# 6 Greenhouse Gas Emissions

This chapter presents the results of the air quality study and Greenhouse Gas (GHG) Emissions Assessment conducted for Phase 1 and 2 of the University of North Carolina Redevelopment project (Project). Two specific analyses were conducted in connection with the air quality assessment of the current project: a mesoscale analysis and a greenhouse gas analysis.

Mesoscale analysis was prepared for the proposed development project for the University of North Carolina to determine project-related ozone precursor emissions. The predominant source of ozone precursor emissions is from project-generated traffic. Ozone is not a direct emission from motor vehicles or stationary sources, but is formed when volatile organic compounds (VOC) and oxides of nitrogen (NOX) undergoes a chemical reaction in the atmosphere under the influence of sunlight and heat. Project-related ozone impacts are determined by assessing the volume of VOC and NOX emissions of motor vehicles.

The following is a discussion of the mesoscale (ozone precursor emissions) and the GHG analyses.

## 6.1 Mesoscale Analysis

This section presents a summary of the ozone mesoscale analysis conducted for the Project. In an effort to comply with the industry's best practices, and to prepare for state or federal regulation, we have adhered to EPA standards.

The ozone mesoscale analysis demonstrates that the Project is in compliance with the EPA standards on ozone (NOX and VOC) emissions. The Project will incorporate reasonable and feasible mitigation measures to reduce VOC and NOX emissions for the build condition.

The purpose of the mesoscale analysis is to estimate the area wide emissions of VOC and $NO_X$ during a typical day in the peak ozone season (summer) consistent with the requirements of EPA. The mesoscale analysis evaluates the change in VOC and $NO_X$ emissions from the average daily traffic volumes, roadway lengths, and vehicle emission rates. To demonstrate compliance with the EPA criteria, the air quality study must show the Project's change in daily (24-hour period) VOC and $NO_X$ emissions. Using EPA-recommended air quality modeling techniques, total pollutant emissions were calculated for the Project under eleven conditions (described below). The mesoscale study area includes all the roadway links and intersections that are projected to experience an increase of ten percent or more in traffic due to the Project and that experience Level-of-Service (LOS) designation of D or lower under existing or future conditions.

The specific roadways include:

- Martin Luther King Road
- Whitfield Road
- Interstate 40 East Ramps
- Weaver Dairy Road
- Homestead Road
- Estes Road
- Rosemary Street
- Columbia Street
- Cameron Ave
- South Road
- Manning Drive
- Culbreth Road
- Mt. Carmel Church Road
- US 15-501
- NC 54
- Merritt Road
- Jones Ferry Road
- Hillsborough Road
- Curtis Street
- Franklin Street
- Raleigh Street
- Europa Road
- Erwin Road
- Seawell School Road
- Old Chapel Hill Hillsborough Road
- Dairyland Road
- NC 54
- Main Street

### 6.1.1 Mesoscale Analysis Modeling Methodology

Traffic and emissions data are incorporated into the U.S. Environmental Protection Agency (EPA) air quality models and modeling procedures to generate emissions estimates that demonstrate whether the Project will have air quality impacts.

The University envisions a build-out of 8.0 million square feet over a 50 year period, with 3.0 million square feet expected to be completed in 2025. An interim step would develop 800,000 square feet by 2015. The air quality study evaluates eleven conditions:

- The 2009 Existing Condition represents current traffic conditions in the study area and assumes no vehicle trips to the Project Site;
- The 2015 No-Build Condition reflects existing traffic volumes increased to account for anticipated background traffic volume growth, and includes traffic related to specific development projects within the study area that are expected to be completed by 2015, and assumes no Project-related vehicle trips;
- The 2015 Build Condition reflects the 2015 No-Build Condition traffic volumes plus project generated vehicle trips related to Phase I of this project;
- The 2015 Build Conditions with Mitigation improvements were determined to offset Carolina North's traffic impacts for the year 2015 scenario.
- The 2015 "Early Phase Ratio" Build Condition. This is a 14 percent increase over the baseline parking supply scenario.
- The 2015 "Constrained Ratio" Build Condition. The Constrained Ratio scenario equals an across-the-board 10 percent reduction for parking among all user groups and facilities.
- The 2025 No-Build Condition reflects existing traffic volumes increased to account for anticipated background traffic volume growth, and includes traffic

related to specific development projects within the study area that are expected to be completed by 2025, and includes Phase I of the Project-related vehicle trips in the background;

- The 2025 Build Condition reflects the 2025 No-Build Condition traffic volumes plus project generated vehicle trips related to Phase II of the Carolina North Development Program.
- The 2025 Build Conditions with Mitigation includes traffic improvements that were designed to offset the project impacts for the year 2025 Build scenario.
- The 2025 "Constrained Ratio (-10%)" Build Condition equals an across-the-board 10 percent reduction for parking among all user groups and facilities.
- The 2025 "Constrained Ratio (-20%)" Build Condition equals an across-the-board 20 percent reduction for parking among all user groups and facilities.

The mesoscale analysis calculated the changes in VOC and NOx emissions for the existing and future conditions within the study area. The mesoscale analysis traffic (volumes, delays, and speeds) and emission factor data were developed for the eleven conditions. These data were incorporated into air quality models to demonstrate whether or not the Project will meet the Clean Air Act Amendments (CAAA).

## Emission Rates

The vehicle emission factors used in the mesoscale analysis were obtained using the EPA's MOBILE6.2[7] emissions model. MOBILE6.2 calculates emission factors from motor vehicles in grams per vehicle-mile for existing and future conditions. The emission rates calculated in this air quality study are adjusted to reflect North Carolina specific conditions such as the vehicle age distribution, the statewide Inspection and Maintenance (I/M) Program, and the Stage II Vapor Recovery System.[8] Emission factors for the mesoscale analysis were determined using the temperatures for the summer (ozone) season. The emissions factors were assigned according to the roadway classification for Orange County with and I&M program, as they are presented in the North Carolina 2030 and 2035 Long-Range Transportation Plans, specifically Appendix F: MOBILE6.2 Emission Factors.

1 MOBILE6.2 (Mobile Source Emission Factor Model), The May 2004 release from US EPA, Office of Mobile Sources, Ann Arbor, MI.

8 The Stage II Vapor Recovery System is the process of collecting gasoline vapors from vehicles as they are refueled. This requires the use of a special gasoline nozzle at the fuel pump.

Traffic Data

The air quality study used traffic data (volumes, delays, and speeds) developed for each analysis condition. The mesoscale analysis uses typical daily peak and off-peak traffic volumes for the ozone season (summer). Vehicle speeds are developed based upon traffic volumes, observed traffic flow characteristics, and roadway capacity.

### 6.1.2 Existing Ozone Air Quality Conditions

The 1990 CAAA partitioned states into attainment and non-attainment areas with classifications based upon the severity of the air quality problem. On June 15, 2005, the EPA revoked the 1-hour ozone standard for most areas in the country. North Carolina , Orange County has been determined to be in attainment for the 1-hour ozone. In addition, Orange Country has been designated as a Maintenance area for the 8-hour ozone standards. The area will remain a Maintenance Attainment area for a 20-year period, after which it can be redesignated to an Attainment area. An ozone Maintenance area is an area where the ozone levels formerly exceeded the NAAQS, but have now been reduced and meet the NAAQS. Orange County is in "attainment" for all remaining criteria pollutants (PM10, Lead, Nitrogen Oxide, and Sulfur Dioxide) for ambient (outdoor) air.

### 6.1.3 Future Ozone Air Quality Conditions

Future project related emission calculations for the Project are based upon changes in traffic and emission factor data. The traffic data include traffic volumes, vehicle-miles-of-travel, roadway operations, and physical roadway improvements. The emission factor data included emission reduction programs, years of analysis, and roadway speeds. The following section reports the findings of the mesoscale analysis for the Project.

The mesoscale analysis estimated the future study area VOC and NOx emissions due to the changes in traffic and emission data. Under the 2015 No-Build Condition, VOC emissions were estimated to be 405.6 kg/day, and NOx emissions were estimated to be 463.1 kg/day. The future No-Build Condition VOC and NOx emissions are lower than the 2009 Existing Conditions emissions due to the implementation of emission control programs, such as the Federal Motor Vehicle Emission Control Program, the Stage II Vapor Recovery System, and the North Carolina Vehicle Inspection and Maintenance program.

Under the 2015 Build Condition, the VOC emissions were estimated to be 416.3 kg/day and the $NO_X$ emissions were estimated to be 475.7 kg/day. This results in an increase of 10.7 kg/day in VOC emissions and an increase of 12.6 kg/day in NOx emissions from the 2015 No-Build Condition. Table 6-1 – Mesoscale Analysis Results presents the mesoscale analysis results for all conditions.

The mesoscale analysis estimated the future study area VOC and NOx emissions due to the changes in traffic and emission data. Under the 2025 No-Build Condition, VOC emissions were estimated to be 352.0 kg/day, and NOx emissions were estimated to be 247.5 kg/day. The future No-Build Condition VOC and NOx emissions are lower than the 2009 Existing Conditions emissions due to the implementation of emission control programs, such as the Federal Motor Vehicle Emission Control Program, the Stage II Vapor Recovery System, and the North Carolina Vehicle Inspection and Maintenance program.

Under the 2025 Build Condition, the VOC emissions were estimated to be 385.5 kg/day and the $NO_X$ emissions were estimated to be 271.6 kg/day. This results in an increase of 33.5 kg/day in VOC emissions and an increase of 24.1 kg/day in NOx emissions from the 2025 No-Build Condition. Table 6-1 presents the mesoscale analysis results for all conditions.

The EPA criteria requires that the Project incorporate air quality mitigation measures because the 2015 and 2025 Build Condition VOC and $NO_X$ emissions are greater than the 2015 and 2025 No-Build Condition VOC and $NO_X$ emissions, respectively. The air quality analysis with the proposed transportation mitigation proposed in connection with the Project is discussed below.

**Table 6-1: Mesoscale Ozone Analysis Results[1]**

| Pollutant | 2009 Existing Condition | 2015 No-Build Condition | 2015 Build Condition | Build / No-Build Difference |
|---|---|---|---|---|
| Volatile Organic Compounds | 677.4 | 405.6 | 416.3 | +10.7 |
| Oxides of Nitrogen | 724.8 | 463.1 | 475.7 | +12.6 |
| **Pollutant** | | **2025 No-Build Condition** | **2025 Build Condition** | **Build / No-Build Difference** |
| Volatile Organic Compounds | | 352.0 | 385.5 | +33.5 |
| Oxides of Nitrogen | | 247.5 | 271.6 | +24.1 |

1 Kilograms per Day

2 The proposed improvements are described in Chapter 5 – *Mitigation Measures/ Recommendations*. Mobile source improvements include the proposed roadway/traffic improvements and parking constraint scenarios.

### 6.1.4 Proposed Air Quality Mitigation

The traffic analysis indicates that the Carolina North Development project will have not have an adverse impact on the majority of study area intersections based upon the implementation of area improvements. The specific roadway improvements are described in previously in Chapter 5. These improvements have been designed to bring each intersection's overall levels of service back to pre-development levels (or better) when compared to both the year 2015 and 2025 No-Build scenarios.

Implementation of parking constraint is also expected to improve air quality in the study area by promoting decreasing single occupant motor vehicle trips. Other improvements include pedestrian, bicycle and transit improvements.

### 6.1.5 Air Quality Analyses with Mitigation

The DEP criteria requires that the Project incorporate air quality mitigation measures because the 2015 and 2025 Build Condition VOC and $NO_X$ emissions are greater than the 2015 and 2025 No-Build Condition VOC and $NO_X$ emissions, respectively.

***2015 Analysis Results.*** With the transportation mitigation measures proposed, the 2015 Build Condition (with mitigation) emissions of VOCs were estimated to be 413.8 kg/day and the emissions of $NO_X$ were estimated to be 480.6 kg/day (as presented in Table 6-2). This results in a decrease of 2.5 kg/day in VOC emissions and a decrease of 7.2 kg/day in $NO_X$ emissions from the 2015 Build Condition. Similarly, the 2015 "Early Phase" Build conditions, results in an increase of 4.3 kg/day in VOC emissions and an increase of 4.9 kg/day in $NO_X$ emissions from the 2015 Build Conditions.

***2025 Analysis Results.*** With the transportation mitigation measures proposed, the 2025 Build Condition (with mitigation) emissions of VOCs were estimated to be 381.6 kg/day and the emissions of $NO_X$ were estimated to be 266.8 kg/day (as presented in Table 6-2). This results in a decrease of 3.9 kg/day in VOC emissions and a decrease of 4.8 kg/day in $NO_X$ emissions from the 2015 Build Condition. Similarly, the 2025 "Constrained Ratio (-10%) and "Constrained Ratio (-20%) results in an increase of 3.8 kg/day and 3.9 kg/day in VOC emissions and an increase of 1.9 kg/day and 0.7 kg/day in $NO_X$ emissions, respectively, from the 2025 Build Conditions.

**Table 6-2: Mesoscale Ozone Analysis Results (with Mitigation)[1]**

| Pollutant | 2015 No-Build Condition | 2015 Build Condition | 2015 Build with Mitigation[2] | 2015 "Early Phase Ratio" Build[2] | 2015 "Constrained Ratio" Build (10%)[2] |
|---|---|---|---|---|---|
| Volatile Organic Compounds | 405.6 | 416.3 | 413.8 | 420.6 | N/A |
| Build vs. Mitigation Scenario Difference | | | -2.5 | +4.3 | N/A |
| Oxides of Nitrogen | 463.1 | 475.7 | 468.5 | 480.6 | N/A |
| Build vs. Mitigation Scenario Difference | | | -7.2 | +4.9 | N/A |
| **Pollutant** | **2025 No-Build Condition** | **2025 Build Condition** | **2025 Build with Mitigation[2]** | **2025 "Constrained Ratio" Build (10%)[2]** | **2025 "Constrained Ratio" Build (20%)[2]** |
| Volatile Organic Compounds | 352.0 | 385.5 | 381.6 | 389.3 | 389.4 |
| Build vs. Mitigation Scenario Difference | | | -3.9 | +3.8 | +3.9 |
| Oxides of Nitrogen | 247.5 | 271.6 | 266.8 | 273.5 | 272.3 |
| Build vs. Mitigation Scenario Difference | | | -4.8 | +1.9 | +0.7 |

1 Kilograms per Day

2 The proposed improvements are described in Chapter 5 – *Mitigation Measures/Recommendations*. Mobile source improvements include the proposed roadway/traffic improvements and parking constraint scenarios.

### 6.1.6 Conclusion of Mesoscale Analysis

The air quality study demonstrates that the Carolina North Development project complies with the Clean Air Act Amendments (CAAA). The ozone mesoscale analysis demonstrates that the Project will result in an increase of VOC and $NO_X$ emissions, as compared to the No-Build Condition. The Project will incorporate reasonable and feasible mitigation measures to reduce VOC and $NO_X$ emissions. These mitigation measures include specific intersection and roadway improvements as well as various parking constraint scenarios. The implementation of these mitigation measures will help reduce the VOC and $NO_X$ emissions associated with the Project.

The 2015 (TIA Phase 1) sensitivity analysis includes two scenarios: the "early phase" scenario, which entails more parking than in the base scenario; and the "constrained' scenario, which entails less parking than in the base. The mesoscale analysis of the "early phase" scenario shows increases in NOx and VOC emissions. The mesoscale analysis of the "constrained" scenario shows a decrease in emissions.

The 2025 (TIA Phase 2) sensitivity analysis includes two scenarios – Constrained Ratio (-10%) and Constrained Ratio (-20%) – both of which entail fewer parking spaces than in the base scenario. In the mesoscale analysis, both constrained parking scenarios reduce

NOx and VOC emissions, with the Constrained Ratio (-20%) scenario resulting in even greater reductions in emissions than the Constrained Ratio (-10%) scenario.

## 6.2 Greenhouse Gas Analysis

The following section presents a summary of the Greenhouse Gas (GHG) assessment for mobile source. The mobile source analysis was conducted following procedures similar to the ozone mesoscale analysis. The mobile source analysis estimated the area-wide GHG emissions from vehicle traffic for a time period of one year. The change in GHG emissions from traffic were based on the average yearly traffic volumes, roadway lengths and vehicle emissions factors for existing and new trips for weekday and weekend conditions. Mobile source GHG emissions are based upon the traffic volumes, the distance traveled and the GHG emission rates. The GHG assessment indicated that the mitigations identified in the 2015 Build with Mitigation will result in a six percent reduction in mobile source GHG emissions, compared to the Build without Mitigation scenario.

### 6.2.1 Summary of Greenhouse Gas Emissions Quantitative Analysis

The air quality analysis calculated GHG emissions for mobile sources for the Project. Mobile source emissions are calculated by performing an annual GHG emissions mesoscale analysis to evaluate the estimated change in $CO_2$ emissions for the existing and future conditions within the study area. Similar to the mesoscale analysis, the mobile source analysis traffic (volumes, delays, and speeds) and emission factor data were developed for eleven conditions: (i) 2009 Existing, (ii) 2015 No Build, (iii) 2015 Build, and (iv) 2015 Build with Mitigation, (v) 2015 "Early Phase" Build, (vi), 2015 "Constrained Ratio (-10%), (vii) 2025 No Build, (viii) 2015 Build, (ix) 2025 Build with Mitigation, (x) 2025 "Constrain Ratio (-10%) Build, and (xi) 2025 "Constrained Ratio (-20%) Build.

### 6.2.2 Mobile Source $CO_2$ Assessment

The following section describes the methodology for calculating mobile source GHG emissions and presents the results for all analysis conditions.

#### Mobile Source Assessment Methodology

The mobile source emissions are calculated by performing a yearly mesoscale analysis to evaluate the changes in $CO_2$ emissions for the existing and future conditions within the traffic study area. The air quality study in includes an analysis of the ozone precursor emissions (mesoscale analysis). The mesoscale analysis estimates the area wide $CO_2$ emissions from vehicle traffic for a time period of one year. The mesoscale analysis traffic (volumes, delays, and speeds) and emission factor data are developed for four conditions: 2009 Existing, 2015 No Build, 2015 Build, and 2015 Build with Mitigation.

#### Mobile Source Emission Rates

Currently MOBILE6.2 has a simple estimate of $CO_2$ emissions factors that do not vary by speed, temperature, fuel content, or the effects of vehicle inspection maintenance programs. It was determined that the study area was large enough to assume that variation in these parameters does not have a significant net effect.

#### Traffic Data

The air quality study used traffic data (volumes, delays, and speeds) developed for each analysis condition. The mesoscale analysis for $CO_2$ emissions used a yearly traffic volume for weekday and weekend periods. Vehicle speeds are developed based upon traffic volumes, observed traffic flow characteristics, and roadway capacity.

### 6.2.3 Existing Mobile Source $CO_2$ Emissions

The calculation of 2009 Existing Condition mobile source emissions provides a base for which future years can be evaluated. The mobile source analysis calculated the 2009 Existing Condition $CO_2$ emissions from the major roadways in the study area, which are estimated to be 94,096.7 tons/year. Table 6-3 – Mobile Source $CO_2$ Emissions below presents the existing mobile source $CO_2$ analysis results for the 2009 Existing Conditions.

### 6.2.4 Future Mobile Source $CO_2$ Emissions

Future Project related mobile source $CO_2$ emissions calculations are based upon changes in traffic and emission factor data. The traffic data includes traffic volumes, vehicle miles traveled, roadway operations, and physical roadway improvements. The emission factor data included emission reduction programs, years of analysis, and roadway speeds.

Under the 2015 No-Build Condition, $CO_2$ emissions were estimated to be 114,600.3 tons per year (Table 6-3). The 2015 No-Build Condition $CO_2$ emissions are greater than the 2009 Existing Condition $CO_2$ emissions (by 20,503.6 tons per year) because the projected increase in traffic volumes in 2015 as compared to the existing traffic volumes due to growth within the study area (without the Project).

Under the 2015 Build Condition, the total mobile source $CO_2$ emissions were estimated to be 152,322.3 tons per year (Table 6-3). Under the 2015 Build Condition with Improvements, the mobile source $CO_2$ emissions were estimated to be 152,297.1 tons per year (Table 6-3). This results in a decrease of 25.2 tons per year in mobile source $CO_2$ emissions as compared to the 2015 Build Condition. This reduction is due to the proposed signal timing improvements of the study area roadways as well as the on-site traffic flow improvements (described under the Chapter 5 - *Mitigation Measures/Recommendations*. This represents an approximately six percent reduction of the 152,322.3 tons per year (2015 Project Emissions).

The mobile source $CO_2$ emissions percent reduction is calculated as follows:

$$\text{Reduction \%} = \frac{\text{Reductions Due to Project Improvements}}{\text{2015 Project-Generated Emissions}}$$

Therefore, the percent reduction in mobile source emissions due to Project-related improvements is: 25.2 / 152,322.3 = 0.000165 x 100 = 0.02%.

Table 6-3 below presents $CO_2$ emissions from mobile sources under all conditions.

**Table 6-3: Mobile Source $CO_2$ Emissions[1]**

| Pollutant | 2009 Existing Condition | 2015 No-Build Condition | 2015 Build Condition | 2015 Build with Mitigation[2] | 2015 "Early Phase Ratio" Build[2] | 2015 "Constrained Ratio" Build (10%)[2] |
|---|---|---|---|---|---|---|
| Carbon Dioxide ($CO_2$) | 94,096.7 | 114,600.3 | 152,322.3 | 152,297.1 | 158,427.2 | |
| Build vs. Mitigation Scenario Difference | | | | -25.20 | +6,104.90 | |
| **Pollutant** | | **2025 No-Build Condition** | **2025 Build Condition** | **2025 Build with Mitigation[2]** | **2025 "Constrained Ratio" Build (10%)[2]** | **2025 "Constrained Ratio" Build (20%)[2]** |
| Carbon Dioxide ($CO_2$) | | 112,143.1 | 191,460.0 | 191,017.6 | 191,157.0 | 190,912.0 |
| Build vs. Mitigation Scenario Difference | | | | -442.40 | -303.00 | -548.00 |

1 Tons per Day

2 The proposed improvements are described in Chapter 5 – *Mitigation Measures/Recommendations*. Mobile source improvements include the proposed roadway/traffic improvements and parking constraint scenarios.

The GHG emissions assessment includes an assessment of the various parking constraint scenario. As represented in Table 6-3 above, all of the improvements scenarios reduce GHG emissions with the exception of the 2015 "Early Phase Ratio" Build Condition.

### 6.2.5 Mobile Source Emissions-Related Improvements

The Proponent is committed to incorporating transportation-related improvements into the Project in order to reduce congestion (i.e., strategies related to improving intersection capacity, traffic safety, traffic flow and progression), reduce single-occupancy vehicle trips by encouraging alternative modes of transportation and provide parking constraints for the Carolina North project– all of which reduces mobile source $CO_2$ emissions. The specific mobile source mitigation measures are presented in Chapter 5 - *Mitigation Measures/Recommendations.*

## 6.3 Conclusion

The intent of this chapter is to provide a broad overview of the air quality benefits from the planning, design, and performance criteria being incorporated into the Carolina North Development project. The ozone ($NO_x$ and VOC) and GHG assessment that was presented quantifies the specific transportation impacts and improvements proposed as part of the Carolina North project. With the exception of the 2015 Early Phase Ratio Condition, all Build condition alternatives reduce greenhouse gas emissions. The one alternative that reduces $NO_x$ and VOC is the Build with Mitigation.