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Influence of solid noise barriers on near-road and on-road air quality

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HIGHLIGHTS

- Mobile monitoring measured near-road air quality impacts of a solid, noise barrier.
- Downwind concentration reductions of up to 50% occurred behind the barrier.
- Downwind reductions were highest within the first 50 m from the road.
- Reductions extended as far as 300 m from the road.
- On-road levels did not increase in front of barrier, contrary to model predictions.

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ABSTRACT

Public health concerns regarding adverse health effects for populations spending significant amounts of time near high traffic roadways has increased substantially in recent years. Roadside features, including solid noise barriers, have been investigated as potential methods that can be implemented in a relatively short time period to reduce air pollution exposures from nearby traffic. A field study was conducted to determine the influence of noise barriers on both on-road and downwind pollutant concentrations near a large highway in Phoenix, Arizona, USA. Concentrations of nitrogen dioxide, carbon monoxide, ultrafine particles, and black carbon were measured using a mobile platform and fixed sites along two limited-access stretches of highway that contained a section of noise barrier and a section with no noise barrier at-grade with the surrounding terrain. Results of the study showed that pollutant concentrations behind the roadside barriers were significantly lower relative to those measured in the absence of barriers. The reductions ranged from 50% within 50 m from the barrier to about 30% as far as 300 m from the barrier. Reductions in pollutant concentrations generally began within the first 50 m of the barrier edge; however, concentrations were highly variable due to vehicle activity behind the barrier and along nearby urban arterial roadways. The concentrations on the highway, upwind of the barrier, varied depending on wind direction. Overall, the on-road concentrations in front of the noise barrier were similar to those measured in the absence of the barrier, contradicting previous modeling results that suggested roadside barriers increase pollutant levels on the road. Thus, this study suggests that noise barriers do reduce potential pollutant exposures for populations downwind of the road, and do not likely increase exposures to traffic-related pollutants for vehicle passengers on the highway.

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1. Introduction

A growing number of health studies have identified that populations spending significant amounts of time near high traffic roadways experience increased risks of a number of adverse effects

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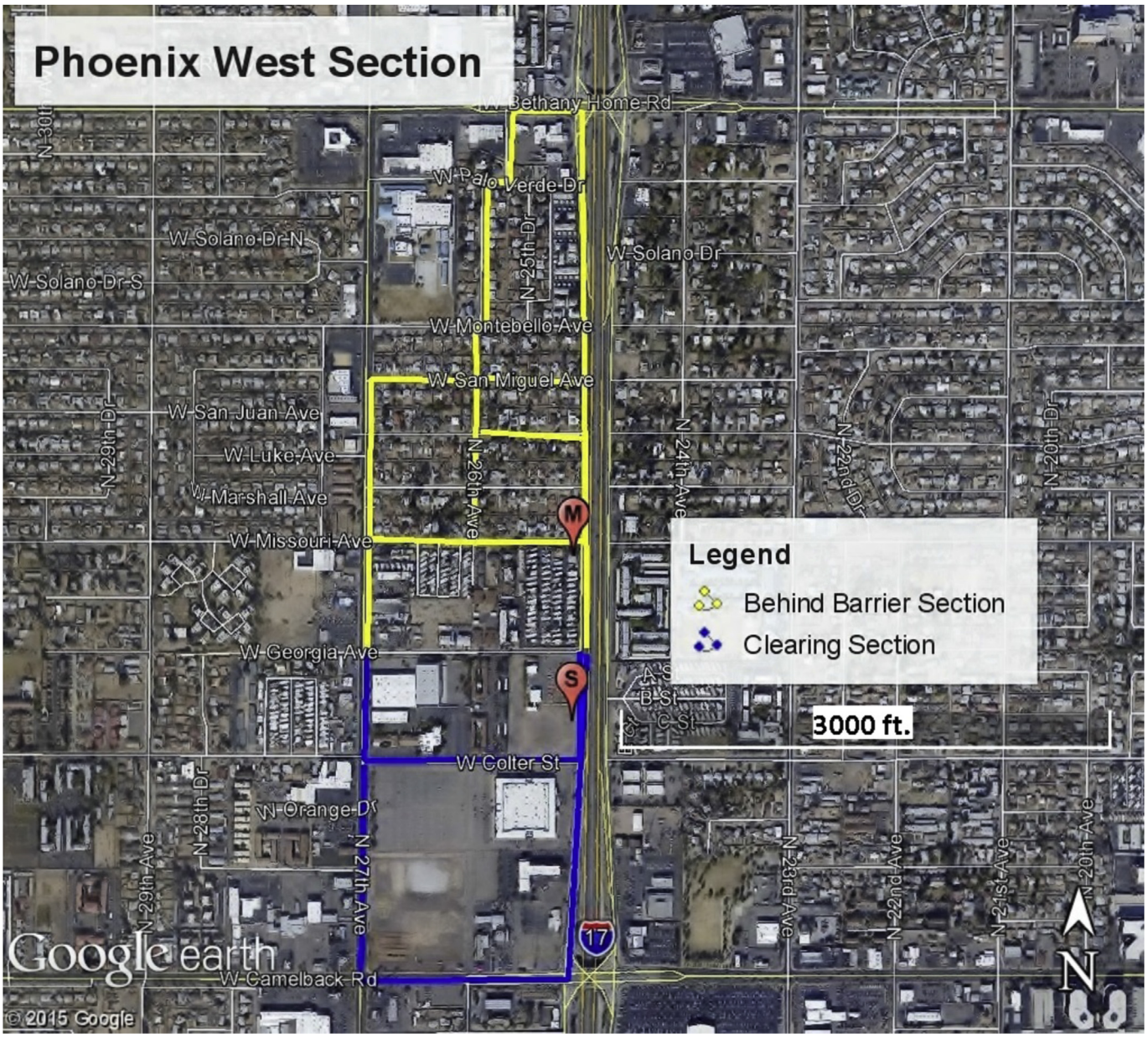

Fig. 1. Mobile and fixed-site monitoring locations. The top figure shows the western section and the bottom the eastern section. The lines represent the mobile driving route (blue lines for the clearing, red lines along the noise barrier). The pins show the fixed-site SUV (S) and portable meteorological and BC instrument (M) locations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(e.g. summary by HEI, 2009). These effects have been attributed to increased exposure to particulate matter, gaseous criteria pollutants, and air toxics emitted by vehicular traffic. This significant impact of traffic emissions on populations all over the world has increased interest on identifying methods to reduce exposures to these pollutants. While emission control technologies and programs to directly reduce air pollution emissions are vital components of air quality management, roadway design techniques that can reduce population exposures may also provide an important role in public health protection.

One roadway design option that has received increased interest is the construction of roadside structures, such as noise barriers (also often referred to as sound walls), which dilute nearby vehicle emissions to reduce pollutant concentrations for the highest exposed populations. This technique can provide planners and developers with an option to reduce concentrations of air pollutants in a relatively short time frame. The addition of noise barriers for near-road air quality improvement can also complement existing pollution control programs or provide measures to reduce impacts from sources difficult to mitigate.

Air quality in areas adjacent to major roadways is influenced by primary emissions from on-road vehicles. Concentrations of primary pollutants (e.g., particulate matter (PM), nitrogen oxides (NO_x), carbon monoxide (CO), mobile source air toxics (MSATs)) in vehicle tailpipes, just before they are emitted into the atmosphere, are often two to four orders of magnitude higher than concentrations measured in ambient air (Zhang et al., 2004). Motor vehicles also emit and re-suspend PM constituents from brake, tire, and pavement wear during operation on the road. Key factors contributing to observed near-road pollutant concentrations