3.3 ENERGY

Methodology

Consideration of energy consumption and conservation potential of alternatives and mitigation measures in Environmental Impact Statement (EIS) documents is required by Council of Environmental Quality (CEQ) guidance at 40 CFR 1502.16(e) and FHWA technical guidance (TA 6640.8A).

This evaluation includes a qualitative comparison of energy consumption associated with the construction and maintenance of the evaluated alternatives and vehicle operation on the affected roadway network. Transportation energy use is categorized as direct or indirect use (FHWA TA 6640.8A). Direct energy use is related to the amount of fuel consumed for vehicle propulsion on the affected roadway. Energy use from vehicle operation is primarily a function of traffic volume, speed, distance traveled, and vehicle and fuel type. Roadway congestion affects travel speeds that impacts fuel consumption, resulting in slower speeds and increased idling that can increase energy consumption.

Indirect energy is energy consumed during construction of a transportation facility that is a function of the scale of the transportation infrastructure being constructed. Accurate construction energy costs cannot be determined given the uncertainty of field variables at this point in the study. However, construction energy factors include the amount of energy to extract raw materials, manufacture and fabricate construction materials, transport materials to the Study Area Corridors, and equipment operation to complete construction. In addition, temporary vehicle delays could be experienced resulting in additional energy usage and fuel consumption of commuter vehicles. More energy usage would also be incurred due to maintenance of the expanded facilities.

A qualitative assessment of the Alternatives’ impacts on energy resources and conservation potential has been performed by comparing each alternative’s energy consumption based on the length of the alternative and the relative construction scale or complexity, which is also based on alternative length.

Affected Environment

In the US the transportation sector is the second largest consumer of energy behind the industrial sector. The transportation sector comprises approximately 27 percent of end-use energy consumption in the country (US Energy Information Administration (EIA), 2013). Within the Commonwealth of Virginia, the transportation sector is the largest consumer of energy accounting for approximately 30 percent of end-use energy consumption (EIA, 2013). Of this consumption, motor gasoline makes up the second largest source of consumption, next to net interstate flow of electricity (EIA 2013). Approximately three-fifths of the petroleum used in Virginia is consumed as motor gasoline (EIA, 2015).

Environmental Consequences

The **No-Build Alternative** would not result in any project-related construction and would therefore not directly impact energy consumption.

Severe congestion occurring during peak travel times at the HRBT, MMMBT, and stopping traffic at the HRBT to allow truck turnarounds leads to traveling at reduced speeds and increased idling that results in increased fuel consumption. During events involving accidents and disabled vehicles, diverting to alternate routes also results in additional fuel consumption to travelers due to extra travel distances. The increasing age of infrastructure in the Study Area Corridors, particularly at the HRBT, requires more frequent maintenance that also increases energy consumption.

Alternative A spans a distance of approximately 12 miles along I-64, including the HRBT. Expanding from four to six lanes and providing an additional tunnel would increase the capacity of I-64 in the Study Area Corridor. By increasing capacity, more vehicles could use the roadway, directly consuming more fuel. However, this would be offset by easing congestion that would reduce slower traffic and idling that consume energy. Additionally, future vehicular energy consumption is expected to be reduced in part by improvements to vehicle energy efficiency. Over time, older and less fuel-efficient vehicles are expected to be replaced with more fuel efficient vehicles, including hybrid and electric vehicles.

Alternative A would make improvements over the smallest area compared to the other Build Alternatives, thus it would consume less indirect energy to build, operate and maintain. Construction energy would be applied to build the expanded mainlines, approach bridges, and tunnels. The construction energy used for Alternative A would therefore be greater than conditions under the No-Build Alternative. Alternative A would require less energy to construct than the other Build Alternatives due to its smaller scale. Because construction is a one-time occurrence and temporary, no long-term impacts to energy consumption would occur.

The **Alternative B** Study Area Corridor spans a distance of approximately 26 miles. Alternative B would be longer than Alternative A but shorter than Alternative C or D. Therefore, it would provide greater benefits relative to Alternative A of increased capacity that leads to more direct energy consumption, and reduced congestion that saves energy. Alternative B, while consuming more energy to construct, operate and maintain relative to Alternative A, would result in fewer benefits and adverse direct and indirect energy effects than Alternative C or D.

Alternative C encompasses approximately 40 miles of improvements. Alternative C would provide more travel lanes in addition to new dedicated transit lanes in both travel directions, but would not make improvements to I-64 or VA 164 from the new VA 164 Connector interchange to I-664. It would also cross the entire Hampton Roads Harbor via the I-664 and I-564 Connectors, and widen I-664 from Hampton to Chesapeake at the I-64/I-264 interchange. Alternative C would be longer than Alternative A or B. It would increase capacity that would consume more direct energy by roadway travelers; however, this consumption would be partially offset by reducing congestion over a larger area than Alternative A or B. Because Alternative C includes dedicated transit lanes, greater gains in transit travel reliability would result in some travelers opting to take transit rather than drive their own vehicle, further reducing energy consumption relative to Alternatives A and B. Alternative C would consume more energy to construct, operate, and maintain than Alternatives A and B. Because Alternative C improvements would be made to a shorter network of roads than Alternative D, it would provide fewer energy benefits and less direct and indirect energy consumption relative to Alternative D.

Alternative D is a combination of elements of all of the other Build Alternatives. Alternative D as a whole would encompass approximately 55 miles of improvements. Because it would increase capacity the most relative to the other Build Alternatives, Alternative D would realize more travel vehicle energy consumption than the other alternatives. Alternative D would also benefit energy consumption the most because of increased congestion relief compared to the other alternatives. This alternative would consume the most energy to construct, operate, and maintain, compared to the other alternatives.

Mitigation

Measures to mitigate the energy usage during construction may include limiting the idling of machinery and optimizing construction methods to lower overall fuel use.

3.4 FARMLANDS AND FORESTAL DISTRICTS

Methodology

This section evaluates the potential alternative impacts to resources protected under the Farmland Protection Policy Act (7 USC 4201 et seq. and 7 CFR 658) and the Virginia Agricultural and Forestal Districts Act (VC15.2-4300 et seq.). These resources include farmland, Virginia Agricultural and Forestal Districts, and sensitive soil types in the Study Area Corridors. In Virginia, the Virginia Department of Agriculture and Consumer Services (VDACS) is responsible for designating Farmland of Statewide Importance with concurrence from the NRCS.

Affected Environment

Active Farmland and Farmland Soils

According to VDACS, there are no active farmlands within the Study Area Corridors. The US Department of Agriculture Natural Resources Conservation Service (NRCS) designates two categories for Farmland and Farmland Soils: prime and unique farmland. NRCS defines Prime Farmland as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops and is available for these uses. Unique Farmland is land that is used for producing specific high-value food or fiber crops (NRCS, 2016).

The Study Area Corridors are located in highly urbanized areas that have already been developed or are planned for development. The National Cooperative Soil Survey by the NRCS shows the majority of the Study Area Corridors do not contain protected farmland soils. There are soils within the I-664 Study Area Corridor on the Southside that are considered to be “prime farmland”, “prime farmland if drained”, or “prime farmland if protected from flooding or not frequently flooded during the growing season”. However, no land in the Study Area Corridors is currently zoned or used for agriculture. Therefore, no lands in the Study Area Corridors are protected by the Farmland Protection Policy Act (FPPA).

Agricultural and Forestal Districts

Virginia State Code authorizes localities to designate Agricultural and Forestal Districts as a means of protecting working farm and forest land (§15.2-4300 and 4400). Designation of these districts require landowners to keep their land in forest product or agricultural production for four to ten years. According to Virginia Department of Forestry data, no Agricultural or Forestal Districts are currently established within the HRCS Study Area Corridors (DOF, 2016).

Environmental Consequences

Active Farmland and Farmland Soils

Because there is no farmland within the Study Area Corridors, neither the **No-Build Alternative** nor the **Build Alternatives** would have an impact to farmland or farmland soils.

Agricultural and Forestal Districts

The **No-Build Alternative** and the **Build Alternatives** would not impact agricultural and Forestal Lands.

Mitigation

Because no effects to farmland are anticipated under any of the **Build Alternatives**, no mitigation is suggested.

3.5 RIGHT-OF-WAY AND RELOCATIONS

Methodology

Data and information were collected on social demographics, property values, and potential relocations, including individual tax parcel data, within the LOD of the retained alternatives. This information was compiled from: city tax parcel databases, aerial photos, the US Census website, Geographic Information System (GIS) databases, conceptual drawings, and field inspections. All existing data is based on information gathered at the time of this study.

Potential impacts were determined by using GIS to overlay the estimated LOD of the retained alternatives on city tax parcel digital data and aerial photography. The individual parcel data was then compiled and the area that may be acquired with implementation of a Build Alternative was computed. Property impacts are classified as either partial or total acquisitions. Total acquisitions occur when the primary structure is impacted, when access to the property is cut-off, when more than 50 percent of the property is taken, when the property is bisected, or when the improvements are located within 10 feet of the primary structure. Partial acquisitions occur when a portion of a parcel is acquired and that portion does not include a primary structure.

Potential relocations include all total acquisitions where there is a primary structure located on the property. Potential relocations may also occur on parcels that are partially acquired where a primary structure is impacted or access is cut off.

Affected Environment

Study Area Corridors are developed to analyze existing and proposed roadway conditions. As such, the Study Area Corridors include land and properties that do currently fall within existing VDOT right-of-way. The Study Area Corridors that make up Alternative A include 173.8 acres and 753 properties. Alternative B includes 634.9 acres and 1,026 properties. Alternative C includes 792.9 acres and 757 properties. Alternative D includes 1,090.0 acres and 1,709 properties.

Environmental Consequences

Potential relocations are summarized in **Table 3-21**. Most relocations are "Residential", with the greatest number occurring under **Alternative D**. The "Residential" numbers all represent single family residences. Potential "Commercial" relocations are a combination of business and commercial zoning, and would occur only with **Alternatives C** and **D**; "Commercial" relocations include a warehouse (Alternative C only), a pizza parlor, a building at an energy provider complex, and a single-family residence with a commercial use.

Table 3-21: Total Relocations by Alternative

Alternative	Alternative A	Alternative B	Alternative C	Alternative D
Residential	9	9	11	20
Commercial	0	0	5	4
Other*	2	4	8	9
Total	**11**	**13**	**24**	**33**

**Other includes Military, Institutional, and Industrial zoning classifications.*

"Other" includes institutional, military, and other industrial properties; the greatest number of such takes would be with Alternative D. The institutional properties include two VDOT properties. The military property impact is located on the USCG site. The industrial properties include a pump technology company (Alternative C only), a pressure washer sales and services company, a building at a cabinet-making shop, and a building each at two port-related industries. Open space properties are included because, while they are zoned as such, buildings on these properties would be acquired as part of the project. The three open space properties would be included part of Alternatives C and D. More details are provided in the *HRCS Right-of-Way and Relocation Technical Memorandum*.

Mitigation

The acquisition of right-of-way and the relocation of displacements would take place in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (42 USC 4601). VDOT has the ability and, if necessary, is willing to provide housing of last resort, including the purchase of land or dwellings; repair of existing dwellings to meet decent, safe, and sanitary conditions; relocation or remodeling of dwellings purchased by VDOT; or construction of new dwellings. Assurance is given that all displaced families and individuals would be relocated to suitable replacement housing, and that all replacement housing would be fair housing available to all persons without regard to race, color, religion, sex, or national origin and would be within the financial means of the displacees. Each person would be given sufficient time to negotiate for and obtain possession of replacement housing. No residential occupants would be required to move from property needed for the Retained Build Alternatives until comparable decent, safe, and sanitary replacement dwellings have been made available to them.

3.6 AIR QUALITY

Regulatory Context

Pursuant to the Federal CAA of 1970, the EPA established National Ambient Air Quality Standards (NAAQS) for major pollutants known as "criteria pollutants." Currently, the EPA regulates six criteria pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, and lead (Pb). Particulate matter (PM) is divided into two particle size categories: particles with a diameter less than 10 micrometers (PM_{10}) and those with a diameter of less than 2.5 micrometers ($PM_{2.5}$). The primary and secondary NAAQS for the criteria pollutants are listed in the *HRCS Air Quality Analysis Technical Report*.

EPA promulgated the transportation conformity rule (40 CFR Parts 51 and 93) pursuant to requirements of the CAA. The rule **only** applies in EPA designated non-attainment or maintenance areas (40 CFR 93.102(b))[1]. The Hampton Roads area is in attainment of all of the applicable NAAQS; therefore, transportation conformity rule requirements do not apply for this region.

The federal conformity rule requires that a conforming transportation plan and program be in place at the time of the project approval (40 CFR 93.114), and for the project to be included in the conforming plan and program (40 CFR 93.115). The HRCS was included in the HRTPO fiscal year (FY) 2012-2015 Transportation Improvement Program (TIP) and the 2034 Long Range Transportation Plan (LRTP) as a study-only project on March 21, 2013, and as such, did not require a new regional conformity

[1] See: https://www.gpo.gov/fdsys/pkg/CFR-2015-title40-vol20/xml/CFR-2015-title40-vol20-sec93-102.xml

determination. Since then, EPA revoked the 1997 8-hour ozone standard for transportation conformity purposes on July 20, 2013, and therefore, transportation conformity requirements do not currently apply throughout the Study Area Corridors.

On May 16, 2016, FHWA and VDOT implemented a "*Programmatic Agreement for Project-Level Air Quality Analyses for Carbon Monoxide*" (hereinafter "2016 Agreement") that was developed based on a national template that was created in a recently completed National Cooperative Highway Research Program (NCHRP) study[2]. The NCHRP template was designed to be applied using state-specific background concentrations and persistence factors, without the need to update the detailed worst-case CO modeling as presented in its Technical Support Document (TSD). The 2016 Agreement uses number of lanes and other criteria to screen projects involving highway links, unskewed intersections and interchanges with adjacent unskewed intersections.

As the new NCHRP template agreement does not include skewed intersections, the 2016 FHWA-VDOT Agreement incorporates by reference the previously existing 2009 FHWA-VDOT "*Project-Level Carbon Monoxide Air Quality Studies Agreement*" (hereinafter "2009 Agreement") that did include skewed intersections. Under the terms of the 2009 Agreement, project-level air quality (hot-spot) analyses are typically only conducted for CO for projects that exceed specified ADT and level of service (LOS) thresholds or for any project for which an Environmental Impact Statement is being prepared. Different ADT thresholds are specified for different intersection skew angles. Worst-case ranked intersections and interchanges that cannot be screened using the Agreement are quantitatively assessed using worst-case modelling assumptions for CO consistent with the VDOT Resource Document.

Projects that meet the criteria specified in the 2016 Agreement (or by reference the thresholds from the 2009 Agreement) do not require project-specific modelling for CO. For those projects, the air quality analysis can simply reference as appropriate the 2016 Agreement and the worst-case modelling for CO on which its thresholds/criteria are based.

In March of 2006, EPA and FHWA issued joint guidance for conducting a hot-spot analysis for particulate matter[3]. The guidance applies to projects within a maintenance or non-attainment area for $PM_{2.5}$ and outlines the criteria for determining whether a project is considered to be one of "air quality concern". EPA recently updated the Transportation Conformity guidance for quantitative hot-spot analyses in November of 2015[4]. The Study Corridor is located in an area designated by EPA as attainment for the coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$) NAAQS; therefore, transportation conformity requirements pertaining to particulate matter do not currently apply for this Project.

In December of 2012, the FHWA issued an interim guidance update regarding the evaluation of Mobile Source Air Toxics (MSAT)[5] in NEPA analyses and included projections utilizing the EPA MOVES emission model and updated research on air toxic emissions from mobile sources. In accordance with the MSAT guidance, the study area is best characterized as a project with "higher potential MSAT effects" since

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[2] ICF International, Zamurs and Associates LLC, and Volpe Transportation Systems Center, "*Programmatic Agreements for Project-Level Air Quality Analyses*", NCHRP 25-25 (78), 2015. See: http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3311

[3] http://www.fhwa.dot.gov/environment/air_quality/conformity/policy_and_guidance/pmhotspotguidatt.cfm

[4] https://www3.epa.gov/otaq/stateresources/transconf/documents/420b15084.pdf

[5] http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/aqintguidmem.cfm

projected design year traffic is expected to reach the 140,000 to 150,000 annual average daily traffic (AADT) thresholds. Therefore, a quantitative MSAT analysis has been completed.

Climate change is a critical national and global concern. Human activity is changing the earth's climate by causing the buildup of heat-trapping greenhouse gas (GHG) emissions through the burning of fossil fuels and other human activities. Carbon dioxide (CO_2) is the largest component of human produced emissions; other prominent emissions include methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbons (HFCs). These emissions are different from criteria air pollutants since their effects in the atmosphere are global rather than localized, and also since they remain in the atmosphere for decades to centuries, depending on the species.

Greenhouse gas emissions have accumulated rapidly as the world has industrialized, with concentration of atmospheric CO_2 increasing from roughly 300 parts per million in 1900 to over 400 parts per million today. Over this timeframe, global average temperatures have increased by roughly 1.5 degrees Fahrenheit (1 degree Celsius), and the most rapid increases have occurred over the past 50 years. Scientists have warned that significant and potentially dangerous shifts in climate and weather are possible without substantial reductions in greenhouse gas emissions. They commonly have cited 2 degrees Celsius (1 degree Celsius beyond warming that has already occurred) as the total amount of warming the earth can tolerate without serious and potentially irreversible climate effects. For warming to be limited to this level, atmospheric concentrations of CO_2 would need to stabilize at a maximum of 450 ppm, requiring annual global emissions to be reduced 40-70 percent below 2010 levels by 2050.[6] State and national governments in many developed countries have set GHG emissions reduction targets of 80 percent below current levels by 2050, recognizing that post-industrial economies are primarily responsible for GHGs already in the atmosphere. As part of a 2014 bilateral agreement with China, the US pledged to reduce GHG emissions 26-28 percent below 2005 levels by 2025; this emissions reduction pathway is intended to support economy-wide reductions of 80 percent or more by 2050.[7] To date, EPA has not established any air quality standards for GHG under the NAAQS, however, the EPA is taking a number of steps to address climate change from both stationary and mobile sources through:

- Collecting emissions data;
- Reducing GHG through regulatory initiatives (e.g. vehicle greenhouse gas rules, clean power plan, renewable fuel standard, new generation clean vehicle standards)
- Reducing EPA's carbon footprint;
- Evaluating Policy Options and the cost benefits
- Partnering Internationally along with States, Localities, and tribes
- Helping communities adapt.

As such, a qualitative analysis of GHG emissions was conducted to address climate change impacts from the Project.

[6] IPCC, 2014: Climate Change 2014: Synthesis Report Summary for Policymakers. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
[7] "US-China Joint Announcement on Climate Change," White House, Office of the Press Secretary, November 11, 2014, on the White House website, https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change, accessed June 5, 2015.

Methodology

Project-level analyses for highway projects typically consist of evaluations of carbon monoxide (CO), particulate matter (PM), and Mobile Source Air Toxics (MSATs). The methodologies and assumptions applied for the analysis for each pollutant, which are discussed below, are consistent with FHWA and EPA guidance as well as the VDOT Project Level Air Quality Analysis Resource Document[8] including its associated on-line data repository.

Roadway Carbon Monoxide

The CO hot-spot analysis utilized the traffic assessment conducted by the design team for the 2015 existing year, interim year Build and No-Build (2028), and the design year Build and No-Build (2040) conditions.

Intersections

An analysis of the LOS and peak hourly volumes was evaluated for each Alternative to confirm the worst-case intersection locations for consideration under the 2016 Agreement. The intersections were ranked for each Alternative using peak AM and PM volumes and LOS criteria as specified in the EPA guidance. The three highest ranked intersections by LOS and the higher of the AM or PM peak hourly ranked volumes were summarized for each Alternative (Figures are included in Section 4 and Appendix A of the *HRCS Air Quality Technical Report* denoting the worst-case intersections of each Alternative).

The 2016 Agreement was then applied to screen the worst-case intersections for each Alternative. Based on the traffic forecasts, all of the worst-case intersections identified for each Alternative would meet the design year ADT thresholds referenced in that Agreement. Project-specific CO hot spot modeling therefore is not needed for any of the intersections, as they can be cleared based on the Agreement and the worst-case CO hot-spot modeling for intersections on which it was based.

Interchanges

Similarly, the interchanges were also ranked by worst-case volumes for the mainline traveling through each interchange. Traffic volumes used in the ranking of the interchanges as well as the interchange locations studied for each Alternative is included in Section 4 and Appendix A of the *HRCS Air Quality Technical Report*. The top five interchanges by volume for each Alternative were further analyzed to include skew angles, average speeds, and LOS along the mainline for evaluation and justification for any additional interchanges for modeling beyond just worst-case traffic volumes.

In summary, the worst-case interchanges which were modeled based on the methodology described above are as follows:

- I-64 and I-664 (Northern Termini)
- I-564 and Route 460 and I-64
- I-64 and Route 167 Lasalle Ave
- I-664 and West Military Hwy
- I-664 and I-64 (Southern Termini)

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[8] VDOT Project–Level Air Quality Analysis Resource Document, April 2016.

For the highway interchanges, a worst-case analysis approach was taken using the latest version of the FHWA CAL3i program to develop conservative estimates for CO concentrations using a number of simplifying assumptions as discussed in more detail in Section 4 of the *HRCS Air Quality Technical Report*.

Tunnel Assessment

The methodology and assumptions for assessing the tunnel air quality analysis were consistent with the most recent FHWA guidance: *Revised Guidelines for the Control of Carbon Monoxide (CO) Levels in Tunnels* and the methodologies developed from the Downtown Tunnel-Midtown Tunnel-Martin Luther King Freeway Extension (DT-MT-MLK) project in August, 2010. The methodology included a series of calculations using the tunnel dimensions, ventilation system data, and traffic emissions and assumptions to estimate the CO concentration inside the tunnel. According to the ASHRAE standard, tests and operating experience have shown that when CO is adequately controlled, the other vehicle emission pollutants are likewise adequately controlled. Therefore, the analysis demonstrates that the one-hour CO NAAQS of 35 ppm along with the FHWA/EPA 15-minute exposure level of 120 ppm will be met inside the new tunnels. The analysis was conducted for the Existing, No-Build and each of the four 2040 Build Alternatives for two worst-case scenarios: 1) peak-hour conditions in order to address the worst-case scenario associated with routine peak hour traffic operations; and 2) an incident (idling) that stops traffic such as an accident or vehicle breakdown. A detailed discussion of the methodologies and assumptions used in the CO tunnel analysis is presented in Section 5 of the *HRCS Air Quality Technical Report*.

Mobile Source Air Toxics (MSAT)

The affected network for the MSAT analysis was developed using the Hampton Roads Travel Demand Forecast Model for each Alternative. Using the forecast model, the affected network will extend well-beyond the study area in order to capture changes in MSAT emissions due to changes in traffic volumes when comparing the No-Build to each Build Alternative condition. The affected networks for each Alternative were developed using as many of the FHWA criteria for which traffic data existed. For this analysis, the daily volume change and travel time change for congested and uncongested links to develop each network. Based on traffic projections for the base, opening year, and design years, the segments directly associated with the Study Area Corridors and those roadways in the affected network; where the AADT is expected to change +/- 5 percent or more and where travel time is expected to change by +/- 10 percent for the Build Alternatives compared to the No-Build Alternatives were identified. The affected network for each of the Build Alternatives is shown in Figures 4-11 through 4-18 of the *HRCS Air Quality Technical Report.* The EPA MOVES2014a model was utilized in order to obtain air toxic emissions for acrolein, benzene, 1, 3-butadiene, diesel PM, formaldehyde, naphthalene and polycyclic organic matter. Details on the traffic methodology used to develop the affected network and associated MOVES2014a inputs for each condition and Alternative are discussed in the *HRCS Air Quality Technical Report*.

Climate Change and Greenhouse Gas

GHG emissions from vehicles using roadways are a function of distance traveled (expressed as vehicle miles traveled, or VMT), vehicle speed, and road grade. GHG emissions are also generated during roadway construction and maintenance activities. VMT derived from the MSAT Affected Network for each Alternative was used to characterize the VMT changes for the GHG discussion as the links identified in the Affected Network include only roadway links that could significantly impact the project Study Area (based on FHWA criteria) and excludes roadway links not affected by the Alternatives.

VMT was not used to calculate GHG emissions for each Alternative because there is no context in which to evaluate the results. For example, there are no significance thresholds for mobile source GHG emissions nor has the EPA or FHWA identified specific factors to consider in making a significance determination for GHG emissions. CEQ has noted that "it is not currently useful for the NEPA analysis to attempt to link specific climatological changes, or the environmental impacts thereof, to the particular project or emissions; as such direct linkage is difficult to isolate and to understand."[9] Accordingly, it is not useful to attempt to determine the significance of such impacts. There is a considerable amount of ongoing scientific research to improve understanding of global climate change and EPA and FHWA guidance will evolve as the science matures or if new Federal requirements are established. While the results could be used to differentiate between Alternatives, the VMT from which these emissions would be calculated serves the same purpose.

Indirect Effects

Effects of the project that would occur at a later date or are fairly distant from the project are referred to as indirect effects. Cumulative impacts are those effects that result from the incremental impact of

the action when added to other past, present and reasonably foreseeable future actions. Cumulative impacts are inclusive of the indirect effects. As summarized in the Environmental Consequences, the potential for indirect effects or cumulative impacts to air quality that may be attributable to this project is not expected to be significant.

Affected Environment

The Study Area Corridors are located in Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, and Suffolk, Virginia. The EPA Green Book[10], which lists non-attainment, maintenance, and attainment areas, was reviewed to determine the designations for the jurisdictions within Hampton Roads in which the project is located. These include Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, and Suffolk. The EPA Green Book shows that all of the jurisdictions in the region, including those spanning the entire project corridor, are designated as being in attainment for all of the NAAQS[11].

Environmental Consequences

The microscale analysis was conducted using the latest version of the EPA MOVES (MOVES2014a) and CAL3QHC models to estimate worst-case CO concentrations at individual receptor (i.e., receiver) locations. Peak CO concentrations resulting from the project at each location were then added to the appropriate CO background concentrations to determine the worst-case CO impacts at each location. These values were then compared to the 1-hour and 8-hour CO NAAQS to determine compliance.

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[9] CEQ (2010). Draft Guidance Consideration of the Effects of Climate Change and Greenhouse Gas Emissions, 75 Federal Register 8046 (February 23, 2010) available at http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf

[10] EPA Green Book: https://www3.epa.gov/airquality/greenbook/faq.html

[11] Effective April 6, 2015, EPA revoked the 1997 eight-hour ozone NAAQS for which the Hampton Roads region had previously been in attainment-maintenance. Therefore, the associated transportation conformity requirements that applied at the time that the FEIS was prepared no longer apply. See: https://www.gpo.gov/fdsys/pkg/FR-2015-03-06/pdf/2015-04012.pdf

The results of the 1-hour and 8-hour CO hot-spot analysis for the worst-case interchange locations is presented in **Table 3-22** for the Existing, Interim, Design Year Build, and No-Build conditions.

The highest 1-hour predicted concentrations for the base, opening and design year build and no-build conditions were 11.5 ppm, 6.5 ppm and 4.6 ppm, respectively. The maximum 1-hour concentration for all base and future build and no-build conditions was predicted to occur at the I-64 and I-664 (Northern Termini) interchange. However, all predicted peak 1-hour CO concentrations are well below the 1-hour CO NAAQS of 35 ppm.

The highest 8-hour concentrations for the base, opening and design year build and no-build conditions were 8.2 ppm, 4.5 ppm and 3.1 ppm, respectively. Similar to the peak 1-hour concentrations, the maximum 8-hour CO concentration was also predicted to occur at the I-64 and I-664 (Northern Termini) interchange for the base and future build and no-build conditions. However, all predicted peak 8-hour CO concentrations are also below the 8-hour CO NAAQS standard of 9 ppm.

Table 3-22: Modeling Results for the Worst-Case Interchanges

Intersection / Interchange	Averaging Period	2015[1, 2]	2028[1, 2]		2040[1, 2]		NAAQS (ppm)
		Base (No-Build)	No-Build Alternative	Build Alternative	No-Build Alternative	Build Alternative	
		Peak (ppm)	Peak (ppm)	Peak (ppm)	Peak (ppm)	Peak (ppm)	
I-64 and I-664 (northern Termini)	1-Hour	11.5 (4)	3.7 (4)	6.5 (4)	3.0 (4)	4.6 (4)	35
	8-Hour	8.2 (4)	2.4 (4)	4.5 (4)	1.9 (4)	3.1 (4)	9
I-564 and Route 460 and I-64	1-Hour	10.7 (13)	3.8 (9)	6.2 (13)	3.1 (9)	4.4 (13)	35
	8-Hour	7.6 (13)	2.5 (9)	4.3 (13)	1.9 (9)	2.9 (13)	9
I-64 and Route 167 Lasalle Ave	1-Hour	8.0 (9)	3.0 (10)	4.8 (6)	2.6 (13)	3.6 (5)	35
	8-Hour	5.6 (9)	1.9 (10)	3.2 (6)	1.6 (13)	2.3 (5)	9
I-664 and West Military Hwy	1-Hour	10.3 (1)	3.5 (13)	5.9 (1)	2.9 (13)	4.2 (1)	35
	8-Hour	7.3 (1)	2.2 (13)	4.0 (1)	1.8 (13)	2.8 (1)	9
I-664 and I-64 (southern Termini)	1-Hour	8.9 (4)	3.6 (4)	5.4 (4)	3.1 (4)	3.9 (2)	35
	8-Hour	6.3 (4)	2.3 (4)	3.7 (4)	1.9 (4)	2.5 (2)	9

Notes:
1. Number in parenthesis represents the modeled receptor number of maximum modeled concentration from CAL3QHC. Please refer to Figures 4.5 through 4-9.
2. Modeled concentrations includes 1-hour Background Value of 2.0 ppm and 8-hour background value of 1.1 ppm

These results demonstrate that the worst-case interchanges for each existing, build and no-Build Alternative using very conservative assumptions would not cause or contribute to a violation of the CO NAAQS within the study corridor, and thereby satisfies all NEPA and CAA requirements pertaining to CO.

Tunnel Carbon Monoxide

Included in the air quality evaluation is the addition of new tunnels. A series of new tunnels are proposed along the I-64, I-564 Connector, and I-664 Study Area Corridors.

The ventilation system within the proposed tunnels would be designed consistent with the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) Handbook, Chapter 15, Enclosed Vehicular Facilities - Tunnels[12]. The ventilation system design is based on controlling the level of emissions to acceptable concentrations inside the tunnel during normal operations, along with the capacity to remove smoke and gases during emergencies. The design assures the personal safety of both the traveling public as well as highway/emergency workers, ensuring the air quality within the tunnel would be met and consistent with normal ventilation air quantities as described in the referenced ASHRAE standard.

The results of the analysis show that CO levels in the tunnels are estimated to be below the one-hour CO NAAQS of 35 ppm and below the 15-minute FHWA/EPA guideline level of 120 ppm for both the peak hour and incident (idling) condition for all the Alternatives including the Build and No-Build conditions. The Existing and No-Build condition only includes the existing eastbound and westbound HRBT tunnels along I-64. The estimated worst-case CO concentration for the peak hour condition for the Existing condition is 24.0 ppm which is 20 percent of the FHWA/EPA guideline level and 68 percent of the CO NAAQS. The estimated worst-case CO concentration for the idling conditions is 11.1 ppm which is 9 percent of the FHWA/EPA guideline level and 32 percent of the CO NAAQS. Similarly, the estimated worst-case CO concentration for the peak hour condition for the No-Build condition is 12.4 ppm which is 10.3 percent of the FHWA/EPA guideline level and 35 percent of the CO NAAQS. The estimated worst-case CO concentration for the idling condition is 3.0 ppm which is 3 percent of the FHWA/EPA guideline level and 9 percent of the CO NAAQS.

For the peak hour condition for the Build Alternatives, the estimated worst-case CO concentration is 10.5 ppm (Alternative C I-664 Northbound) and is 30 percent of the CO NAAQS and 9 percent of the FHWA/EPA guideline level. For the incident idling condition, the estimated worst-case CO concentration is 7.0 ppm (Alternative C I-664 and I-564 Bus Only) and is 20 percent of the CO NAAQS and 6 percent of the FHWA/EPA guideline level.

The calculations include the one-hour CO VDOT ambient background level of 2.1 ppm, which was assumed to exist in the tunnel ventilation supply air.

Particulate Matter

The Study Area Corridors are located in the Hampton Roads Area which is designated by EPA as attainment for the coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$) NAAQS; therefore, transportation conformity requirements pertaining to particulate matter do not apply for this study. Regardless, the latest 3-year (2012-2014) monitoring data reported by the VDEQ for the Hampton

[12] 2015 ASHRAE Handbook -- HVAC Applications: Chapter 15, Enclosed Vehicular Facilities (SI)

monitor site show that the 24-hour and annual $PM_{2.5}$ background concentrations in the Study Area Corridors are 17 micrograms per cubic meter (ug/m^3) and 7.5 ug/m^3, respectively, which are both well below the respective $PM_{2.5}$ NAAQS of 35ug/m^3 and 12 ug/m^3.

Mobile Source Air Toxics

A quantitative MSAT analysis was conducted consistent with the latest guidance developed by FHWA. These include the Interim Guidance Update mentioned earlier, and the FHWA preliminary guidance for addressing a quantitative MSAT analysis using MOVES titled "Quick-start Guide for Using MOVES for a NEPA Analysis" along with training material developed by FHWA that provided detailed direction on the preparation of quantitative MSAT analyses as available from the VDOT On-line Data Repository.

The results of the quantitative MSAT analysis are presented in **Table 3-23**. Changes in emissions compared to the No-Build for the 2028 and 2040 condition and between the Build and base year are presented in **Table 3-24**. These tables show that all of the MSAT emissions are expected to increase slightly for the Build Alternative scenario when compared to the No-Build condition for 2028 and 2040. In addition, all MSAT pollutant emissions are expected to significantly decline in the opening and design years when compared to existing conditions. The downward trend in emissions is a result of technological improvements, i.e., more stringent vehicle emission and fuel quality standards coupled with ongoing fleet turnover, and is achieved despite increased VMT in this period.

In all cases, the magnitude of the MSAT emissions is small in the opening and design years and significantly lower than in the base year. Due to the small magnitude of projected MSAT emissions, the increase observed in 2028 and 2040 from the No-Build to the Build scenarios are not considered significant, especially when considering that emissions from all MSATs are expected to be significantly lower in future years than in the base year. Overall, the results of the MSAT analysis are consistent with national MSAT emission trends predicted by FHWA. No meaningful increases in MSATs have been identified and are not expected to cause an adverse effect on human health as a result of any of the Build Alternatives in future years.

Table 3-23: Projected Annual MSAT Emissions in tons per year (TPY) on "Affected Network"

Year	Alternative	Annual Vehicle Millions of Miles Traveled (AVMT)	Acrolein (TPY)	Benzene (TPY)	1,3 Butadiene (TPY)	Diesel PM (TPY)	Formaldehyde (TPY)	Naphthalene (TPY)	Polycyclic Organic Matter (TPY)
2015 Base Year	Existing Alternative A	2,428.1	0.544	10.15	1.190	36.30	8.52	1.04	0.450
	Existing Alternative B	3,645.0	0.835	15.42	1.820	55.30	13.03	1.58	0.687
	Existing Alternative C	4,111.2	0.891	16.83	1.970	58.24	13.97	1.70	0.737
	Existing Alternative D	4,571.8	0.989	18.71	2.189	64.62	15.51	1.89	0.820
	Alternative A	3,564.9	0.196	4.05	0.049	8.94	3.66	0.373	0.154

Year	Alternative	Annual Vehicle Millions of Miles Traveled (AVMT)	Acrolein (TPY)	Benzene (TPY)	1,3 Butadiene (TPY)	Diesel PM (TPY)	Formaldehyde (TPY)	Naphthalene (TPY)	Polycyclic Organic Matter (TPY)
2028 Opening Year	No-Build	3,492.8	0.187	4.04	0.046	8.42	3.50	0.360	0.152
	Alternative B	4,459.2	0.239	5.08	0.059	10.82	4.48	0.459	0.191
	No-Build	4,288.9	0.225	4.94	0.055	10.05	4.22	0.435	0.184
	Alternative C	5,274.1	0.275	6.00	0.068	12.36	5.16	0.531	0.223
	No-Build	5,064.6	0.274	5.67	0.067	12.00	5.00	0.528	0.212
	Alternative D	5,775.6	0.317	6.46	0.079	14.74	5.94	0.602	0.245
	No-Build	5,519.9	0.289	6.27	0.071	13.01	5.43	0.557	0.233
2040 Design Year	Alternative A	3,236.3	0.104	1.88	0.006	4.17	2.23	0.199	0.070
	No-Build	3,112.1	0.095	1.81	0.005	3.78	2.04	0.184	0.068
	Alternative B	4,859.9	0.145	2.82	0.008	5.71	3.10	0.281	0.105
	No-Build	4,647.8	0.139	2.70	0.008	5.49	2.97	0.269	0.100
	Alternative C	5,619.7	0.166	3.28	0.009	6.54	3.56	0.323	0.123
	No-Build	5,328.3	0.160	3.06	0.009	6.33	3.42	0.309	0.113
	Alternative D	6,385.6	0.189	3.67	0.010	7.46	4.04	0.366	0.136
	No-Build	5,972.6	0.183	3.45	0.010	7.29	3.91	0.352	0.129

Table 3-24: Projected Annual MSAT Change in Emissions (Percent) on "Affected Network"

Year	Alternative	Change Annual Vehicle Millions of Miles Traveled (AVMT)	Acrolein (TPY)	Benzene (TPY)	1,3 Butadiene (TPY)	Diesel PM (TPY)	Formaldehyde (TPY)	Naphthalene (TPY)	Polycyclic Organic Matter (TPY)
2028 Opening Year	Difference (Alternative A-No-Build)	72.10	0.01	0.01	0.00	0.52	0.16	0.01	0.00
	Difference (Alternative A-Existing)	1136.8	-0.348	-6.1	-1.141	-27.36	-4.86	-0.667	-0.296
	Difference (Alternative B- No-Build)	170.30	0.01	0.14	0.00	0.77	0.26	0.02	0.01
	Difference (Alternative B-Existing)	814.2	-0.596	-10.34	-1.761	-44.48	-8.55	-1.121	-0.496
	Difference (Alternative C-No-Build)	209.50	0.00	0.33	0.00	0.36	0.16	0.00	0.01
	Difference (Alternative C-Existing)	1162.9	-0.616	-10.83	-1.902	-45.88	-8.81	-1.169	-0.514

Year	Alternative	Change Annual Vehicle Millions of Miles Traveled (AVMT)	Acrolein (TPY)	Benzene (TPY)	1,3 Butadiene (TPY)	Diesel PM (TPY)	Formaldehyde (TPY)	Naphthalene (TPY)	Polycyclic Organic Matter (TPY)
	Difference (Alternative D-No-Build)	255.70	0.03	0.19	0.01	1.73	0.51	0.04	0.01
	Difference (Alternative D-Existing)	1203.8	-0.672	-12.25	-2.11	-49.88	-9.57	-1.288	-0.575
2040 Design Year	Difference (Alternative A-No-Build)	124.20	0.01	0.07	0.00	0.39	0.19	0.02	0.00
	Difference (Alternative A-Existing)	808.2	-0.44	-8.27	-1.184	-32.13	-6.29	-0.841	-0.38
	Difference (Alternative B-No-Build)	212.10	0.01	0.12	0.00	0.22	0.13	0.01	0.00
	Difference (Alternative B-Existing)	1214.9	-0.69	-12.6	-1.812	-49.59	-9.93	-1.299	-0.582
	Difference (Alternative C-No- Build)	291.40	0.01	0.22	0.00	0.21	0.14	0.01	0.01
	Difference (Alternative C-Existing)	1508.5	-0.725	-13.55	-1.961	-51.7	-10.41	-1.377	-0.614
	Difference (Alternative D-No-Build)	413.00	0.01	0.22	0.00	0.17	0.13	0.01	0.01
	Difference (Alternative D-Existing)	1813.8	-0.8	-15.04	-2.179	-57.16	-11.47	-1.524	-0.684

Climate Change and Greenhouse Gas (GHG) Impacts

Under the No-Build Alternative, VMT would gradually increase in the project area for each Alternative between 2015 and 2040 as employment and population in the area increases (see **Table 3-23** for VMT by Alternative). Furthermore, under the Build Alternatives, increased capacity, less congestion, and improved transit access across Hampton Roads lead to an increase in VMT relative to the No-Build Alternative. The increase is similar because the project is anticipated to shift traffic to the mainlines from other roadways, not necessarily increase traffic on the roadways beyond the background growth between 2015 and 2040.

Under the No-Build Alternative, VMT increases on average approximately 29 percent (the increase ranges from 28 percent to 31 percent depending on Alternative) between 2015 and 2040; under the Build Alternatives, VMT would increase on average approximately 36 percent compared to 2015 levels (the increases range from 33 percent to 39 percent depending on Alternative). For perspective, the VMT increases on average 3.7 percent (range of 2 percent to 5 percent) from the No-Build to Build Alternatives in 2028 and on average 5.2 percent (range of 4 percent to 7 percent) in 2040 depending on Alternative. Nationally, the Energy Information Administration (EIA) estimates that VMT will increase by approximately 38 percent between 2012 and 2040, so the VMT increase under the Build Alternatives is still at or below the projected national rate.

While VMT will increase as a result of the project, the anticipated increase in GHGs will be mitigated by improvements in national fuel economy standards. EIA projects that vehicle energy efficiency (and thus, GHG emissions) on a per-mile basis will improve by 28 percent between 2012 and 2040. This improvement in vehicle emissions rates will help mitigate the increase in VMT for both the No-Build and Build Alternatives. Other factors related to the project would also help reduce GHG emissions relative to the No-Build Alternative. The project would reduce congestion and improve vehicle speeds by increasing regional accessibility through providing extra lanes so that motorists can more easily pass slow-moving vehicles, improve transit access across Hampton Roads waterway, dedicated transit facilities in specific locations along with Bus Rapid Transit (BRT), and converting existing lanes to transit only lanes; the safety improvements associated with the planned upgrades would produce emissions benefits by reducing vehicle delay and idling.

The average travel speed across the mainlines within the Study Area would increase on average 49.4 miles per hour (range from 41 to 55 miles per hour) under the Build Alternatives compared to 44.7 miles per hour (range from 37 to 52 miles per hour) under the No-Build. GHG emissions rates decrease with speed over the range of average speeds encountered in this corridor, although they do increase at very high speeds. Reduction of road grade also reduces energy consumption and GHG emissions. The proposed road widening under the various Build Alternatives would match existing roadway grades. Proposed grades for both mainline and interchanges at-grade and on structure range from 0 to 4 percent. EPA estimates that each 1 percent decrease in grade reduces energy consumption and GHG emissions by 7 percent, although the effect is not linear. The safety improvements associated with the proposed widening and new Elizabeth River crossings, which include better incident management capabilities, would produce emissions benefits by reducing vehicle delay and idling.

Construction and subsequent maintenance of the project would generate GHG emissions. Construction of the roadway (e.g., earth-moving activities) involves a considerable amount of energy consumption and resulting GHG emissions. Manufacturing the materials used in construction and fuel used by construction equipment also contribute to GHG emissions. Typically, construction emissions associated with a new roadway account for approximately 5 percent of the total 20-year lifetime emissions from the roadway, although this can vary widely with the extent of construction activity and the number of vehicles that use the roadway.

The addition of new roadway miles to the study area roadway network would also increase the energy and GHG emissions associated with maintaining those new roadway miles in the future. The increase in maintenance needs due to the addition of new roadway infrastructure would be partially offset by the reduced need for maintenance on existing routes (because of lower total traffic and truck volumes on those routes).

In connection with GHG emissions, transportation system resiliency and adaptation to extreme weather events have been a focus area for USDOT. Climate change and extreme weather events present potentially significant risks to safety, reliability, effectiveness, and sustainability of transportation infrastructure and operations. In 2008, the USDOT Center for Climate Change and Environmental Forecasting sponsored a study, *The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure*.[13] The study was designed to produce high level estimates of the net effect of sea level

[13] http://climate.dot.gov/impacts-adaptations/pdf/entire.pdf

rise and storm surge on the transportation network. As such, the study provides a broad, first look at potential sea level changes on the Atlantic coast using the predictions of global sea level rise from the Intergovernmental Panel on Climate Change (IPCC) Third and Fourth Assessment Reports. Due to the broad approach of the study and uncertainties in the models involved, the study considered sea level rise estimates from the IPCC study as uniform sea level rise estimates as opposed to estimates for a particular geographic location. The confidence stated by the IPCC in the regional distribution of sea level change is low due to significant variations in the included models; thus, according to the study, it is inappropriate to use the IPCC model series to estimate local changes in sea level rise.

The study evaluated nine scenarios of sea level rise between 6 and 59 centimeters. For each scenario, regularly inundated areas and at-risk areas for the transportation system (i.e. highways, railroads, ports, and airports) were estimated. Based on the analysis, the majority of the HRCS study area corridors fall outside the potentially regularly inundated and at-risk areas due to sea level rise and storm surge for all scenarios. However, a couple sections of the corridors under consideration do fall within regularly inundated areas under the higher sea level rise scenarios. These portions include I-64 (in Hampton) and the VA 164 Connector (along the eastern edge of CIDMMA).

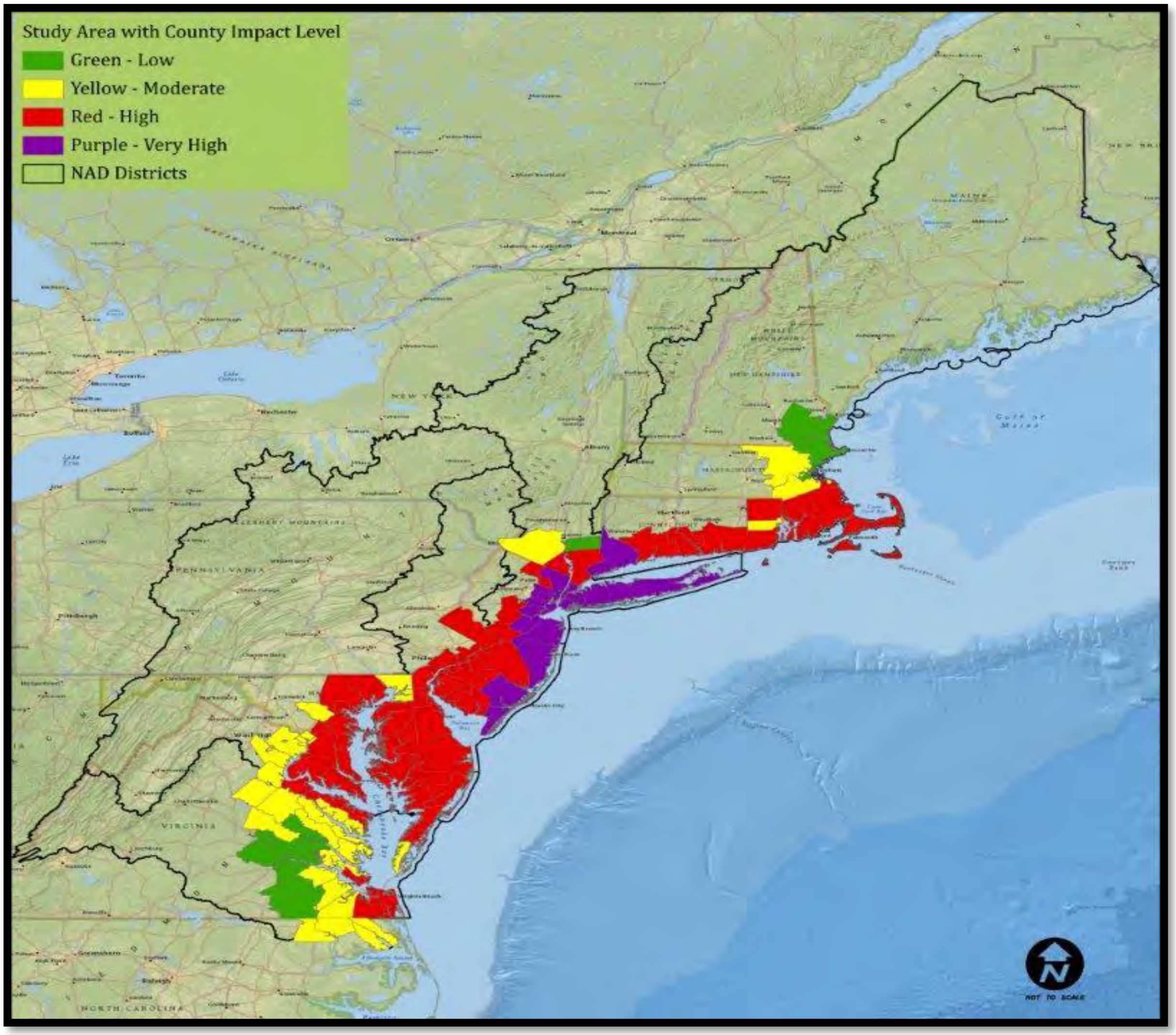
USACE completed a report detailing the results of a two-year study to address coastal storm and flood risk to vulnerable populations, property, ecosystems, and infrastructure affected by Hurricane Sandy in the United States' North Atlantic region.

The purpose the North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk Final Report (January 2015) is to catalyze and spearhead innovation and action to implement comprehensive coastal storm risk management strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to future storms and impacts of relative sea level change (SLC). The NACCS is designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. It builds on lessons learned from Hurricane Sandy and attempts to bring to bear the latest scientific information available for state, local, and tribal planners. The study area for the NACCS encompasses approximately 31,200 miles of coastline (**Figure 3-8**) and shows areas impacted by Hurricane Sandy with highlighted Counties included in NACCS Study Area.

The goals of the NACCS are to provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and to support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure. The HRCS SEIS takes into account the findings of the NAAS when assessing the potential impact of SLC and climate changes on the alternatives.

Hampton Roads, Virginia, is a low-lying, coastal metropolitan region that serves as the site for multiple military installations, including the largest naval base in the world, Naval Station Norfolk.

Figure 3-8: NAACS Study Area Impact Map

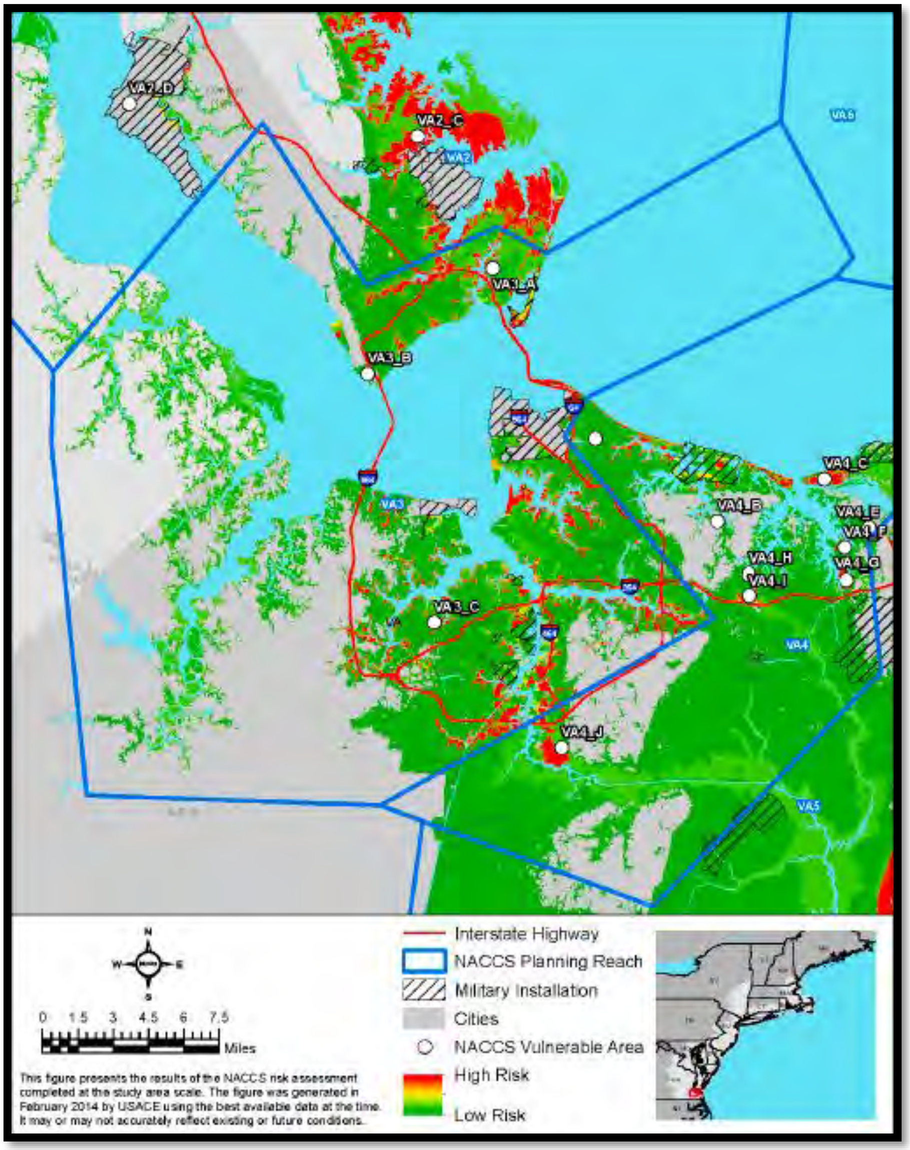


Source: North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk USACE (January 2015)

The NACCS describes the area VA3 (**Figure 3-9**) as where southern portion of the James River meets the Chesapeake Bay. This area also includes the Willoughby Bay and the Elizabeth, Nansemond, and Lafayette Rivers. The Port of Hampton Roads and CIDMMA are located within the reach on the Elizabeth River.

VA3 covers a large segment of the Hampton Roads Region, including Hampton, southern Newport News, Suffolk, Portsmouth, Chesapeake, and Norfolk. The majority of Virginia's Federal deep draft navigation channels are in VA3. The Cape Henry and Thimble Shoal channels are at the mouth of the Chesapeake Bay and the Willoughby and Norfolk Harbor Channels are on the Elizabeth River. There are also Federal shore stabilization and flood risk management projects located throughout including Hampton

Figure 3-9: VA3 Hampton Roads Risk Areas



University, Anderson Park, and the Norfolk floodwall project. Hampton University and Anderson Park are both small shoreline stabilization projects that were designed only to prevent land loss under normal conditions and would not provide coastal storm risk management to any structures during a coastal storm event, as tide levels and wave heights would exceed the design of the revetment structures.

There are three projects in VA3 that were designed for the purpose of coastal storm damage reduction on the Chesapeake Bay. One of these, the Chesapeake Bay Shoreline project, is a USACE project that was cost shared with the City of Hampton. The project widened the beach in front of the existing seawall that was constructed by the city and has been regularly renourished since initial construction. The City has also constructed nearshore breakwaters at the project. The other two beach projects, Salt Ponds and Willoughby, were implemented by the cities of Hampton and Norfolk, respectively. The City of Hampton regularly uses material dredged from Salt Ponds Inlet as beachfill to maintain the dunes and beach at Salt

Ponds. In Norfolk, the City has been maintaining the beach in Willoughby and has also constructed nearshore breakwaters in the area. Because these projects are all well maintained and have been designed to reduce storm damages, the risk of flooding and other storm damage is lower in the areas they protect than in locations without similar flood risk management measures.

Climate change and extreme weather impacts, such as more frequent and intense heat waves and flooding, will increasingly affect system integrity and threaten the considerable federal investment in transportation infrastructure.

Climate change impacts may include, but are not limited to, shoreline retreat from erosion and inundation, increased frequency and magnitude of storm related flooding, increased frequency of minor local flooding during high tide (NOAA, 2014), and saltwater intrusion into the estuaries and aquifers.

Climate change is projected to have a number of impacts on the natural environment. Relative SLC will not only inundate the landscape, but will also be a driver of change in habitat and species distribution. Additionally, the presence of developed shorelines behind many of these habitats will prevent migration of those habitats landward and limit their capacity for adaptation. Habitat changes may be structural or functional; species that depend on coastal habitats for feeding, nesting, spawning, protection, and other activities could be severely impacted if this critical habitat is converted or lost. Additional ecosystem services provided by coastal habitats would also be affected.

Climate change is anticipated to have effects on water resources in Hampton Roads. Warming temperatures and sea level rise may cause existing water supplies to decline or disappear, forcing utilities and regions to change the way water is used and distributed. Climate change is anticipated to have water quality impacts. Greater precipitation intensity will likely increase runoff, which will decrease surface water quality. Overall, climate change is expected to impact humans culturally, socially, and economically.

Newly constructed infrastructure should be designed and built in recognition of the best current understanding of future environmental risks. In order for this to happen, understanding of projected climate changes would need to be incorporated into infrastructure planning and design processes, across the many public and private builders and operators of transportation infrastructure. Building resilience to climate change risk is common-sense management to protect current and future investments and to maintain safe operational capabilities. Engineering solutions to adapt to climate vulnerabilities for highway facilities are anticipated to be implemented during project design and construction to address climate change, SLC, and extreme weather impacts

FHWA is partnering with VDOT, the University of Virginia (UVA), the Hampton Roads Planning District Commission (HRPDC), and HRTPO to evaluate the *Computational Enhancements for the VDOT Regional River Severe Storm Model* that is anticipated to be completed in January 31, 2017. This pilot study used an existing decision model to evaluate how the transportation priorities of the region might be influenced by a variety of climate change, economic, regulatory, travel-demand, wear-and-tear, environmental, and technology scenarios. Some of these, sea-level rise, storm surge and other extreme weather events – already are affecting Virginia's Tidewater region. Being able to accurately and quickly project the potential impacts to transportation infrastructure from forecasted weather events will become more critical, given such challenges. The VDOT Hampton Roads District has begun to address the issue by creating a flood-warning system called the Regional River Severe Storm Model. The model is a planning tool to help VDOT efficiently allocate resources when roads are closed and assist first responders with entering and exiting flood-prone areas. The purpose of this study is to speed the time from when rainfall forecasts are made to when on-the-ground projections of road closures are available to decision-makers.

The **No-Build Alternative** would not involve any construction or any efforts to adapt the existing transportation system to extreme weather impacts. As a result, environmental effects impacts to the transportation system from climate change would continue to worsen under the No-Build Alternative.

It is expected that the **Build Alternatives** could be developed to adapt to the effects of climate change. During final design the best available, climate science data and methods, as well as the results of the current FHWA/VDOT pilot study to evaluate engineering solutions, operations and maintenance strategies, and asset management plans to address risk, could be used to inform refinements to the Preferred Alternative.

Indirect Effects and Cumulative Impacts

The quantitative assessments conducted for project-specific CO and MSAT impacts can be considered indirect effects analyses because they look at air quality impacts attributable to the project that occur at a later time in the future. These analyses demonstrated that in the future, 1) air quality impacts from CO would not cause or contribute to violations of the CO NAAQS; and 2) MSAT emissions from the affected network would be significantly lower than they are today.

Regarding the potential for cumulative impacts, EPA's air quality designations for the region (as attainment of all of the NAAQS) reflect, in part, the accumulated mobile source emissions from past and present actions.

Therefore, the indirect and cumulative effects of the project are not expected to be significant.

Construction Emissions

The temporary air quality impacts from construction activities under any of the Build Alternatives are not expected to be significant. Construction activities would be performed in accordance with VDOT's current "Road and Bridge Specifications." The specifications require compliance with all applicable local, state, and federal regulations.

Mitigation

The Study Area Corridors are located within a volatile organic compounds (VOC) and nitrogen oxides (NOx) Emissions Control Area. As such, all reasonable precautions will be taken to limit the emissions of VOC and NOx. In addition, the following VDEQ air pollution regulations must be adhered to during the construction of this project: 9 VAC 5-130, Open Burning restrictions; 9 VAC 5-45, Article 7, Cutback Asphalt restrictions; and 9 VAC 5-50, Article 1, Fugitive Dust precautions.

3.7 NOISE

Methodology

The noise assessment has been performed pursuant to 23 CFR 772: Procedures for Abatement of Highway Noise and Construction Noise and the VDOT *Highway Traffic Noise Impact Analysis Guidance Manual* (Version 7, July 2015). To assess the degree of impact of highway traffic and noise on human activity, the FHWA established Noise Abatement Criteria (NAC) for different categories of land use activity (**Table 3-25**). The NAC are given in terms of the hourly, A-weighted, equivalent sound level in decibels (dBA). The A-weighted sound level is commonly used when measuring environmental noise to provide a single number descriptor that correlates with human subjective response to noise because the sensitivity of human hearing varies with frequency. The A-weighted sound level is widely accepted by acousticians as a proper unit for describing environmental noise. Most environmental noise (and the A-weighted sound level) fluctuates from moment to moment, and it is common practice to characterize the fluctuating level by a single number called the equivalent sound level (L_{eq}). The L_{eq} is the value or level of a steady, non-fluctuating sound that represents the same sound energy as the actual time-varying sound evaluated over the same time period. For traffic noise assessment, L_{eq} is typically evaluated over a one-hour period, and may be denoted as L_{eq}(h).

In this study, residential (Category B), recreational (Category C), indoor institutional (Category D) and commercial (Category E) land uses are evaluated for noise impact. For Categories B and C, noise impact is assumed to occur when predicted exterior noise levels approach or exceed 67 dBA in terms of L_{eq}(h) during the loudest hour of the day. For Category D (noise-sensitive institutional) land uses such as schools and church buildings, impact is projected where predicted interior sound levels due to the Project would approach or exceed 52 dBA, L_{eq}(h). For Category E land uses, examples of which are outdoor eating areas adjacent to restaurants or offices and motel swimming pools, noise impact is assumed to occur when predicted exterior noise levels due to the Project approach or exceed 72 dBA in terms of L_{eq}(h) during the loudest hour of the day. VDOT defines the word “approach” in “approach or exceed” as within 1 decibel. Therefore, the threshold for noise impact is where exterior noise levels are within 1 decibel of 67 dBA L_{eq}(h), or 66 dBA for Categories B and C, and within one decibel of 72 dBA L_{eq}(h), or 71 dBA for Category E. For Category D, the threshold for noise impact is where interior noise levels are within 1 decibel of 52 dBA L_{eq}(h), or 51 dBA. Noise impact also would occur wherever Project noise causes a substantial increase over existing noise levels. VDOT defines a substantial increase as an increase of 10 decibels or more above existing noise levels.

All traffic noise computations for this study were conducted using the latest version of the FHWA Traffic Noise Model (FHWA TNM version 2.5). TNM incorporates state-of-the-art sound emissions and sound propagation algorithms, based on well-established theory or on accepted international standards. The acoustical algorithms contained within TNM have been validated with respect to carefully conducted noise measurement programs, and show excellent agreement in most cases for sites with and without noise barriers.

Available project engineering plans, aerial photography, topographic contours and building information are used to create a three-dimensional model in the TNM of the geometry of the existing and future design roadway configurations and the surrounding terrain and buildings. The noise modeling also accounts for such factors as propagation over different types of ground (acoustically soft and hard ground), elevated roadway sections, significant shielding effects from local terrain and structures, distance from the road, traffic speed, and hourly traffic volumes including percentage of medium and heavy trucks. To fully characterize existing and future noise levels at all noise-sensitive land uses in the study area, over 6,600 noise prediction receivers (also called "receptors" and "sites"), were added to the measurement sites in TNM.

To fully account for potential noise impacts, barrier analysis along VA 164 assumed widening to the outside. If this Study Area Corridor is identified as part of a Preferred Alternative, the Final SEIS could document the noise impact of inside widening. Additional detailed information regarding the noise analysis methodology is provided in the *HRCS Noise Technical Report*.

Affected Environment

The existing, measured short-term noise levels are provided in **Table 3-25** as equivalent sound levels (L_{eq}), along with site address. The measured "Total" L_{eq} range from a low of 52 dBA at the Churchland High School baseball field in Portsmouth (Site M54) to a high of 74 dBA at 9279 Coleman Avenue in Norfolk (Site M25). These measurement results also show that the measured total L_{eq}s and the "Traffic-only" L_{eq}s are the same at most sites, which is an indication that traffic is the dominant source of noise at most locations in spite of the presence of occasional aircraft. Monitoring at sites M1 through M31 was conducted during 2011 for the HRBT Draft EIS study, sites M32 through M69 were measured in 2015 for the HRCS SEIS project, and monitoring for sites MR1 through MR3 was carried out in 2014 for the I-564 Intermodal study.

Table 3-25: Noise Measurement Results

Site	Address	Total L_{eq}, dBA	Traffic Only L_{eq}, dBA
M1	48 Red Robin Turn, Hampton	55	55
M2	Swing Set @ Horizon Plaza Apts, Hampton	60	60
M4	1303 Patrick Court, Hampton	62	62
M5	1105 Thomas Street, Hampton	69	69
M6	808 Langley Avenue, Hampton	66	66
M7	931 Mason Street, Hampton	69	66
M8	100 Spanish Trail (Pool Deck), Hampton	61	61
M9[1]	15 Colbert Avenue, Hampton	67[1]	N/A
M10	326 Poplar Avenue, Hampton	67	67
M11	101 Brough Lane, Hampton	67	67
M12	72 S Boxwood Street. Hampton	62	62
M13	Hampton University Baseball Stadium, Hampton	62	62
M14	114 Cameron Street, Hampton	63	63
M15	9 Home Place, Hampton	63	63
M16	Small Beach East Side of I-64, Hampton	63	63
M17	1560 Chela Avenue, Norfolk	63	63
M18	1353 Bayville Court, Norfolk	66	65
M19	Int. of 14th View and Little Bay Avenue, Norfolk	65	65

Site	Address	Total L_{eq}, dBA	Traffic Only L_{eq}, dBA
M20	Pier/Beach Willoughby Boat Club, Norfolk	61	61
M21	Captain's Quarters Waterfront Park, Norfolk	59	59
M22	9605 6th View Street, Norfolk	61	58
M23	8667 O'Conner Crescent, Norfolk	69	64
M24	381 Cherry Street, Norfolk	65	62
M25	9279 Coleman Avenue, Norfolk	74	73
M26	9246 Hickory Street, Norfolk	66	61
M27[1]	235 Burgoyne Road, Norfolk	68[1]	NA
M28	15 Burrage Road, Norfolk	59	59
M29	145 Burrage Road, Norfolk	69	NA[1]
M30	8587 Granby Street, Norfolk	64	64
M31	Executive Manor Apartments Norfolk	69	69
M32	340 Bradford Ave, Norfolk	63	63
M35	North End of Summerset, Chesapeake	68	68
M36	Side Yard of 1432 Branchview Way, Chesapeake	66	66
M37	4355 Topsail Landing, Chesapeake	69	69
M38	1509 James Landing, Chesapeake	62	62
M39	4401 Old Woodland Dr, Chesapeake	67	66
M40	4441 Woodland Dr, Chesapeake	64	64
M41	4512 Winnie Dr, Chesapeake	63	63
M42	2914 Old Stone Way, Chesapeake	66	64
M43	4956 Old Pughsville Rd, Chesapeake	60	60
M44	4903 Clifton St, Chesapeake	69	69
M45	3670 Mardean Dr, Chesapeake	65	65
M46	4733 Camelia Dr, Suffolk	68	68
M47	7020 Kenny Ln, Portsmouth	60	60
M48	3909 Old Farm Rd, Portsmouth	59	59
M49	3105 Polk St, Portsmouth	52	52
M50	6229 Hightower Rd, Portsmouth	57	56
M51	5229 Crabtree Pl., Portsmouth	55	55
M52	5416 Lilac Crescent, Portsmouth	57	56
M53	5010 Huntersville Pl, Suffolk	60	60
M54	Churchland HS Baseball Field - Cedar Ln, Portsmouth	52	52
M55	535 13th St, Newport News	62	62
M56	523 22nd St, Newport News	60	60
M57	Madison Ave, North of 36th St, Newport News	62	62

Site	Address	Total L_{eq}, dBA	Traffic Only L_{eq}, dBA
M58	Corner of 40th and Madison, Newport News	61	61
M59	Between Marshall Ave and Orcutt Ave, Newport News	65	65
M60	1118 41st St, Newport News	59	56
M61	1124 39th St, Newport News	72	72
M62	2604 W Pembroke Ave, Newport News	66	66
M63	730 Birch Ave, Hampton	73	73
M64	309 Ward Drive, Hampton	60	60
M65	228 Prince James Drive, Hampton	60	59
M66	Back yard of #5 Dundee Road, Hampton	66	66
M67	Hampton High School Batting Cages, Hampton	61	61
M68	West End of Braemar Drive, Hampton	66	66
M69	52 Allison Sutton Drive, Hampton	67	66
MR1	Fleet Recreation Park Pools, Norfolk	63	NA
MR2	Breezy Point Apartments, Norfolk	60	NA
MR3	Ingersol Ave. Apt. Complex, Rec. Areas, Golf Crs., Norfolk	62	NA

Note: Detailed data are provided in Appendix D of the HRCS Noise Technical Report and in the HRBT and I-564 Intermodal Connector Noise Technical Reports.
[1] 24-hour long-term measurement site. Loudest-hour L_{eq} is reported.
[2] Duration too short for meaningful measurement.

Existing Noise Barriers

There are several existing noise barriers along the I-64, I-664 and VA 164 Study Area Corridors. Field surveys and reviews of these barriers were conducted so that their locations and heights could be included in the noise modeling of both the existing and future conditions. More detail is provided in the *HRCS Noise Technical Report*.

Environmental Consequences

All noise levels predicted are the A-weighted equivalent sound level, or L_{eq}, in dBA. Loudest-hour noise levels are predicted for the Existing 2015 and the Design Year 2040 No-Build and Build Alternatives. Sound levels at all study area receivers are computed explicitly from the provided traffic data for Build Alternatives B, C and D. It was determined during the loudest-period assessment that the traffic for I-64 in Alternative A is very similar to that for Alternative B, such that the noise levels along I-64 are different by an average of less than 0.2 decibels. VDOT agreed that this made the two alternatives effectively equivalent along I-64. Therefore, only Alternative B is evaluated in detail, and all of the conclusions about noise along I-64 for Alternative B are applied to Alternative A as well. Overall, predicted exterior noise levels range from around 50 up to 77 dBA. On average for all receptors, sound levels are predicted to increase by approximately 1 decibel from the 2015 Existing case to the 2040 No-Build condition, due to increases in projected traffic volumes. Sound level increases from Existing to the 2040 Build Alternatives are similar to those for the No-Build, that is, approximately 1 decibel or slightly greater than existing levels, except in places where there are proposed improvements that would bring roadways closer to affected communities, or in places where existing shielding, such as existing noise barriers must be removed as part of the project construction. In those areas, sound level increases are higher, and particularly where barriers would be removed, can constitute "Substantial Increases" in existing noise levels greater than 10 dBA. While VDOT has a policy of replacing existing barriers that must be removed for roadway improvements, the sound levels and impact without the replacement barriers are reported initially.

Notably, the existing noise barriers along I-64 in Hampton and Norfolk are not affected by the roadway widening, which is planned to occur to the inside of the existing lanes. Therefore, these barriers have been retained for the Build Alternative noise analysis, and their benefits accrue to the receptors in all alternatives. However, the existing barriers along VA 164 in Portsmouth and along I-664 in Hampton and Newport News must all be removed in the Build Alternatives that apply to those roadways to accommodate the roadway widening.

Table 3-26 presents a summary of the predicted noise impact for the 2015 Existing and 2040 **No-Build Alternative** and **Build Alternatives**. In this table, the impacts are summarized by major corridors in the study area and by FHWA land use activity categories. In addition, a grand total of noise impact by alternative is given at the bottom. **Alternative D** has the greatest total impact, since it represents all of the project corridors. **Alternative B** has the next highest total impact, and it is greater than the No-Build Alternative impact primarily because of the removal of the existing noise barriers along VA 164 in Portsmouth, where there are 859 more impacts in Alternative B than in the No-Build Alternative. All of the Build Alternatives are predicted to have less impact than the No-Build Alternative in the I-64 corridor, due to two factors related to the roadway widening occurring to the inside of the existing roadway throughout much of the corridor. Where I-64 is elevated on structure, such as over the water near Willoughby Spit and at overpasses, the gap between the eastbound and westbound structures would be closed by the widening. That would prevent noise from the far direction lanes from traveling under the structure carrying the near direction lanes to receivers below the roadway. Closing this gap results in reductions of up to 2 or 3 decibels in some areas relative to the existing and No-Build conditions. The second benefit of widening to the inside is that the existing noise barriers along I-64 in Norfolk and Hampton are expected to be able to remain in place, so the existing benefit they provide is also assumed to occur in the future Build conditions.

The I-64 corridor has many Category C recreational land uses along it that are predicted to be impacted under all of the alternatives, including several cemeteries, golf courses, and playing fields.

Along the I-664 corridor, Alternatives C and D show similar levels of impact, although, the slightly higher traffic volumes forecasted for Alternative C on the peninsula would result in somewhat higher noise impact there. The removal of noise barriers along I-664 in Newport News and Hampton would result in noticeably higher impact under the Build Alternatives as compared with the Existing and No-Build Alternatives.

Table 3-26: Noise Impact Summary by Corridor and Land Use Activity Category

Corridor	Alternative	Number of Receptors Impacted by Activity Category				
		Residential Category B	Recreational/ Parks Category C	Institutional Interior Category D	Commercial Category E	Total
I-64	2015 Existing	653	125	0	0	778
	2040 No-Build	826	176	0	0	1,002
	2040 Alternative A	780	173	0	0	953
	2040 Alternative B	780	173	0	0	953
	2040 Alternative D	705	159	0	0	864
I-564	2015 Existing	1	17	0	0	18
	2040 No-Build	7	0	0	0	7
	2040 Alternative B	10	8	0	0	18
	2040 Alternative C	14	8	0	0	22
	2040 Alternative D	14	8	0	0	22
VA 164	2015 Existing	26	0	0	0	26
	2040 No-Build	51	0	0	0	51
	2040 Alternative B	901	6	3	0	910
	2040 Alternative C	1	0	0	0	1
	2040 Alternative D	751	6	3	0	760
I-664 Southside	2015 Existing	250	11	0	0	261
	2040 No-Build	323	14	0	0	337
	2040 Alternative B	104	2	0	0	106
	2040 Alternative C	386	14	0	0	400
	2040 Alternative D	397	16	0	0	413
I-664 Peninsula	2015 Existing	124	24	0	1	149
	2040 No-Build	263	37	0	1	301
	2040 Alternative C	492	62	0	1	555
	2040 Alternative D	422	58	0	1	481
Alternative A Totals	**2015 Existing A**	**653**	**125**	**0**	**0**	**778**
	2040 No-Build A	**826**	**176**	**0**	**0**	**1,002**
	2040 Alternative A	**780**	**173**	**0**	**0**	**953**
Alternative B Totals	**2015 Existing B**	**722**	**143**	**0**	**0**	**865**
	2040 No-Build B	**930**	**178**	**0**	**0**	**1,108**
	2040 Alternative B	**1,795**	**189**	**3**	**0**	**1,987**
Alternative C Totals	**2015 Existing C**	**368**	**58**	**0**	**1**	**427**
	2040 No-Build C	**585**	**59**	**0**	**1**	**645**
	2040 Alternative C	**921**	**92**	**0**	**1**	**1,014**

Corridor	Alternative	Number of Receptors Impacted by Activity Category				
		Residential Category B	Recreational/ Parks Category C	Institutional Interior Category D	Commercial Category E	Total
Alternative D Totals	2015 Existing D	1,047	183	0	1	1,231
	2040 No-Build D	1,462	235	0	1	1,698
	2040 Alternative D	2,289	255	3	1	2,548

Mitigation

When the predicted Design Year Build Alternative scenario noise levels approach or exceed the NAC during the loudest hour of the day or cause a substantial increase in existing noise, consideration of traffic noise reduction measures is warranted. If it is found that such mitigation measures would cause adverse social, economic or environmental effects that outweigh the benefits received, they may be dismissed from consideration. FHWA noise abatement criteria are provided in **Table 3-27**.

Table 3-27: FHWA Noise Abatement Criteria

Activity Category	$L_{eq}(h)$[1]	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
B[2]	67 (Exterior)	Residential
C[2]	67 (Exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52 (Interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E	72 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	–	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G[2]	–	Undeveloped lands that are not permitted (without building permits)

[1] Hourly Equivalent A-weighted Sound Level (dBA).
[2] Includes undeveloped lands permitted for this activity category.
Source: 23 CFR Part 772.

Noise Abatement Measures

VDOT guidelines recommend a variety of mitigation measures that should be considered in response to transportation-related noise impacts. While noise barriers and/or earth berms are generally the most effective form of noise mitigation, additional mitigation measures exist that have the potential to provide considerable noise reductions under certain circumstances. Mitigation measures considered for this project include:

- Traffic management measures,
- Alteration of horizontal and vertical alignments,
- Acoustical insulation of public-use and non-profit facilities,
- Acquisition of buffer land,
- Construction of earth berms,
- Construction of noise barriers.

Traffic management measures normally considered for noise abatement include reduced speeds and truck restrictions. Reduced speeds would not be an effective noise mitigation measure alone since a substantial decrease in speed is necessary to provide a significant noise reduction. Typically, a ten mph reduction in speed will result in only a two dBA decrease in noise level, which is not considered a sufficient level of attenuation to be considered feasible. Further, a two dBA change in noise level is not considered to be generally perceptible. Restricting truck usage on the different Study Area Corridors is not practical since one of the primary purposes of those facilities is to accommodate trucks. Diversion of truck traffic to other roadways would increase noise levels in heavily developed residential areas.

A significant alteration of the horizontal alignment of the Study Area Corridors would be necessary to make such a measure effective in reducing noise, since a doubling of distance to the highway is usually needed to affect a five-decibel reduction. However, such shifts would create undesirable impacts by increasing right-of-way acquisitions and relocations. Also, shifting the horizontal alignment is not practical since there are impacted receptors on both sides of the corridor throughout much of the study area. Shifting the alignment away from receptors on one side of the road would bring it closer to receptors on the other side of the road. Further alteration of the vertical alignment would not be feasible since the majority of the project involves widening an existing facility. Particularly given the large number of interchanges, raising or lowering the vertical alignment of the Study Area Corridors would result in significant environmental impacts to the surrounding environment and costly engineering challenges.

Acoustical Insulation of public-use and non-profit facilities applies only to public and institutional use buildings. Since no public use or institutional structures are anticipated to have interior noise levels exceeding FHWA’s interior NAC, this noise abatement option will not be applied.

The purchase of property for noise barrier construction or the creation of a “buffer zone” to reduce noise impacts is only considered for predominantly unimproved properties because the amount of property required for this option to be effective would create significant additional impacts (e.g., in terms of residential relocations), which were determined to outweigh the benefits of land acquisition.

Berms are considered a more attractive alternative to noise walls where there is sufficient land and fill available for them. However, berms do not appear feasible for the HRCS because they would greatly increase the cost and the footprint of the project by substantially increasing the amount of right-of-way required to accommodate the berms. Since much of the study corridor is densely developed, many costly and disruptive residential relocations necessarily would result from acquiring the needed right-of-way. The feasibility of berms in any areas with available unimproved property adjacent to the project may be reevaluated during the detailed noise study during final design.

Additionally, the Noise Policy Code of Virginia (HB 2577, as amended by HB 2025) states: *Requires that whenever the Commonwealth Transportation Board or the Department plan for or undertake any highway construction or improvement project and such project includes or may include the requirement for the mitigation of traffic noise impacts, first consideration should be given to the use of noise reducing design and low noise pavement materials and techniques in lieu of construction of noise walls or sound barriers. Vegetative screening, such as the planting of appropriate conifers, in such a design would be utilized to act as a visual screen if visual screening is required.* Consideration would be given to these measures during the final design stage, where feasible. The response to this requirement from project management is included Appendix F of the *HRCS Noise Technical Report*.

<u>Noise Barriers</u>

The only remaining abatement measure for consideration is the construction of noise barriers. The feasibility of noise barriers is evaluated for locations where noise impact is predicted to occur in the Build condition. Where the construction of noise barriers is found to be physically practical, barrier noise reduction is estimated based on roadway, barrier, and receiver geometry as described below.

To be constructed, any noise barriers identified in this document must satisfy VDOT's feasibility and reasonableness criteria. Therefore, the noise barrier design parameters and cost identified in this document are preliminary and should not be considered final. A final decision on the feasibility and reasonableness of noise barriers would be made during final design when the project design is developed and traffic updated. If a noise barrier is determined to be feasible and reasonable, the affected public would be given an opportunity to decide whether they are in favor of construction of the noise barrier.

Feasibility and Reasonableness

FHWA and VDOT require that noise barriers be both "feasible" and "reasonable" to be recommended for construction.

To be feasible, a barrier must be effective, that is it must reduce noise levels at noise sensitive locations by at least five decibels, thereby "benefiting" the property. VDOT requires that at least 50 percent of the impacted receptors receive five decibels or more of insertion loss from the proposed barrier for it to be feasible.

A second feasibility criterion is that it must be possible to design and construct the barrier. Factors that enter into constructability include safety, barrier height, topography, drainage, utilities, maintenance of the barrier, and access to adjacent properties. VDOT has a maximum allowable height of 30 feet for noise barriers.

Barrier reasonableness is based on three factors: cost-effectiveness, ability to achieve VDOT's insertion loss design goal, and views of the benefited receptors. To be "cost-effective," a barrier cannot require more than 1600 square feet per benefited receptor. VDOT's maximum barrier height of 30 feet figures into the assessment of benefited receptors. Where multi-family housing includes balconies at elevations above 30 feet, these receptors are not assessed and included in the determination of a barrier's feasibility or reasonableness.

The second reasonableness criterion is VDOT's noise reduction design goal of seven decibels. This goal must be achieved for at least one of the impacted receptors for the barrier to be considered reasonable.

The third reasonableness criterion relates to the views of the owners and residents of the potentially benefited properties. A majority of the benefited receptors must favor the barrier for it to be considered reasonable to construct. Community views would be surveyed in the final design phase of projects.

Existing Noise Barriers

There are many existing noise barriers in the Study Area Corridors. Several of these along I-64 are expected to be able to remain in place, since the proposed widening will not displace them, and no impact or limited noise impact is predicted behind them. However, the proposed roadway widening would impact the existing barriers adjacent to I-664. Replacement barriers that would provide at least the same level of protection as the existing barriers have been evaluated for each of these existing barriers, in accordance with VDOT's policy.

Details of Replacement and Potential Barriers

Noise abatement must be considered where noise impact is predicted. Noise abatement is evaluated to determine if it is warranted, feasible and reasonable. **Table 3-28** summarizes each corridor and city, the total length, estimated cost and benefits separately, that would be provided by the potential and replacement barriers evaluated that are found to be warranted, feasible, and reasonable. All replacement barriers are feasible and reasonable. Since the different Build Alternatives in each corridor are identical or nearly the same physically and they are also projected to carry very similar traffic in 2040, the barriers and their benefits are the same for each alternative in most of the corridors. Feasible and reasonable noise barriers are summarized below. Preliminary feasible and reasonable noise barriers are shown in **Appendix B**.

Table 3-28: Summary of Feasible and Reasonable Noise Barriers

Corridor and City	Alternatives	Length (miles)	Estimated Cost ($31/sq. ft.)	Number of Benefited Receptors		
				Impacted	Not Impacted	Total
I-64 Hampton	A, B, D	3.7	9,902,609	174	239	**413**
I-64 Norfolk	A, B, D	5.3	19,159,888	574	718	**1,292**
I-564 Norfolk	B, D	1.2	2,759,496	14	93	**107**
I-564 Norfolk	C	1.3	3,100,155	22	94	**116**
VA 164 Portsmouth	B, D	3.1	11,000,164	545	1,152	**1,697**
I-664 Chesapeake	C, D	3.8	12,950,746	243	349	**592**
I-664 Suffolk	C, D	1.9	7,653,094	145	284	**429**
I-664 Newport News	C, D	3.5	14,018,665	281	782	**1,063**
I-664 Hampton	C, D	2.9	8,714,968	213	386	**599**