Project 5: Simulation Analysis of Traffic-Operation-Related Emission

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Project Summary

The U.S transportation conformity program requires transportation plans, programs, and projects to "confirm to" the goals established in statewide transportation improvement programs (STIP). It requires that transportation activities will not cause new air quality violations, or worsen existing violations, or delay timely attainment of the National Ambient Air Quality Standards (NAAQS) for traffic-generated air pollutants such as carbon monoxide (CO) and particulate matters ($PM_{2.5}$). Recent studies also indicated that exposures to traffic emission increase the risk of adverse health effects for population, living, working, in particular for young developing children going to school near large roadways who are especially vulnerable to increased levels of air pollutants.

This RET project will explore the methodology for analyzing the impact of traffic flow operation on the on-road emissions (CO or $PM_{2.5}$ will be targeted in the project) by using simulation approach. In this approach, microscopic traffic simulation model, VISSIM, emission factor simulator, MOVES (Motor Vehicle Emission Simulator), and a dispersion model, CalRoasd View will be used. For any given traffic scenario, VISSIM can be running to simulate the traffic operation and result in vehicle trip distribution aligned with other parameters that are required as inputs to MOVES. The MOVES model is used to estimate emission factors, and the CALRoads View is used to estimate spatial dispersion levels at varying distances away from the roadway (which is viewed as an emission source).

In order to calibrate the simulation models, minor field data collection work will be needed. The data collection includes: 1) vehicle trajectory data gained by Global Positioning System (GPS) Travel Loggers to calibrate the travel behavior parameters involved in VISSIM; 2) traffic video data for validating the traffic flow rates with the VISSIM model; 3) on-site CO measurement at the selected highway infrastructure to verify with the MOVES result. A section of I-75 near the location of 1030 Cutter St, Cincinnati, OH 45203, is selected as the case study site (**Figure 1**). Hays-Porter Elementary School is very close to the study site and may be a good case place for the emission exposure analysis.

Training activities for learning fundamental traffic theories, data collection, and simulation software will be conducted. The teachers will be first introduced to fundamentals of traffic and emission theories and simulation by using VISSIM, MOVES and CALRoads View software. VISSIM will be used to

analyze performance of traffic scenarios with varied traffic conditions. As an optional activity, the teachers will learn sensitivity analysis of traffic operational impact on emission and ambient CO level. Computer reacts with informative feedback in simulation, which is almost always of a visual nature. Thus, the simulation enables decision making without running risks. A field trip to the Advanced Regional Traffic Interactive Management & Information System (ARTIMIS) in Downtown Cincinnati will be arranged to make the teachers to feel a real practice in traffic management. The Graduate Mentors will provide guidance to these training activities. The schedule for the six weeks is tentatively arranged as follows:

Week 1: Training and practice of basic traffic and emission theories and field data collection;
Weeks 2 to 4: Training and application of simulation software and data analysis;
Week 5: Conduct "what-if" analysis and set up hands-on examples for classroom implementation;
Week 6: This week will be devoted to preparing final presentation, final report, and summary.

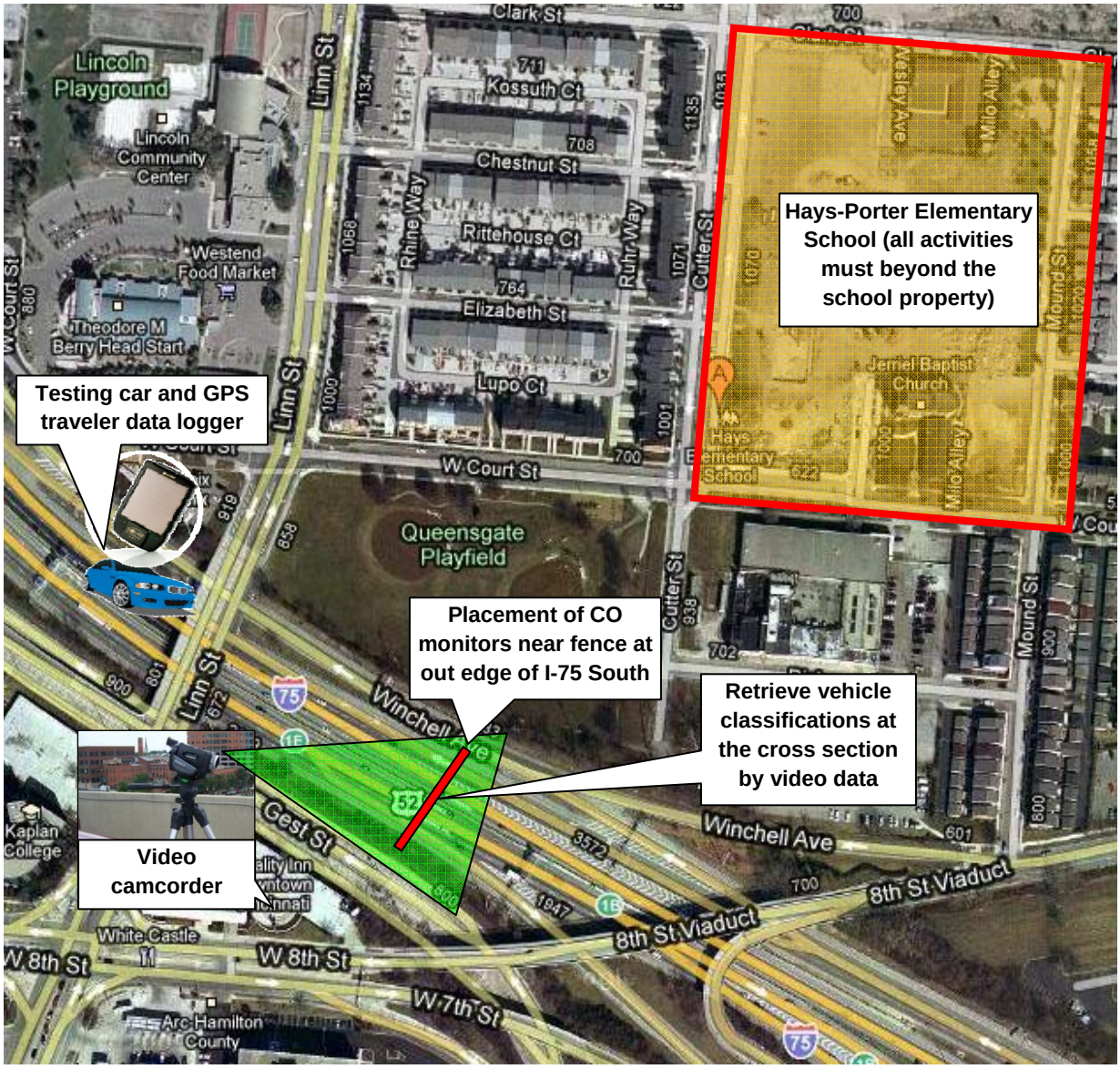

Figure 1. Date collection and required instruments at the study site

The teachers are required to develop a lesson implementation plan on the basic theme of *"Transportation-generated air pollution Impact on your Community and daily life?"* or relevant one on their

own. This plan will introduce students to analyzing impact of traffic-related environmental issues on our life. A simplified analysis approach will be taught to the teachers as a tool to produce exercises for students.

The following deliverables are expected as a result of the project: **A)** a PowerPoint Presentation, including both the research and classroom implementation plan; **B)** a Classroom Poster created by each teacher; **C)** a Project Summary Report (4-5 pages); **D)** a high resolution Movie (3-5 minutes) showcasing the research work completed during the summer; **E)** one Journal Article draft that highlights the engineering research experience and how it can be integrated into the classroom; and **F)** Biweekly Reports (weeks 2 and 4 by teacher team).