Project 4: Air Quality Monitoring and Emissions Characterization Near a Major Railyard

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Project Summary

There is growing interest from regulatory agencies to quantity ambient concentrations of air pollutants adjacent to, as well as emissions estimates from, railroads and railyard facilities. Railroads are vital for transport of goods. However, as they pass through communities, they emit air pollution and are also a source of noise, but the extent of these externalities are not well quantified. Cincinnati's location – its centrality and proximity to major metropolitan areas and a major waterway - makes the city an ideal location as an intermodal transportation hub. Cincinnati is the largest inland port in the country and 4th in the nation in total rail mileage and has the highest density of rail lines. Along with this growth, comes air and noise pollution that are associated with numerous health effects in communities adjacent to freight facilities (e.g., railyards). These communities are often comprised of economically disadvantaged and underrepresented sections of the general population. In Cincinnati, the largest railyard is adjacent to the Camp Washington neighborhood, which has the fourth lowest life expectancy in Cincinnati, of ~67 years (**Figure 1**). Therefore, agencies such as the Southwest Ohio Air Quality Agency (**SWOAQA**) are particularly interested understanding air quality in this neighborhood.

Measuring emissions from railyards is not a trivial task. Railyards are on private property and measurements in the railyard cannot be taken without approval from rail companies. Unfortunately, rail

companies are often not willing to allow measurement campaigns on their property. However, recent advances in portable monitoring technology can be utilized to deploy a suite of monitoring stations around the railyard. Air pollutant concentrations can be measured and emissions from the railyard can be calculated.

Participating teachers will conduct surveys at rail yards, document rail activities and identify other potential sources nearby, and contribute to selection of several representative sites for monitoring. They will learn to calibrate portable equipment and low cost sensors, and gather air pollution and sound measurements as well as meteorological data (**Figure 2**). As a control, they will also conduct background monitoring at several other neighborhoods sites not expected to be impacted by the railyard. Teachers will learn data analytical techniques used to understand the spatiotemporal distribution of air and noise pollutants as well as estimation of emissions factors.

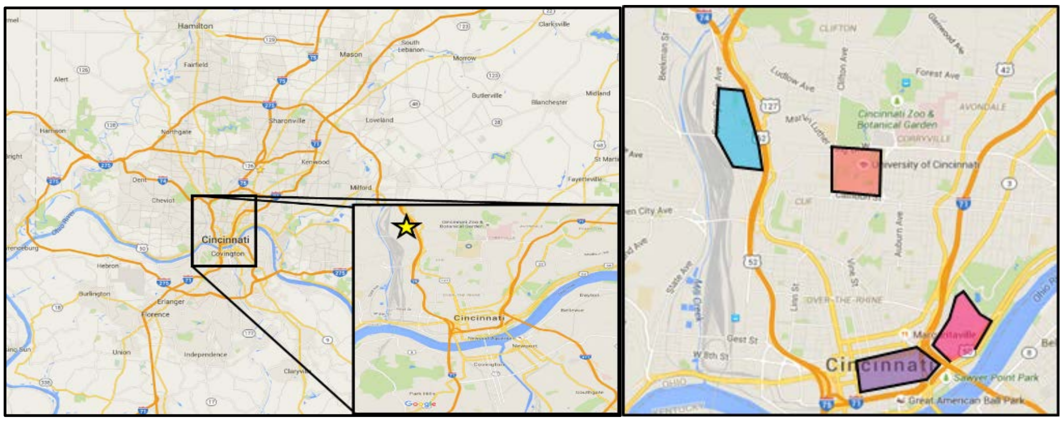

Figure 1: Cincinnati Metropolitan Area (Left) and Camp Washington Neighborhood (Right, Shaded In Light Blue) and Other Potential Neighborhood Sampling Locations (Right, Shaded Areas)

Figure 2: Portable Monitors Used for Air Pollution and Noise Measurements

The research tasks will be completed in 7 weeks, including the following activities that are specifically designated for the 2014 summer project:

Week 1: The teachers will be taking an Engineering Foundations course along with other groups of teachers involved in the summer project.

Week 2: The teachers will learn how to operate portable monitors and assemble low-cost sensors. An important component will be to understand measuring air pollutant concentrations can be utilized to calculated emissions factors. In addition, a field trip will be arranged to visit the Near Roadway site operated by SWOAQA (**Figure 2**).

Weeks 3: Site visit to several locations around the railyard and quantify railyard activities, including number truck counts during peak hour periods. In addition, several sites will be selected for data gathering.

Weeks 4-5: Field campaign using multiple portable monitoring stations around the railyard. A few of these days will be devoted to gathering data from neighborhoods not expected to be impacted by railyards.

Week 6: The teachers will compile the results and knowledge gained from the above tasks to develop their future classroom teaching improvement and implementation plan. Specifically they will develop a lesson plan for students to understand the basic concepts of correlation and source-receptor relationships as it pertains to air pollution.

Week 7: The teachers will prepare their final presentations and write their final reports and summaries.

Possible Ideas for Classroom Implementation

Students will receive hands-on training to design and build small, low-cost sensors. Skills gained will include basic electronics, programming the Arduino board controller, and potentially designing the housing box for the sensors. The students will then design a sampling protocol, deploy the instruments and gather data. A math unit could be developed based on this real-world monitoring data. Students can analyze the data by performing basic statistics (e.g., average, maximum, minimum and standard deviation) of air pollutant concentrations, and compare difference in seasons, mornings, or afternoons, etc. An important part of this classroom experience will be to utilize data visualization techniques to communicate results. An example of a classroom project would be to design and build multiple low-cost $PM_{2.5}$ and sound sensors that would be deployed. Students would analyze the gathered results for each monitor and compare results to understand the spatial variability of $PM_{2.5}$ and sound. One such analysis could be use MS Excel to plot concentrations at two locations and plot the trend line, with the idea that students gain a conceptual understanding of correlation.