NAAQS. Therefore, effects on air quality are among the many types of impacts that must be addressed when evaluating highway projects.

In this report, the air quality impacts for the U.S. Route 29 Corridor Study are addressed. The Corridor Study identified and evaluated transportation alternatives for improving traffic conditions on U.S. Route 29 in Albemarle County and the City of Charlottesville. Air pollutants are described along with their sources and allowable ambient atmospheric concentrations. Existing regional air quality is described. An assessment of the project's effects on air quality is presented with special regard to changes in carbon monoxide concentrations predicted with a microscale dispersion analysis. A qualitative discussion of construction impacts to air quality is provided. Finally, conclusions are presented regarding the project's effects on attainment and maintenance of the NAAQS.

II. AIR POLLUTANTS AND THEIR SOURCES

National Ambient Air Quality Standards, published by the Environmental Protection Agency, are listed in Table 1. These national standards have been adopted by the State Air Pollution Control Board as state standards. Primary ambient air quality standards define the levels of air quality necessary to protect the public health with an adequate margin of safety. Secondary standards define levels of air quality necessary to prevent any degradation or harm to the total environment.

The Virginia Ambient Air Quality Data Report 1988, gives the following descriptions of pollutants for which the National Ambient Air Quality Standards were developed:

> "TOTAL SUSPENDED PARTICULATES are solids, non-volatile liquids, dust, smoke, pollen, and crystals small enough to be suspended in the air, and result from fossil fuel combustion, industrial processes, fugitive dust (wind and erosion) and photochemical reactions. Rainfall is the major source of removal. Interactions of particulates, sunlight, and moisture can result in haze. Particles contribute to the formation of clouds, and emission of large numbers of particulates can, in some instances, result in local increase in cloud formation and possible precipitation. Particulate matter soils materials and may cause respiratory irritation and material corrosion either by its direct actions or by serving as a carrier of damaging substances absorbed by it."

> "PM_{10} Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}) is that portion of total suspended particulate that has the capability to penetrate the thoracic region of the human respiratory system. In addition to health effects, particles in this size range can impair visibility, have an effect on climate, and contribute to acidic dry deposition."

TABLE 1

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Primary Standard		Secondary Standard	
	ug/m³	ppm	ug/m³	ppm
SUSPENDED PARTICULATE*****				
annual geometric mean	75		60**	
24-hour	260*		150*	
CARBON MONOXIDE				
8-hour concentration		9.0*	same as primary	
1-hour concentration		35.0*		
SULFUR DIOXIDE				
annual arithmetic mean	80	0.03		
24-hour concentration	365*	0.14*		
3-hour concentration			1300*	0.5*
NITROGEN DIOXIDE				
annual arithmetic mean	100	0.05	same as primary	
OZONE				
1-hour concentration	235***	0.12***	same as primary	
LEAD				
quarterly arithmetic mean	1.5		same as primary	
PM_{10}				
annual expected arithmetic mean	50		same as primary	
24-hour concentration	150****			

ug/m³ = micrograms per cubic meter
ppm = parts per million
* Not to be exceeded more than once a year
** A guide for assessing the achievement of 24-hour standards
*** Not to be exceeded more than 1 day per year (3 year average)
**** No more than one expected exceedance per year
***** This is a Virginia Ambient Air Quality Standard

"CARBON MONOXIDE is produced by incomplete combustion of carbon compounds, principally in internal combustion engines. Concentrations in the vicinity of heavily traveled highways are much higher than ambient concentrations more than 100 meters from any highway. Carbon monoxide is not an irritant, and has little or no effect on plants or materials; however, it reacts in the bloodstream to deprive the heart and brain of oxygen. Moderate concentrations significantly reduce brain function and high concentrations can be lethal."

"SULFUR DIOXIDE (SO_2) results from combustion processes (mainly burning of fossil fuels containing sulfur compounds), refining of petroleum, manufacture of sulfuric acid, and smelting of ore containing sulfur. SO_2 causes chlorosis in plant leaves and in moist air forms acids that damage structural materials. Their irritating effects in the respiratory tract are magnified by high particulate levels. Once in the atmosphere, some sulfur dioxide can be oxidized (either photochemically or in the presence of a catalyst) to form SO_3 (sulfur trioxide). With water vapor, SO_3 is converted to sulfuric acid mist. Other basic oxides combine with SO_3 to form surface aerosols. These compounds can be transported large distances and fall back to earth as acid rain."

"NITROGEN DIOXIDE (NO_2) (a secondary derivative of atmospheric nitric oxide), is formed when combustion temperatures are extremely high as in the burning of coal, oil, gas, and gasoline, and has been clearly established as exerting detrimental effects on human health and welfare. NO_2 in high concentrations can cause impairment of dark adaptation, increase airway resistance and respiratory rate, and enhance susceptibility to respiratory infections."

"OZONE (O_3) is formed by a complex series of reactions among nitrogen oxides and certain organic compounds under the influence of solar ultraviolet radiation (sunlight). Ozone shows a very strong diurnal (daily) and seasonal (April to October) cyclical character. Ozone injures vegetation, has adverse effects on materials (rubber and fabrics) and is a pulmonary irritant that affects the respiratory mucous membranes, lung tissues, and respiratory functions."

"LEAD is emitted into the atmosphere by vehicles burning leaded fuel and by certain industries. Particles of airborne lead range between 0.1 to 5.0 microns in diameter. Particle size and shape are important in helping to determine the deposition and suspension of lead in the atmosphere, as well as retention and absorption of lead in human beings. Children are particularly susceptible to the adverse effects of lead which can interfere with the blood-forming system, the nervous system, and the renal system, and can affect the normal functions of the reproduction and cardiovascular systems."

Motor vehicles emit all of the above pollutants except ozone. Ozone can be formed photochemically in the atmosphere from precursors emitted by motor vehicles. According to the State Air Pollution Control Board's Emission Inventory for the year 1985, automobiles are responsible for the following percentages of manmade emissions in Virginia: Carbon monoxide - 78.3%, nitrogen oxides - 48.6%, particulates - 24.1%, sulfur dioxide - 3.4%, volatile organic compounds (mostly hydrocarbons which, when combined photochemically with nitrogen oxides, form ozone) - 51.6%.

The Inventory shows that the automotive percentages for Albemarle County are somewhat higher than for the state as a whole: Carbon monoxide - 86.9%, nitrogen oxides - 72.2%, particulates - 36.2%, volatile organic compounds - 71.4%. This is probably due to a lower intensity of industrial development in Albemarle County than in other parts of Virginia.

Burning of leaded fuels in automobiles is still the major source of atmospheric lead both statewide and in Albemarle County. However, increasing use of unleaded fuels is effectively reducing motor vehicle emissions of this pollutant.

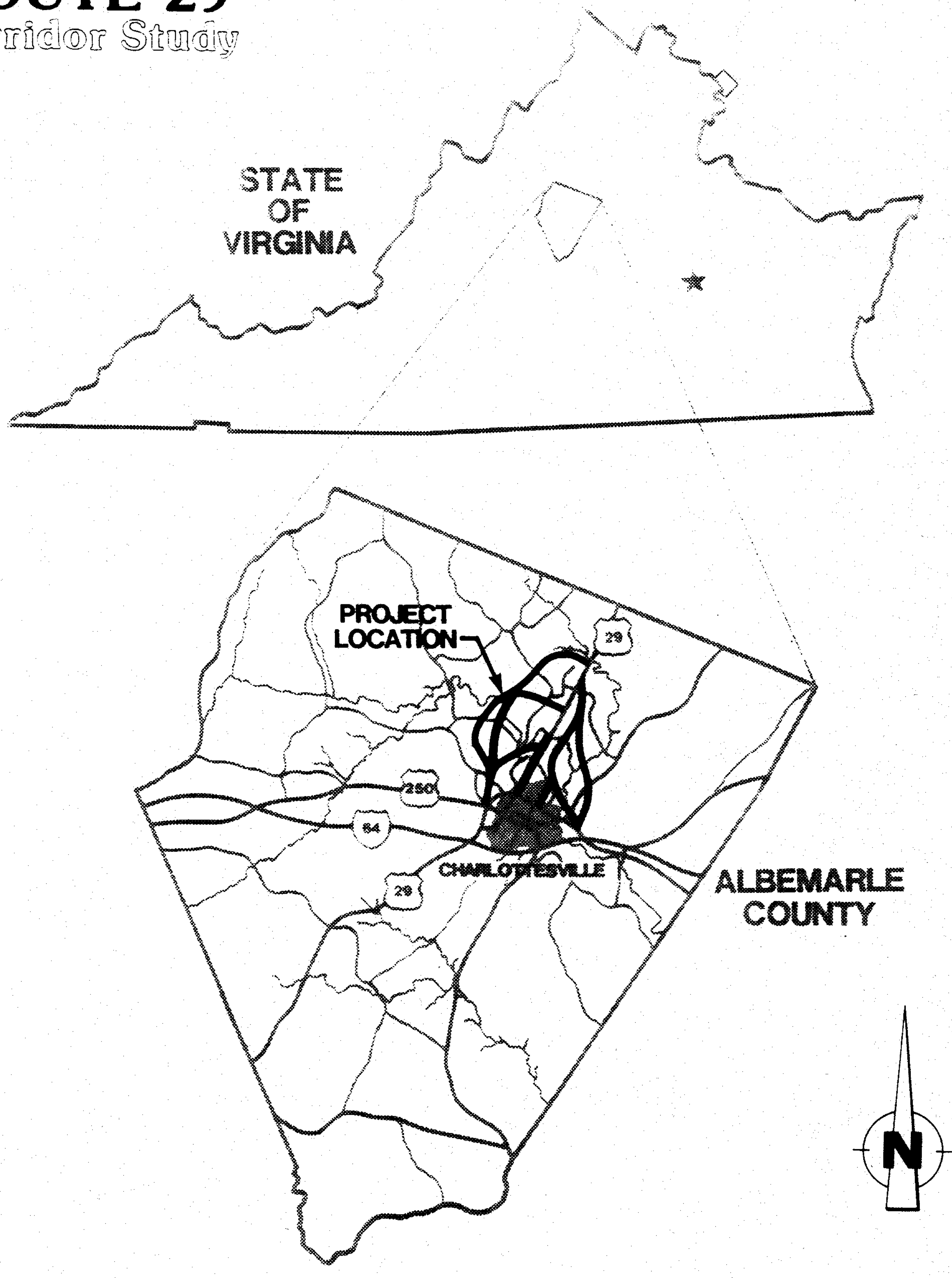
III. PROJECT DESCRIPTION

U.S. Route 29 north of Charlottesville is currently a four-lane divided highway with at-grade, signalized intersections. The signal system is synchronized to provide progressive traffic movement. The existing right-of-way varies but is generally 165 to 180 feet wide. The median is nominally 55 to 60 feet wide although it is narrower at intersections where left turn lanes have been added.

Commercial and residential growth in the area have caused increased traffic volumes on Route 29 which, in turn, have resulted in congested conditions and travel delays during peak traffic periods. These problems led to initiation of the Route 29 Corridor Study.

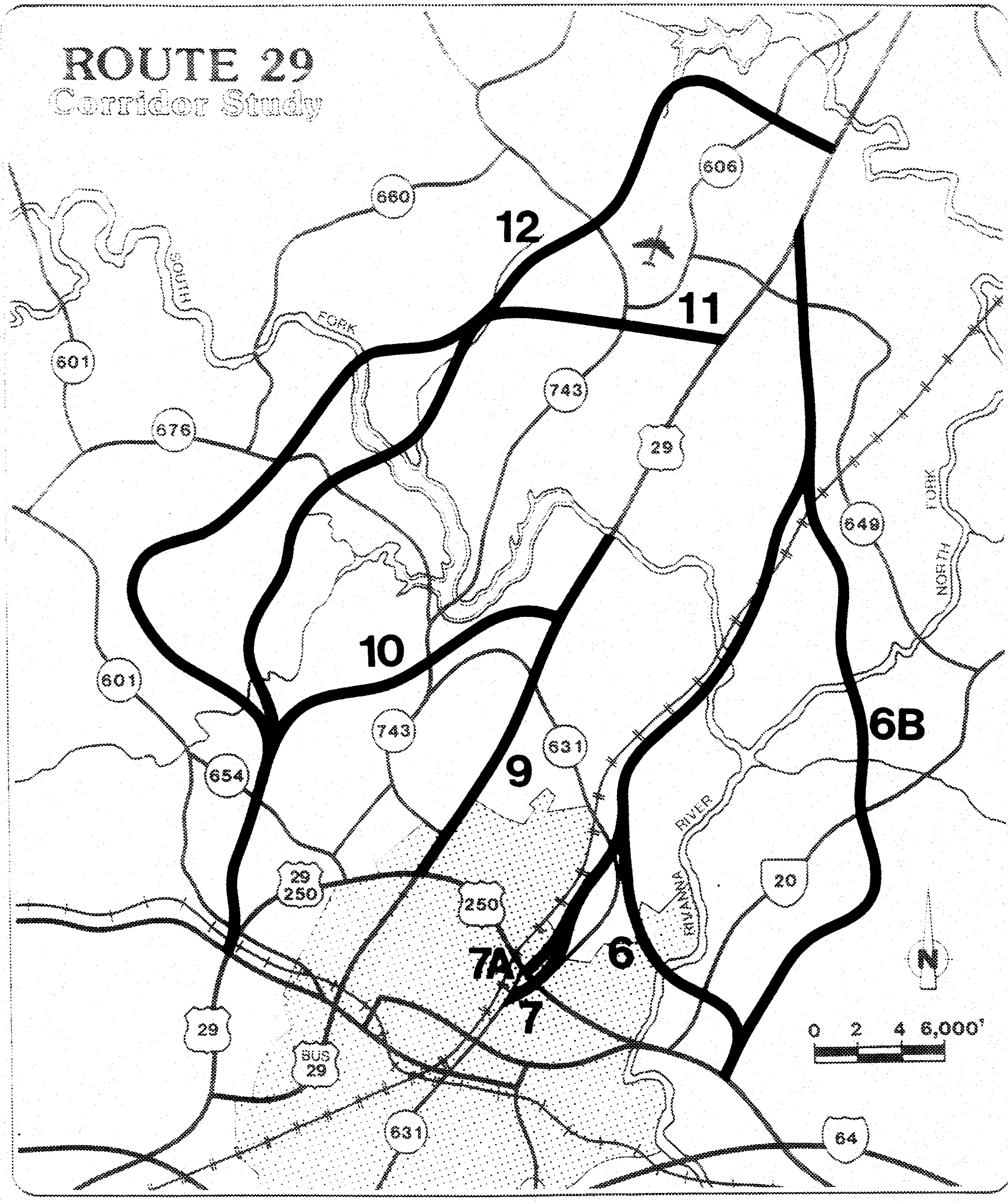
The Route 29 Corridor Study was undertaken to identify and evaluate transportation alternatives to improve traffic conditions along the Route 29 Corridor in Charlottesville and Albemarle County. Figure 1 shows the project location within the state while Figure 2 shows the study area and the proposed candidate build alternatives. The initial phases of the study in late 1987 and early 1988 identified a large number of potential highway corridors in the study area. Through a process of comparison, refinement, and public participation, the potential alignments were screened using factors such as traffic, social and natural environmental impacts, engineering, and costs. The alternatives remaining after the screening process are the candidate build alternatives which are discussed in detail in the Environmental Impact Statement. The candidate build alternatives include six new location bypass alternatives (three west and three east of existing Route 29) and an expressway alternative within the median

ROUTE 29
Corridor Study



Project Location

Figure No. 1



Project Location

Figure No. **2**

of existing Route 29. In addition to the candidate build alternatives, a no-build alternative is being considered. However, it is not strictly a no-build alternative since it would involve upgrading existing Route 29 to provide a six-lane facility.

The proposed new location alternatives feature four 12-foot lanes, a graded median 84 feet wide, and a limited access right-of-way 300 feet wide. The expressway alternative features four 12-foot express lanes in the existing median separated from six 12-foot local lanes by concrete barriers. Opposing lanes on the expressway would be separated by a concrete median barrier. Expressway entrance and exit would be accomplished by slip ramps at various intervals.

IV. EXISTING REGIONAL AIR QUALITY

In accordance with the 1977 Clean Air Act Amendments, the State Air Pollution Control Board developed the current State Implementation Plan (SIP) for Virginia. The SIP outlines control strategies, compliance schedules, surveillance schedules, and source review programs to attain and maintain the National Ambient Air Quality Standards. Contained in the SIP are "attainment" and "nonattainment" designations for each pollutant within the seven air quality control regions in Virginia. For areas designated "nonattainment", the SIP may contain transportation control measures and inspection and maintenance measures for reducing pollutant concentrations to "attainment" levels. The Clean Air Act and Federal Highway Administration policy require that projects conform with the SIP.

Albemarle County is in the Virginia Department of Air Pollution Control's Region IV, Northeastern Virginia. Air quality in the region is in compliance with the National Ambient Air Quality Standards. The region has therefore been given attainment status in Virginia's SIP approved by the U.S. Environmental Protection Agency. The SIP contains no transportation control measures for the region nor are there any inspection and maintenance programs required.

V. STUDY PROCEDURES

A. General Approach

A microscale dispersion analysis of carbon monoxide emissions was used to assess the impacts of the project on air quality. As shown in Section II, carbon monoxide is the predominant pollutant associated with motor vehicles in Albemarle County. Its highest concentrations are found near highways. Further, carbon monoxide is a stable gas for which atmospheric concentrations can be accurately estimated with computer dispersion models.

Concentrations of other pollutants, such as nitrogen oxides and ozone, with high correlations to motor vehicle emissions involve complex chemical reactions and atmospheric transport. There are no models available to accurately predict their concentrations at a microscale level. These pollutants must be analyzed on a large regional scale and are addressed at a system planning level as part of the State Implementation Plan.

With the increasing use of unleaded gasoline and lower levels of lead in leaded gasoline, lead standards are not expected to be violated on any project. Consequently, Federal Highway Administration guidelines recommend that lead emissions not be analyzed.

Since motor vehicles contribute very little to regional levels of sulfur dioxide and particulates, these pollutants have not been analyzed.

Carbon monoxide concentrations were analyzed for the base year (1987), an interim year (2000), and the design year (2010). Using a computer model, carbon monoxide concentrations due to highway vehicles were calculated at selected sites along the proposed alternates. These concentrations were then added to background carbon monoxide concentrations and compared to the NAAQS of 35 parts per million for one hour and 9 parts per million for eight hours. A "worst case" approach was used in the evaluation. That is, site locations and model inputs such as traffic volumes, speeds, and meteorological conditions were selected so that the highest possible concentrations would be calculated.

B. Background Carbon Monoxide

Ambient atmospheric carbon monoxide concentrations consist of background concentrations plus contributions from local sources such as highways. Background concentrations are due to carbon monoxide emissions from within and outside the community and remain fairly constant across the region. They are a function of land use type and density and transportation-related activity. Ambient carbon monoxide concentrations vary due to specific localized sources.

The Virginia Department of Air Pollution Control monitors carbon monoxide concentrations at various locations across the state. However, there is no carbon monoxide monitoring station in the Charlottesville area. Table 2 shows the maximum and second highest observations for 1-hour and 8-hour carbon monoxide concentrations at other locations.

TABLE 2

OBSERVED CARBON MONOXIDE CONCENTRATIONS AT SELECTED VIRGINIA MONITORING STATIONS

	Parts per Million 1-hour		Parts per Million 8-hour	
	maximum	2nd highest	maximum	2nd highest
Vinton	5.1	4.4	3.2	2.8
Richmond	8.2	7.9	5.2	4.2
Newport News	11.4	8.8	4.2	3.7
Norfolk	12.7	12.7	9.9	5.6
VA Beach	7.0	6.1	4.8	3.7

Source: Virginia Ambient Air Quality Data Report 1988
Virginia Department of Air Pollution Control

The National Ambient Air Quality Standards for CO are not to be exceeded more than once per year. Therefore, for a worst case analysis, the second highest carbon monoxide concentrations are considered to represent background concentrations. As seen in the table, cities with highly developed urban areas and large populations have higher background carbon monoxide concentrations than those in less intensely developed areas. The site in the City of Vinton has characteristics most similar to the Charlottesville/Albemarle area.

The U.S. Environmental Protection Agency and the Federal Highway Administration recommend that, in rural areas, background concentrations of one part per million be used for both one-hour and eight-hour analysis periods. Other Environmental Protection Agency guidance suggests that one-hour background of five parts per million and eight-hour background of two parts per million may be appropriate for less rural areas. (Guidelines for Air Quality Maintenance Planning and Analysis Volume 9: Evaluating Indirect Sources).

For purposes of this study, background concentrations of six parts per million for one hour and three parts per million for eight hours were assumed. The Virginia Department of Transportation, with the approval of the Federal Highway Administration, routinely uses these values for air quality studies in areas where monitoring data is not available. These values are considered reasonable as they result in conservative estimates of total carbon monoxide concentrations.

C. Microscale Dispersion Analysis

1. Model Used

Atmospheric concentrations of CO resulting from motor vehicle emissions from each of the proposed project alternatives were calculated using VACAL 3. VACAL 3 is a microcomputer program that calculates CO concentrations within 300 feet of a roadway. It was developed by the Virginia Department of Transportation from the Federal Highway Administration's Mobile 3/CALINE 3 Graphic Assessment Procedure. The underlying basis of the program is the Gaussian diffusion equation which employs a mixing zone concept to characterize pollutant dispersion along a line source such as a roadway. The program incorporates mobile source emission factors and meteorological conditions. The user inputs the years for which calculations are desired, peak one-hour and eight-hour traffic volumes, speeds, and the number of lanes. The program then calculates the one-hour and eight-hour CO concentrations. The calculations include the background concentrations of 6 parts per million and 3 parts per million for 1 and 8 hours respectively. In making the calculations, the program assumes level terrain. This eliminates the influence of intervening topography and gives more conservative values. A source length of 0.5 kilometers (1640 feet) is assumed in the program. Source lengths greater than this have very little effect on the outcome of the calculations.

2. Emission Factors

The Mobile 3 Emission Factors used in the VACAL 3 program were developed by the U.S. Environmental Protection Agency (EPA). These factors were published in EPA's "Mobile Source Emission Factors", June, 1985. These factors reflect the Clean Air Act Amendment Standards under the Federal New Car Emissions Program. Factors include national average or default values with respect to vehicle age, percentage of vehicles by type, and annual travel. The percentages of hot and cold starts were set at normal default values: 27.3% hot transient vehicle miles traveled by catalyst-equipped vehicles and 20.6% cold transient vehicle miles traveled by both catalyst and noncatalyst vehicles.

3. Meteorological Conditions

The VACAL 3 program incorporates meteorological conditions that would promote CO concentrations. These conditions include:

- Stability Class D

- Low wind speed of one meter per second which inhibits turbulence and mixing.
- Low wind angle of 10 degrees which reduces dispersion away from the road and increases concentrations along the road.
- Average temperature of 30 degrees Fahrenheit for the coldest month in Virginia based on National Oceanic and Atmospheric Administration 30-year averages. Vehicular emissions of CO are higher during colder weather.

4. Analysis Sites

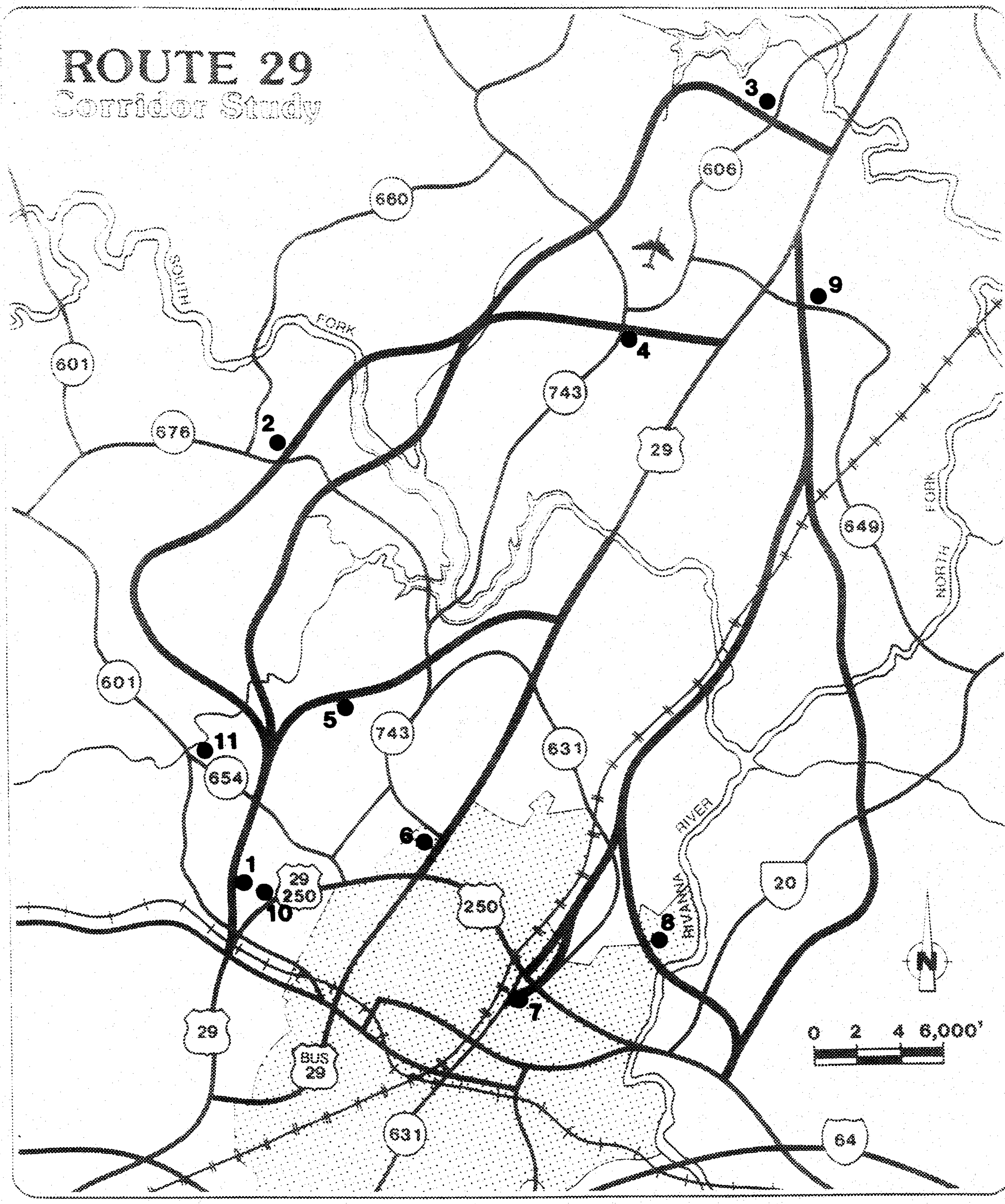
To obtain "worst case" conditions, representative sites were selected at locations where the highest carbon monoxide concentrations could be expected and where the general public has access or where outdoor activities are likely to occur. In general, the sites are located near proposed right of way lines on roadway sections with highest peak-hour traffic volumes. Since parks and schools have a high degree of public use, several sites were selected in or near parks and school playgrounds along the alternate alignments. In addition, secondary sites were selected at locations where local roads beyond the project limits would experience substantial increases (more than 20%) in traffic volumes as a result of the project. Eleven sites described in Table 3 and located as shown on Figure 3 were evaluated.

TABLE 3

CARBON MONOXIDE MICROSCALE ANALYSIS SITES

Site #	Location	Areas Represented
1	160 feet right (east) of station 546 approximately 10 feet outside proposed right of way near St. Anne's-Belfield School.	Areas on both sides of alternates 11 and 12 from Route 250 to Route 676 and areas on both sides of alternate 10 from Route 250 to Barracks Road (Route 654).
2	180 feet left (west) of station 837 behind dwelling in Clearview Knolls subdivision.	Areas on both sides of alternate 12 from Route 676 to Miller Road (Route 743).
3	155 feet left (west) of station 1124 in side yard of dwelling in Lake Acres subdivision.	Areas on both sides of alternate 12 from Miller Road (Route 743) to Route 29.
4	160 feet right (east) of station 931 in churchyard at Pleasant Grove Baptist Church.	Areas on both sides of alternate 11 from Route 676 to Route 29.
5	240 feet right (east) of station 653 in play area at Mary Greer Elementary School.	Areas along both sides of alternate 10 from Barracks Road to Route 29.
6	110 feet left (west) of station 108 at Zanece Restaurant just outside proposed right of way.	Areas along both sides of Route 29 for the base case and expressway alternatives.
7	34 feet east of centerline of McIntire Road at McIntire tennis courts.	Areas along both sides of McIntire Road and alternates 7 and 7A from Route 250 to Rio Road (Route 631).
8	155 feet right (east) of station 381 on green at Pen Park Golf Course approximately 5 feet outside proposed right of way.	Areas along both sides of alternate 6 from Route 250 to Rio Road Interchange.
9	165 feet right (east) of station 704 + 50 in churchyard at Mount Ephraim Pentecostal Church.	Areas along both sides of alternate 6B from Route 250 to Route 29 and both sides of alternates 6 and 7 from Rio Road to Route 29.

10	A secondary site located approximately 5 feet outside the right-of-way of Route 250 Bypass near St. Anne's-Belfield School.	Areas on both sides of Route 250 Bypass where higher traffic volumes would result from construction of the expressway alternative.
11	A secondary site located approximately 5 feet outside the right-of-way of Barracks Road (Route 654) approximately 2000 feet west of Colthurst subdivision.	Areas on both sides of Barracks Road where higher traffic volumes would result from construction of Alternates 10, 11, or 12.



Carbon Monoxide Analysis Sites

Figure No. 3

5. Traffic Data

The VACAL 3 program calculates CO concentrations based on traffic volumes and speeds. The one-hour concentrations are calculated from peak hour volumes and speeds. The eight-hour concentrations are calculated from the average hourly volume and speed for the eight highest volume hours of the day. Data are required for existing conditions, an interim year, and the design year.

For this analysis, existing (1987) traffic volumes were taken from information developed by the Virginia Department of Transportation. Interim year (2000) and design year (2010) traffic data were developed by COMSIS, Inc. in concert with travel forecasts and levels of service analyses. Table 4 shows the existing average daily traffic volume (ADT), the peak hour traffic volume, travel speed during the peak hour, and the percentages of automobiles and trucks for Route 29 and other road segments for which CO calculations were made. Tables 5 and 6 show similar data for the year 2000 and 2010 for all of the alternatives.

The highest eight-hour traffic volumes were determined by taking counts on selected representative existing roads, determining the percentages the highest eight hours comprised of the total daily count, and applying those percentages to existing and forecast average daily traffic volumes on the alternatives. For example, if the highest eight hours comprised 53% of the total traffic, 53% of the ADT was divided by eight to obtain the eight-hour average hourly volume. The average speed for the eight hour period was assumed to be the same as the peak hour speed. This may be very conservative since peak hour speeds should be lower than the eight-hour average. Table 7 shows the % ADT by hour for the eight highest volume hours by roadway type.

TABLE 4

EXISTING (1987) TRAFFIC DATA

ROUTE	FROM	TO	%LDV	%LDT	%HDT	ADT	PHT	PHS
U.S. 29 N	250 Bypass	Rio Road	94	1	5	50680	6082	40
U.S. 29 N	Rio Road	S Fork Rivanna	94	1	5	25800	3096	40
U.S. 29 N	S Fork Rivanna	Airport Road	94	1	5	23970	2876	55
U.S. 29 N	Airport Road	N Fork Rivanna	94	1	5	25976	3117	55
250 Bypass	Barracks Road	250 Bypass	94	1	5	18342	2201	55
Barracks Road	Colthurst Drive	Garth Road	94	1	5	5553	666	55
McIntire Road	250 Bypass	Harris Street	94	1	5	16645	1997	30

% LDV = Light Duty Vehicles (Autos)

% LDT = Light Duty Trucks

% HDT = Heavy Duty Trucks

ADT = Average Daily Traffic

PHT = Peak Hour Traffic (12% of ADT)

PHS = Peak Hour Speed

TABLE 5
YEAR 2000 TRAFFIC DATA

ROUTE	FROM	TO	%LDV	%LDT	%HDT	ADT	PHT	PHS
NO BUILD ALTERNATIVE								
US 29N	250 BYPASS	HYDRAULIC RD	94	1	5	61100	7332	36
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	54900	6588	37
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	44800	5376	39
250 BYPASS	BARRACKS RD.	250 BUSINESS	94	1	5	35600	4272	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	5700	684	55
MCINTIRE RD.	250 BYPASS	HARRIS ST.	94	1	5	25200	3025	35
EXPRESSWAY ALTERNATIVE								
EXPRESSWAY	250 BYPASS	HYDRAULIC RD.	91	1	8	14900	1788	55
EXPRESSWAY	SPERRY DR.	GREENBRIER DR.	91	1	8	34900	4188	55
EXPRESSWAY	RIO RD.	WOODBROOK DR.	91	1	8	31100	3732	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	52500	6300	38
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	29300	3516	40
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	21000	2520	40
250 BYPASS	BARRACKS RD.	250 BUSINESS	94	1	5	36700	4404	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	5600	672	55
ALTERNATIVE 6								
ALT 6	US 29N	SR 643	91	1	8	15900	1908	55
ALT 6	SR 643	INT. AT RIO	91	1	8	17900	2148	55
ALT 6	INT. AT RIO	250 BYPASS	91	1	8	8900	1068	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	59800	7176	36
US 29N	SPERRY DR.	GREENBRIAR DR.	94	1	5	53200	6384	37
US 29N	RIO RD.	WOODBDROOK DR.	94	1	5	40800	4896	39
ALTERNATIVE 6B								
ALT 6B	US 29N	SR 643	91	1	8	16300	1956	55
ALT 6B	SR 643	US 20	91	1	8	3500	420	55
ALT 6B	US 20	250 BYPASS	91	1	8	2700	324	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	59100	7092	36
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	52500	6300	38
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	40900	4908	39
ALTERNATIVE 7								
ALT 7	US 29N	SR 643	91	1	8	16000	1920	55
ALT 7	SR 643	RIO RD.	91	1	8	17800	2136	55
ALT 7	RIO RD.	250 BYPASS	91	1	8	29700	3564	55
ALT 7	250 BYPASS	MCINTIRE RD.	91	1	8	44100	5292	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	58100	6972	36
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	52200	6264	38
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	40500	4860	39
MCINTIRE RD.	250 BYPASS	HARRIS ST.	94	1	5	34050	4086	35
ALTERNATIVE 7A								
ALT 7A	US 29N	SR 643	91	1	8	15600	1872	55
ALT 7A	SR 643	RIO RD.	91	1	8	17400	2088	55
ALT 7A	RIO RD.	250 BYPASS	91	1	8	27600	3312	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	60000	7200	36
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	53500	6420	37
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	40900	4908	39
MCINTIRE ROAD	250 BYPASS	HARRIS ST.	94	1	5	25800	3421	35

ALTERNATIVE 10

ALT 10	US 29N	SR 743	91	1	8	13400	1608	55
ALT 10	SR 743	SR 601-BARRACKS	91	1	8	12900	1548	55
ALT 10	SR 601-BARRACKS	250 BYPASS	91	1	8	13500	1620	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	52100	6252	38
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	47000	5640	38
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	34200	4104	40
250 BYPASS	BARRACKS RD.	250 BUS	94	1	5	23000	2760	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	8300	996	55

ALTERNATIVE 11

ALT 11	US 29N	SR 743	91	1	8	14900	1788	55
ALT 11	SR 743	SR 676	91	1	8	9600	1152	55
ALT 11	SR 676	SR 601-BARRACKS	91	1	8	8600	1032	55
ALT 11	SR 601-BARRACKS	250 BYPASS	91	1	8	10800	1296	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	54300	6516	37
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	49200	5904	38
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	39200	4704	39
250 BYPASS	BARRACKS RD.	250 BUS	94	1	5	26600	3192	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	7100	852	55

ALTERNATIVE 12

ALT 12	US 29N	SR 743	91	1	8	8600	1032	55
ALT 12	SR 743	SR 686	91	1	8	10700	1284	55
ALT 12	SR 676	SR 601-BARRACKS	91	1	8	7300	878	55
ALT 12	SR 601-BARRACKS	250 BYPASS	91	1	8	9900	1188	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	55400	6648	37
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	50600	6072	38
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	39500	4740	39
250 BYPASS	BARRACKS RD.	250 BUS	94	1	5	29200	3504	55
BARRACKS RD	COLTHURST RD.	GARTH RD.	94	1	5	7100	852	55

%LDV=PERCENT LIGHT DUTY VEHICLES (AUTOS)
%LDT=PERCENT LIGHT DUTY TRUCKS (2-AXLE 6 TIRE; 3-AXLE)
%HDV=PERCENT HEAVY DUTY VEHICLES
ADT=AVERAGE DAILY TRAFFIC
PHT=PEAK HOUR TRAFFIC (12% OF ADT)
PHS=PEAK HOUR SPEED (MILES PER HOUR)

TABLE 6
YEAR 2010 TRAFFIC DATA

ROUTE	FROM	TO	%LDV	%LDT	%HDT	2010 ADT	PHT	PHS
NO BUILD ALTERNATIVE								
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	64700	7764	35
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	61000	7320	36
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	52100	6252	38
250 BYPASS	BARRACKS RD.	250 BYPASS	94	1	5	37900	4548	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	7600	912	55
MCINTIRE RD.	250 BYPASS	HARRIS ST.	94	1	5	33600	4032	35
MILLER ROAD	RT. 606	RT. 643	94	1	5	13600	1632	55
EXPRESSWAY ALTERNATIVE								
EXPRESSWAY	250 BYPASS	HYDRAULIC RD.	91	1	8	19600	2352	55
EXPRESSWAY	SPERRY DR.	GREENBRIER DR.	91	1	8	43200	5184	55
EXPRESSWAY	RIO RD.	WOODBROOK DR.	91	1	8	35500	4260	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	55600	6672	37
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	30100	3612	40
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	26400	3168	40
250 BYPASS	BARRACKS RD.	250 BYPASS	94	1	5	45900	5508	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	7400	888	55
ALTERNATIVE 6								
ALT 6	US 29N	SR 643	91	1	8	22300	2676	55
ALT 6	SR 643	INT AT RIO	91	1	8	25000	3000	55
ALT 6	INT AT RIO	250 BYPASS	91	1	8	13400	1608	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	63500	7620	35
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	58900	7068	36
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	47000	5640	38
ALTERNATIVE 6B								
ALT 6B	US 29N	SR 643	91	1	8	22300	2676	55
ALT 6B	SR 643	US 20	91	1	8	5400	648	55
ALT 6B	US 20	250 BYPASS	91	1	8	5000	600	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	62700	7524	35
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	58400	7008	36
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	50100	6012	38
ALTERNATIVE 7								
ALT 7	US 29N	SR 643	91	1	8	23200	2784	55
ALT 7	SR 643	RIO RD.	91	1	8	24200	2904	55
ALT 7	RIO RD.	250 BYPASS	91	1	8	36400	4368	55
ALT 7	250 BYPASS	MCINTIRE RD.	91	1	8	50600	6072	54
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	62000	7440	36
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	58300	6996	36
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	47200	5664	38
MCINTIRE RD.	250 BYPASS	HARRIS ST.	94	1	5	45400	5448	35
ALTERNATIVE 7A								
ALT 7A	US 29N	SR 643	91	1	8	22700	2724	55
ALT 7A	SR 643	RIO RD.	91	1	8	23400	2808	55
ALT 7A	RIO RD.	250 BYPASS	91	1	8	33900	4068	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	64000	7680	35
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	59600	7152	36
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	47800	5736	38
MCINTIRE RD.	250 BYPASS	HARRIS ST.	94	1	5	34400	4130	35

TABLE 6 (CONT)

ALTERNATIVE 10								
ALT 10	US 29N	SR 743	91	1	8	17400	2088	55
ALT 10	SR 743	SR 601-BARRACKS	91	1	8	17900	2148	55
ALT 10	SR 601-BARRACKS	250 BYPASS	91	1	8	17900	2148	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	54100	6492	37
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	50100	6012	38
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	38100	4572	39
250 BYPASS	BARRACKS RD.	250 BUSINESS	94	1	5	24500	2940	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	11000	1320	55
ALTERNATIVE 11								
ALT 11	US 29N	SR 743	91	1	8	19300	2316	55
ALT 11	SR 743	SR 676	91	1	8	14200	1704	55
ALT 11	SR 676	SR 601-BARRACKS	91	1	8	12200	1464	55
ALT 11	SR 601-BARRACKS	250 BYPASS	91	1	8	14600	1752	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	57300	6876	37
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	53200	6384	37
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	46900	5628	38
250 BYPASS	BARRACKS RD.	250 BUSINESS	94	1	5	28300	3396	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	9500	1140	55
MILLER RD.	RT.606	RT. 643	94	1	5	9200	1104	55
ALTERNATIVE 12								
ALT 12	US 29N	SR 743	91	1	8	11400	1368	55
ALT 12	SR 743	SR 676	91	1	8	15100	1812	55
ALT 12	SR 676	SR 601-BARRACKS	91	1	8	9500	1140	55
ALT 12	SR 601-BARRACKS	250 BYPASS	91	1	8	12600	1512	55
US 29N	250 BYPASS	HYDRAULIC RD.	94	1	5	57300	6876	37
US 29N	SPERRY DR.	GREENBRIER DR.	94	1	5	53200	6384	37
US 29N	RIO RD.	WOODBROOK DR.	94	1	5	46900	5628	38
250 BYPASS	BARRACKS RD.	250 BUSINESS	94	1	5	31100	3732	55
BARRACKS RD.	COLTHURST DR.	GARTH RD.	94	1	5	9400	1128	55

%LDV=PERCENT LIGHT DUTY VEHICLES (AUTOS)
%LDT=PERCENT LIGHT DUTY TRUCKS (2-AXLE 6 TIRE; 3-AXLE)
%HDV=PERCENT HEAVY DUTY VEHICLES
ADT=AVERAGE DAILY TRAFFIC
PHT=PEAK HOUR TRAFFIC (12% OF ADT)
PHS=PEAK HOUR SPEED (MILES PER HOUR)

Table 7

%ADT BY HOUR FOR THE 8 HIGHEST VOLUME HOURS (BY FACILITY TYPE)

SR 20N (Minor Arterial)

Time	Mon	Tues	Wed	Thurs	Total /hour	Ave. /hour	% of Total 8 Hours	% of Day
7-8	260	343	312	330	1245	311		
8-9	177	220	228	226	851	213		
9-10	152	131	146	124	553	138		
10-11	152	147	119	146	564	141		
11a-12p	180	141	137	120	578	145	9%	5%
12-1	177	161	147	146	631	158	10%	5%
1-2	147	165	158	156	626	157	10%	5%
2-3	172	182	157	171	682	171	11%	6%
3-4	194	162	206	195	757	189	12%	6%
4-5	304	303	296	269	1172	293	18%	10%
5-6	323	282	292	303	1200	300	19%	10%
6-7	204	196	195	227	822	206	13%	7%
					8 Hrs	1617		
					24 Hr	2984		

US 29 (Principal Arterial)

Time	Mon	Tues	Wed	Thurs	Total /hour	Ave. /hour	% of Total 8 hours	% of Day
6-7	1017	979	1030	1081	4107	1027		
7-8	1319	1280	1222	1365	5186	1297		
8-9	1234	1223	1198	1175	4830	1208		
9-10	1010	902	926	989	3827	957		
10-11	1012	898	865	951	3726	932		
11a-12p	1089	929	966	1045	4029	1007		
12-1	1466	1311	1308	1458	5543	1386	12%	6%
1-2	1488	1269	1259	1365	5381	1345	12%	6%
2-3	1410	1256	1184	1278	5128	1282	11%	6%
3-4	1481	1397	1387	1445	5710	1428	12%	7%
4-5	1801	1725	1674	1837	7037	1759	15%	8%
5-6	1835	1780	1746	1745	7106	1777	16%	8%
6-7	1434	1423	1448	1525	5830	1458	13%	7%
7-8	1199	1071	1149	1287	4706	1177	10%	5%
8-9	1044	1022	1079	1027	4172	1043		
9-10	788	783	874	878	3323	831		
					8 Hr	11441		
					24 Hr	21794		

SR 743-Hydraulic Rd. (Minor Arterial)

Time	Mon	Tues	Wed	Thurs	Total /hour	Ave. /hour	% of Total 8 hours	% of Day
5-6			258	250	508	254		
6-7			476	500	976	488		
7-8			269	266	535	268		
8-9			229	234	463	232		
9-10			231	233	464	232		
10-11		272	207	199	678	226		
11a-12p		252	239	271	762	254	10%	6%
12-1		231	264	220	715	238	9%	5%
1-2		239	231	277	747	249	10%	6%
2-3		291	253	299	843	281	11%	6%
3-4		415	509	439	1363	454	18%	10%
4-5		452	473	472	1397	466	18%	10%
5-6		337	345	325	1007	336	13%	7%
6-7		280	296	286	862	287	11%	6%
7-8		235	255	267	757	252		
8-9		160	175	202	537	179		
					8 Hr	2565		
					24 Hr	4491		

I-64 (Freeway/Expressway)

Time	Mon	Tues	Wed	Thurs	Total /hour	Ave. /hour	% of Total 8 hours	% of Day
6-7	751	658	670	652	2731	683		
7-8	1316	1281	1219	1238	5054	1264		
8-9	1135	1159	1046	1066	4406	1102		
9-10	1041	1054	1010	1030	4135	1034		
10-11	991	912	947	995	3845	961	11%	6%
11a-12p	964	929	952	1035	3880	970	11%	6%
12-1	923	872	884	970	3649	912	11%	5%
1-2	963	935	961	983	3842	961	11%	6%
2-3	987	922	1074	1105	4088	1022	12%	6%
3-4	1130	1077	1204	1176	4587	1147	13%	7%
4-5	1243	1261	1287	1380	5171	1293	15%	8%
5-6	1247	1373	1288	1383	5291	1323	16%	8%
6-7	848	819	882	997	3546	887		
7-8	586	587	671	777	2621	655		
8-9	554	497	556	635	2242	561		
					8 Hr	8514		
					24 Hr	16872		

VI. RESULTS

Table 8 shows the peak one-hour and eight-hour carbon monoxide concentrations under "worst case" conditions at the 11 analysis sites. In all cases, the one-hour concentrations include background of six parts per million and eight-hour concentrations include background of three parts per million. In comparing the concentrations in the table with the NAAQS of 35 parts per million for one hour and nine parts per million for eight hours, it can be seen that in no case will the NAAQS be violated. In fact, in all cases, CO concentrations will be well below the NAAQS.

The analysis shows that the proposed bypass alternatives would have only slight effects on CO concentrations. Except at sites 4, 7, and 9, the bypass alternatives would increase CO levels only 0.1 parts per million above background levels. The higher levels at sites 4, 7, and 9 may be attributed to the added effects of traffic on existing roads. The maximum impact would occur at site 7, the McIntire Tennis Courts, where year 2010 build concentrations would increase over existing concentrations by 1.8 and 1.0 parts per million for one and eight hours respectively.

For site 6 on the expressway alternative, year 2010 build concentrations would not be substantially higher than either existing or year 2010 no-build concentrations.

Secondary analysis sites represent areas not directly affected by the project alternatives. However, in some cases, implementation of a particular alternative could result in traffic volume increases on local roads that would not occur without that alternative. Sites 10 and 11 represent worst case secondary impact areas. As shown in the table, neither site will experience substantial air quality degradation as a result of implementation of any of the alternatives.

Sites 5, 7, and 8 represent school, outdoor recreation, and park areas. Site 5 at Greer Elementary School and site 8 representing Pen Park and Rivanna Park would experience only slight (0.1 parts per million) increases in CO concentrations. Site 7 at the McIntire Tennis Courts would experience greater increases, however, the resulting concentrations would still be well below the NAAQS.

TABLE 8

PEAK CARBON MONOXIDE CONCENTRATIONS (PARTS PER MILLION)
UNDER WORST CASE METEOROLOGICAL CONDITIONS

SITE #	YEAR/CASE	INCLUDING BACKGROUND one hour	eight hour
1	1987 BASE	6.0	3.0
	2000 NO-BUILD	6.0	3.0
	2000 BUILD	6.1	3.1
	2010 NO-BUILD	6.0	3.0
	2010 BUILD	6.1	3.1
2	1987 BASE	6.0	3.0
	2000 NO-BUILD	6.0	3.0
	2000 BUILD	6.1	3.0
	2010 NO-BUILD	6.0	3.0
	2010 BUILD	6.1	3.0
3	1987 BASE	6.0	3.0
	2000 NO-BUILD	6.0	3.0
	2000 BUILD	6.1	3.0
	2010 NO-BUILD	6.0	3.0
	2010 BUILD	6.1	3.1
4	1987 BASE	6.1	3.1
	2000 NO-BUILD	6.2	3.1
	2000 BUILD	6.2	3.2
	2010 NO-BUILD	6.2	3.1
	2010 BUILD	6.4	3.2
5	1987 BASE	6.0	3.0
	2000 NO-BUILD	6.0	3.0
	2000 BUILD	6.1	3.0
	2010 NO-BUILD	6.0	3.0
	2010 BUILD	6.1	3.0
6	1987 BASE	9.1	4.7
	2000 NO-BUILD	8.8	4.5
	2000 BUILD	9.1	4.8
	2010 NO-BUILD	9.1	4.7
	2010 BUILD	9.4	4.9
7	1987 BASE	9.3	4.9
	2000 NO-BUILD	8.8	4.6
	2000 BUILD	9.8	5.2
	2010 NO-BUILD	9.7	5.2
	2010 BUILD	11.1	5.9

8	1987 BASE	6.0	3.0
	2000 NO-BUILD	6.0	3.0
	2000 BUILD	6.1	3.0
	2010 NO-BUILD	6.0	3.0
	2010 BUILD	6.1	3.1
9	1987 BASE	6.3	3.2
	2000 NO-BUILD	6.4	3.2
	2000 BUILD	6.5	3.3
	2010 NO-BUILD	6.5	3.3
	2010 BUILD	6.7	3.4
10	1987 BASE	7.3	3.7
	2000 NO-BUILD	7.4	3.6
	2000 BUILD	7.5	3.8
	2010 NO-BUILD	7.3	3.7
	2010 BUILD	7.6	3.9
11	1987 BASE	6.5	3.3
	2000 NO-BUILD	6.3	3.2
	2000 BUILD	6.4	3.2
	2010 NO-BUILD	6.3	3.2
	2010 BUILD	6.5	3.3

VII. CONSTRUCTION IMPACTS

Construction impacts on air quality would include exhaust emissions from construction equipment and dust generated by construction activities on disturbed earth. Additional emissions could be generated by burning of debris from clearing and grubbing operations. These impacts would be temporary and would be minimized by enforcement of construction specifications.

The Virginia Department of Transportation's Road and Bridge Specifications (January 1987) regulate construction procedures on all projects. The Specifications require the contractor to comply with all applicable laws, ordinances, regulations, orders, and decrees. This includes compliance with emissions standards for construction equipment and adherence to regulations for burning of materials from clearing and grubbing, demolition, or other operations.

The Specifications have been reviewed by the State Air Pollution Control Board and were found to conform with the State Implementation Plan. The Specifications prohibit burning of tires, asphaltic materials, used crankcase oil, or similar materials which produce dense smoke. Provisions will be included in the contract for allaying dust resulting from construction activities.

VIII. CONCLUSION

Potential air quality impacts of the proposed project alternatives have been evaluated. The evaluation included a review of existing regional air quality and projections for future air quality, with particular attention to carbon monoxide. The carbon monoxide analysis shows the NAAQS for this pollutant will not be exceeded under any alternative considered.

The project is located in an area designated "attainment" for all automotive-related pollutants. The State Implementation Plan for the area includes no transportation control measures. Therefore, except for construction procedures, the conformity requirements of 23CFR770 do not apply.

Construction activities will be conducted in accordance with Virginia Department of Transportation Specifications which have been approved by the Virginia Department of Air Pollution Control as conforming with the State Implementation Plan. Temporary air quality impacts from construction are not expected to be significant.

In view of the above, the project is in conformance with the State Implementation Plan, and will not interfere with attainment and maintenance of the National Ambient Air Quality Standards.