

8.0 AIR QUALITY

This chapter documents the air quality impacts associated with the No-Build, the TSM, and the Preferred Alternative for the Norfolk LRT Project. The purpose of the analysis is to estimate the future air quality conditions in the study area with the alternatives, to identify air quality impacts and mitigations, and to address conformity with state and regional air quality implementation plans.

8.1 Applicable Legal Authority

The Federal Clean Air Act Amendments of 1990 (CAAA), regulated by the U.S. Environmental Protection Agency, sets national ambient air quality standards (NAAQS) that identify pollutant concentrations that are not to be exceeded over specified time periods. In some cases, more stringent secondary standards have been established to protect the public welfare from the adverse effects of air pollutants. Compliance is required for both primary and secondary standards.

Ambient air quality is a function of many factors, including climate, topography, meteorological conditions and the production of airborne pollutants by natural or artificial sources. Major airborne pollutants of interest in the study area include the following:

- *Carbon Monoxide* – Carbon monoxide (CO) is an odorless, colorless gas formed by the burning of fuels containing carbon. Motor vehicles are the principal source of CO emissions in urban areas. Maximum concentrations usually occur near intersections and other areas of traffic congestion, and they decrease rapidly with distance from the source.
- *Particulate Matter* – Particulate matter enters the air from industrial operations, vehicular traffic and other sources, including fireplaces. Most of the particulate matter generated by motor vehicles consists of resuspended road dust. Measurements of particulate matter concentrations include TSP (total suspended particulates), PM₁₀ (particles with a diameter less than or equal to 10 micrometers), and PM_{2.5} (particles with a diameter less than or equal to 2.5 micrometers).
- *Ozone* – Ozone (O₃) in the lower atmosphere is a harmful air pollutant and contributes to the formation of smog. It is a secondary pollutant formed by the reaction of volatile organic compounds and oxides of nitrogen in the presence of strong sunlight. Thus, ozone levels are reduced by minimizing emissions of those precursor pollutants.
- *Volatile Organic Compounds* – Volatile organic compounds (VOC) are a key component in the formation of ozone. These hydrocarbons are emitted or evaporate into the atmosphere from a variety of sources, particularly the storage and combustion of fuels in motor vehicles.

- *Oxides of Nitrogen* – Oxides of nitrogen (NO_x) are another precursor to the formation of ozone. They are produced as the result of high-temperature fuel combustion and subsequent atmospheric reactions. Major sources of NO_x include diesel engines, power plants, refineries and other industrial operations.

Table 8-1 shows the National Ambient Air Quality Standards for the major airborne pollutants of interest.

**Table 8-1
National Ambient Air Quality Standards**

Pollutant	Primary Standard		Secondary Standard	
	µg/m ³ ^f	ppm ^f	µg/m ³	ppm
Carbon Monoxide			same as primary	
8-hour concentration	10,000 ^a	65 ^a		
1-hour concentration	40,000 ^a	35 ^a		
Sulfur Dioxide				
annual arithmetic mean	80	0.03		
24-hour concentration	365 ^a	0.14 ^a		
3-hour concentration			1,300 ^a	0.50 ^a
Nitrogen Dioxide			same as primary	
annual arithmetic mean	100	0.053		
Ozone			same as primary	
8-hour concentration	157	0.08 ^b		
1-hour concentration	235 ^c	0.12 ^c		
Lead			same as primary	
quarterly arithmetic mean	1.5			
Particulate Matter			same as primary	
PM₁₀				
annual arithmetic mean	50 ^d			
24-hour concentration	150 ^e			
PM_{2.5}				
annual arithmetic mean	15 ^d			
24-hour concentration	65 ^e			

Source: *Virginia Ambient Air Monitoring 2000 Data Report, VDEQ.*

Notes: ^a Not to be exceeded more than once per year.

^b Three-year average of the fourth highest 8-hour concentration may not exceed 0.08 ppm.

^c Areas not attaining the 1-hour standard by the end of 1997 must attain that standard before demonstrating attainment with the 8-hour standard.

^d Based on a 3-year average of annual averages.

^e Based on a 3-year average of annual 98th percentile values.

^f µg/m³ refers to micro-grams per cubic meter; ppm is parts per million.

Under federal regulations, areas that violate primary ambient air quality standards are designated as nonattainment areas. A State Implementation Plan (SIP) must be developed to bring these areas into attainment. The Federal Clean Air Act Amendments of 1990 require that regionally significant transportation plans, programs and projects in nonattainment areas conform with the appropriate SIP. SIP conformity involves eliminating or reducing the severity and number of violations of the NAAQS and achieving attainment of those standards.

The Virginia Department of Environmental Quality (VDEQ) enforces ambient air quality standards identical to the NAAQS.

8.2 Affected Environment

The Norfolk LRT study area lies within the Hampton Roads Intrastate Air Quality Control Region, which includes the counties of James City and York, along with the cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg.

Ongoing air quality monitoring throughout the Hampton Roads Intrastate Air Quality Control Region indicates that the area is in compliance with the National Ambient Air Quality Standards for all pollutants, except the newly designated 8-hour standard for ozone. In November 1991, EPA designated the Hampton Roads Intrastate Air Quality Control Region as a marginal nonattainment area for ozone. Beginning in 1993, EPA and VDEQ conducted three years of quality-assured ambient air monitoring to demonstrate that the NAAQS for ozone had been achieved. In June 1997, EPA redesignated the region as an attainment area for ozone (*Federal Register*, Volume 62, Number 123, June 26, 1997). As part of revisions to the State Implementation Plan, EPA approved a maintenance plan under which the Hampton Roads region will demonstrate continued compliance with the 1-hour ozone standard. The City of Norfolk has been in attainment in the 1-hour standard for ozone since 1997. Currently, the newly created 8-hour average standard for ozone puts Hampton Roads in a marginal non-attainment status for ozone, with a requirement to obtain attainment by 2007.

The current ozone standard is based on air quality measurements averaged over a 1-hour block of time. Table 8-2 identifies the number of times the one-hour and eight-hour ozone standards were exceeded between 1996 and 2001 in the City of Norfolk.

Table 8-2
Air Quality Trends in the City of Norfolk

	Number of Days Exceeding the Ozone Standard*					
	1996	1997	1998	1999	2000	2001
1-Hour	0 days	0 days	0 days	3 days	0 days	1 days
8-Hour	2 days	11 days	10 days	10 days	0 days	4 days

Source: Virginia Department of Environmental Quality

Note: *The 1-hour standard for ozone of 124 parts per billion cannot be exceeded more than one day per year averaged over three consecutive years.

8.3 Environmental Impacts

The purpose of this section is to identify and compare the air quality impacts of the Norfolk LRT Project alternatives. Automobiles and other motor vehicles represent a major source of air pollution in the region. Minimizing the growth in travel by single-occupant automobiles will be an important factor in achieving the regional air quality goals. The Preferred Alternative and the TSM Alternative would both reduce the total vehicle miles traveled by single occupancy vehicles. The proposed project would provide a critical link in the regional network of high capacity transit services, increasing the opportunities for non-automotive travel. As a result, the Preferred Alternative is expected to have positive regional air quality impacts.

8.3.1 Regional Air Quality

A. Methodology

For the purposes of this analysis, air quality impacts are defined as the incremental change in Year 2026 regional emissions of CO, VOC, and NO_x under the TSM and Preferred Alternative relative to the No-Build alternative. Furthermore, relative differences in regional pollutant levels among the alternatives are attributed entirely to changes in daily vehicular emissions. Differences in vehicular emissions are a direct function of the change in daily vehicle-miles traveled (VMT) and pollutant emission rates.

Specific steps in the air quality analysis include the following:

- Identify the impact of the project alternatives on the Year 2026 regional VMT;
- Estimate Year 2026 average pollutant emission rates for CO, VOC and NO_x;
- Determine the relative regional pollutant emissions for each alternative by applying the emission rates to the corresponding changes in regional VMT; and
- Compare the relative pollutant emissions to identify regional air quality impacts.

B. Analysis

The reductions in regional VMT for the TSM and Preferred Alternative were derived from ridership forecasts based on the Hampton Roads Crossing Study Travel Demand Model. Model runs were based on Year 2026 socioeconomic forecasts that reflect the most recent Hampton Roads Planning District Commission (HRPDC)/Office of State Planning (OSP) projections, disaggregated to the model traffic analysis zone (TAZ) level.

Comparing the highway network assignments of the project alternatives provided an estimate of the reduction in regional VMT due to mode shift. The initial VMT reduction estimates then were adjusted to account for the portion of vehicular travel that would be redirected to park-and-ride locations. The resulting net VMT reductions were used as the basis of the regional air quality analysis.

Year 2026 emission rates for CO, VOC and NO_x were estimated using the EPA MOBILE6.2 model, conducted by VDOT, with selected parameters adjusted to reflect assumed conditions in the study area.

Table 8-3 summarizes the results of the Year 2026 regional air quality analysis for the No-Build, TSM and Preferred Alternatives. It shows the net reduction in regional VMT for the TSM and Preferred Alternative relative to the No-Build Alternative, along with the estimated pollutant emission factors and the corresponding differences in regional emissions.

Table 8-3
Year 2026 Regional Air Quality Impact Analysis and Results
Relative to the No-Build Alternative

Project Alternative	Annual VMT Reduction (veh-mi)	Carbon Monoxide (CO)		Hydrocarbons (NO _x)		Volatile Organic Compounds (VOC)	
		Emission Factor (g/veh-mi)	Emission Reduction (tons/year)	Emission Factor (g/veh-mi)	Emission Reduction (tons/year)	Emission Factor (g/veh-mi)	Emission Reduction (tons/year)
No-Build	0.00	13.37	0.00	0.3114	0.00	0.327	0.00
TSM	11,143,500	13.37	163.9	0.3114	3.82	0.327	4.01
Preferred	13,680,000	13.37	201.2	0.3114	4.69	0.327	4.92

Source: URS Corp., July 2005

Notes: Tons = grams/ 909,000

As the results in Table 8-3 indicate, the Preferred Alternative and the TSM Alternative are expected to reduce the amount of regional vehicular travel relative to the No-Build Alternative. The reduction in VMT would result in lower emissions of CO and the ozone precursors (VOC and NO_x). Based upon this analysis, neither the TSM nor Preferred Alternative would have an adverse effect on the regional air quality. Furthermore, by providing an alternative to single-occupant vehicle travel, implementation of the TSM or Preferred Alternative would support the attainment and maintenance of air quality standards in the region.

8.3.2 Microscale Air Quality

Vehicular traffic is the most significant source of CO emissions in the region. Because CO emissions dissipate rapidly with increasing distance from the source, the highest concentrations are likely to occur in the vicinity of congested roadway intersections or other locations where motor vehicles tend to idle for a period of time. The local intersection air quality analysis consists of a microscale “hot spot” investigation for violations of the ambient air quality standards for CO.

A. Methodology

The methodology for identifying local air quality impacts follows the EPA-recommended procedure for CO microscale impact analysis. The general evaluation procedure, outlined in the *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (EPA, 1992), includes a multiple intersection screening process, followed by microscale CO analysis with the CAL3QHC line-source dispersion model.

The multiple intersection screening analysis is used to identify study area locations requiring further analysis for CO hot spots. The intersection screening process includes the following steps:

1. Identify and rank the top 12 signalized intersections in the study area by peak hour traffic volumes.
2. Determine the average delay and level-of-service (LOS) for those 12 intersections.

From those 12 intersections, select the three highest volume locations and the three highest delay locations for further analysis. The total may be less than six if one or more study area intersections meet both selection criteria. The selected intersections then are evaluated for each alternative using a microscale analysis procedure. The procedure is used to estimate maximum 1-hour and 8-hour CO concentrations in the vicinity of each intersection for comparison with the NAAQS. It is assumed that if microscale analysis does not identify significant local air quality impacts at the selected intersections, then impacts would be unlikely at any other study area location.

The microscale air quality analysis procedure includes the following steps:

1. Assemble the required data for the analysis, including meteorological conditions, site characteristics, traffic parameters and emission variables.
2. Estimate the future background CO concentration based on monitoring data and the expected change in regional emissions.
3. Identify receptor locations near the intersection for simulation of future ambient CO concentrations.
4. Compute the worst-case 1-hour CO concentration using CAL3QHC.
5. Estimate the worst case 8-hour CO concentration by applying a suitable persistence factor to the computed 1-hour concentration. The use of a persistence factor is intended to reflect the relationship between 1-hour and 8-hour traffic and meteorological conditions.
6. Compare the results with the ambient air quality standards to identify adverse impacts, including new or aggravated violations.

B. Analysis

Using peak hour traffic analysis results for the Norfolk LRT study area, the top 12 intersections were identified, ranked and screened. These intersections are listed in Table 8-4. The shaded rows represent intersections with the three highest volumes and three highest delays, with levels of service D or worse. Level of Service is provided for informational purposes only.

**Table 8-4
Intersection Screening Results (Preferred Alternative)**

Project Study Area Top 12 Intersections by Volume	Year 2026 PM Peak Hour Traffic		
	Volume ^a	Delay ^b	LOS ^c
Brambleton Ave. / St. Pauls Blvd	6,324	124.2	F
Waterside Dr. / St. Pauls Blvd.	5,538	125.5	F
Brambleton Ave. / Boush Street	6,203	22.5	C
Brambleton Ave. / Park Ave. ^e	5,116	184.2	F
Newtown Road / Kempsville Road	5,251	76.2	E
City Hall Ave. / St. Pauls Blvd.	5,458	114.6	F
Brambleton Ave. / Colley Ave.	5,379	103.1	F
Campostella Rd. / Kimball Terrace	3,508	-	C
Brambleton Ave. / Duke Street	5,569	30.8	C
Ballentine Blvd. / I-264 WB on/off Ramps	3,136	65.5	E
Brambleton Ave. / Granby St.	4,516	42.9	D
Brambleton Ave. / Monticello Ave.	4,313	24.2	C

Source: URS Corp., September 2004

Notes:

^a Combined intersection approach volume, in vehicles per hour.

^b Average delay per vehicle, in seconds.

^c Estimated intersection level-of-service based on average delay.

The screening resulted in a total of three intersections being selected for further analysis based on traffic volume and delay. Those intersections included the following:

- Brambleton Ave. / St. Pauls Blvd.
- Waterside Dr. / St. Pauls Blvd.
- Brambleton Ave. / Park Ave.

The microscale modeling process requires a number of parameters and assumptions. The model inputs listed below are consistent with current EPA recommendations, and are intended to represent reasonable worst case scenarios at the three selected intersections.

- **Meteorological Characteristics**
 - Averaging Time: 60 minutes
 - Surface Roughness: 108 cm
 - Settling Velocity: 0 cm/sec
 - Deposition Velocity: 0 cm/sec
 - Wind Speed: 1.0 m/sec
 - Stability Class: D
 - Mixing Height: 1,000 meters
- **Traffic Characteristics**
 - Lane configuration, link volume, signal cycle length, red time and lost time were taken from Norfolk LRT Traffic Technical Appendix C, *Traffic Operations, Grade Crossings and Parking Study*, URS, Inc. July 2004.
- **Site Characteristics**
 - Intersection layouts and roadway link coordinates were determined from maps and aerial photographs of the study area.
- **Emission Characteristics**
 - Running emission rates were obtained from the Virginia DOT Air Quality Program. Mobile6.2 input and output files are included in Appendix G. The average free flow speed was assumed to be 31 mph on all roadway links, and the minimum and maximum temperatures were assumed to be 71° F and 94° F.
 - Idle emission rates were calculated by converting the 2.5 mph MOBILE6.2 running rate from grams per mile to grams per hour.
 - The EPA-recommended default persistence factor for urban areas of 0.7 was used to estimate 8-hour CO concentrations.

The VDEQ *Virginia Ambient Air Monitoring 2002 Data Report* monitoring data was used to identify background CO levels. CO levels of 7.1 ppm (1-hour average) 5.1 ppm (8-hour average) were assumed for Year 2002. The Year 2002 background CO level then was modified to approximate conditions in Year 2026 using the following adjustment factors:

- **Change in Average CO Emission Rates** – Average CO emission rates in the region are expected to decrease because of emission controls and turnover in the vehicle fleet. The change in average CO emission rates will tend to decrease background CO concentrations. Average CO emission rates for Year 2002 and Year 2026 were generated using MOBILE6.2, with an average speed of 31 mph. The ratio of the Year 2026 rate to the Year 2002 rate was used to adjust the background CO level. The Year 2026 MOBILE6.2 emission rate for idling vehicles (2.5 mph) is 34.67 grams per vehicle mile.

- **Change in Regional VMT** – As travel in the region increases, it will tend to increase background CO levels. Based upon input from HRPDC, an annual VMT growth rate of 1.0 % was assumed. To approximate the change in regional VMT between Year 2002 and Year 2026, the annual growth rate was compounded for a 24-year period. The resulting value was used to adjust the background CO level.

The computation of the Year 2026 background CO level is summarized in Table 8-5. Based upon this analysis, the estimated Year 2026 background CO levels are 4.0 ppm for the 1-hour average and 2.9 ppm for the 8-hour average.

Receptors at each intersection were defined where the public is likely to have access and long-term exposure to the ambient CO concentrations.

**Table 8-5
Year 2026 Background CO Level Computations**

	1-hour	8-hour
Background CO Level 2002	7.1 ppm	5.1 ppm
MOBILE6.2 Emission Factor for 2002 (31 mph)	30.30 g/veh-mi	30.30 g/veh-mi
MOBILE6.2 Emission Factor for 2026 (31 mph)	13.37 g/veh-mi	13.37 g/veh-mi
Adjustment for Emission Reduction (2002 to 2026)¹	0.44	0.44
Adjustment for VMT Growth at 1.0% per year (2002 to 2026)	1.28	1.28
Estimated CO Level for 2026 (1-Hour Average)²	4.0 ppm	2.9 ppm

Source: URS Corp September 2004

Notes: ¹ MOBILE6.2 Emission Factor for 2026 divided by MOBILE6.2 Emission Factor for 2002

² Background CO level X Adjustment for Emission Reduction X Adjustment for VMT growth

After all the necessary parameters and assumptions had been defined for the selected intersections, the CAL3QHC model was run for each project alternative. The results of the CO microscale modeling are included in Appendix G and summarized in Table 8-6. For each location, the table shows the highest predicted 1-hour and 8-hour CO concentrations under each of the project alternatives. Intersection level traffic volumes associated with the Preferred Alternative are almost identical to those of the TSM and No-Build Alternatives. As a result, CO computations are the same for the No-Build, TSM and Preferred Alternative.

**Table 8-6
Year 2026 Maximum Predicted CO Computations**

Intersection	Maximum Concentration (ppm) ^c	
	1-Hour ^a	8-Hour ^b
Brambleton Ave. / St. Pauls Blvd	7.0	5.0
Waterside Dr. / St. Pauls Blvd.	5.1	3.7
Brambleton Ave. / Park Ave. ^c	6.1	4.4

Source: URS Corp October 2004

Notes:

^a Results include estimated background CO levels of 4.0 ppm (1-hour) and 2.9 ppm (8-hour) plus CAL3QHC model output.

^b Results include CAL3QHC model output * 0.7 + background CO levels of 4.0 ppm (1-hour) and 2.9 ppm (8-hour)

^c The applicable ambient CO standards for the 1-hour and 8-hour averaging periods are 35 ppm and 9 ppm, respectively.

The No-Build, TSM and Preferred Alternatives are identical due to minimal changes in traffic volume and signal timing operations.

As the results in Table 8-6 indicate, no violations of the current CO standards are projected under the No-Build, TSM or Preferred Alternative. As a result, the implementation of the Preferred Alternative would have no significant air quality impacts at these locations. Because the selected intersections represent the worst locations in the corridor in terms of traffic volume and vehicular delay, it is reasonable to conclude that other locations in the study area would not experience significant air quality impacts as a result of the Preferred Alternative.

8.3.3 Summary of Impacts

A. No-Build Alternative

Under the No-Build Alternative, total vehicle miles traveled in year 2026 would not be reduced from projected levels. Therefore, the No-Build Alternative would not have a positive affect on regional air quality.

B. TSM Alternative

Under the TSM Alternative, total annual vehicle miles traveled in the region would be reduced by approximately 11,143,500 miles from the No-Build levels in 2026, resulting in regional emission reductions of approximately 164 tons of CO, 3.8 tons of NO_x, and 4 tons of VOC. The TSM Alternative would contribute to the improvement of regional air quality.

C. Preferred Alternative

Under the Preferred Alternative, total annual vehicle miles traveled in the region would be reduced by approximately 13,680,000 miles from the No-Build levels in 2026. This would result in regional emission reductions of approximately 201 tons of CO, 4.7 tons of NO_x, and 4.9 tons of VOC. The Preferred Alternative would contribute to the improvement of regional air quality and its efforts to obtain ozone attainment status by 2007. In addition, as stated above, the implementation of the Preferred Alternative would have no substantial air quality impacts at local intersections.

8.4 Mitigation Plan

This study identified no adverse regional or local air quality impacts associated with the proposed Preferred Alternative, therefore, no specific mitigation plan is recommended.

8.5 Conformity

Based on the recently adopted ozone 8-hour standard, Hampton Roads is in an ozone non-attainment area and is required to be in compliance with the standard by June 2007.

Federal and state air quality regulations require that a project-level conformity analysis be conducted. A conformity analysis is used to determine if a transportation activity conforms to the purpose of the State Implementation Plan (SIP) of achieving and maintaining the applicable air quality standards. The criteria for conformity specify that a transportation activity cannot:

- Cause or contribute to any new violation of the federal air quality standards;
- Increase the frequency or severity of any existing violation of the standards; or
- Delay timely attainment of the standards.

Project-level conformity for ozone and CO is established by verifying that the project is included in a current TIP, and that the TIP has been found to conform to the SIP. The region also must meet four additional requirements to establish conformity with state and federal standards:

1. Conformity determinations must be based upon the latest accepted planning assumptions (Section 93.110, 40 CFR Part 51, Subpart T).
2. The latest emissions model must be used for the conformity analysis. For the Hampton Roads region, this is the MOBILE6.2 model developed by EPA (Section 93.111).
3. Conformity determinations must be accompanied by appropriate agency and public review (Section 93.112).
4. The Long Range Plan (LRP) and Transportation Improvement Program (TIP) must provide for the timely implementation of transportation control measures (TCMs) (Section 93.113).

The Norfolk LRT Corridor is not located in a maintenance or non-attainment area for PM10. Therefore, Conformity Ruling states that a project-level PM10 analysis is not required to demonstrate conformity.

Because the Norfolk LRT Corridor is located in a maintenance area for the 1-hour ozone standard and a nonattainment areas for the 8-hour ozone standard, federal air quality regulations (42 U.S.C. 7476[c]) require that a project-level conformity analysis be conducted for regionally significant projects. A conformity analysis is used to determine if a transportation activity (plan, program or project) conforms to the purpose of the State Implementation Plan, which is to achieve and maintain the applicable air quality standards. To maintain conformity, a transportation activity cannot:

- Cause or contribute to any new violation of the federal air quality standards;
- Increase the frequency or severity of any existing violation of the standards; or
- Delay timely attainment of the standards.

The Preferred Alternative, which is included in the 2026 Regional Transportation Plan and was approved by the Metropolitan Planning Organization, HRPDC, in December 2003, was reviewed by VDOT in December 2003 for air quality conformity. On December 10, 2004, USDOT determined that the FY2005 TIP and the 2026 Long Range Plan for the Hampton Roads 8-hour Ozone Non-attainment area demonstrate conformity with the Clean Air Act requirements.

The Preferred Alternative is also included in HRPDC's financially constrained 2003-2006 Hampton Roads, Virginia Transportation Improvement Program (TIP), which was adopted by the MPO in July 2004, and would result in decreases in the tons of pollutants emitted each day of the year into the region. The project represents an improvement in regional emission burdens as established in the TIP. MOBILE6.2 was used to model emissions; and conformity regulations have received public and agency approval. The CO micro-scale analysis demonstrated the project would not cause or contribute to any violation of the NAAQS. Therefore, the Preferred Alternative conforms to the goals set forth in the CAAA of 1990 and is in conformity with the SIP.