Wisconsin Department of Natural Resources

Recommendations for a New Near Road Air Monitoring Station Located in Milwaukee, WI

Final 03/06/2013

Recommendations

The Wisconsin DNR has analyzed data from six locations or zones along the Milwaukee Interstate 94 (I94) corridor. Based on the analyses of the six locations the College Avenue site is recommended as the best location for the near road air monitoring station.

The College Avenue site located on the section of the highway designated as I94 south. This zone is located on the eastern edge of and is south of the Milwaukee urban core. The site is just south of the I43 and I894 interchange and is south of the airport spur. Average traffic counts are not as high as some locations, but the peak traffic measures are similar to the highest sites. Truck values are low but may be underestimated. Wisconsin DOT estimates that the Wisconsin and Illinois border to the south has approximately 17% truck traffic. Roadway features support this location and the monitoring site can be placed in close proximity to the roadway. Both the southwest and northeast Park and Ride lots are adjacent to entrance ramps but offer locations where vehicles are close to merging speeds. Sites on both the east and west side of the I94 roadway are clear of obstructions from the roadway. There are sound barrier walls in the area, but they would not block emissions from the roadway, nor would they be expected to cause any significant trapping of emissions. The analysis of wind data suggests a site on the east side of I94 would be downwind of the prevailing westerly winds. Site logistics also support a site in the northeast parking lot.

The following locations are not recommended:

The Zoo Interchange of highway I94 and highway 45 is the road segment with the highest traffic count. A site could be placed on the west side of the interchange along I94 on the west bound lane. This area is on WE Energy property adjacent to the Milwaukee County Zoo. A second option would be to site on the south bound lane of the highway 45 at the Zoofari Center. A look at prevailing winds shows that the Zoofari site would not be downwind. Site elevation presents a problem in this zone, particularly the siting option on highway 45. Additionally, the interchange is scheduled to be rebuilt with construction on the intersection scheduled to begin in 2013 and extend into 2018. During the construction, the traffic flow and vehicle numbers will be impacted. The new construction design could also move traffic away from a nearby monitoring site. Planned construction makes this a poor choice for establishing a long term near-road monitoring site.

The Stadium interchange where I94 and Miller Parkway (highway 41) intersect is another zone with high traffic counts. This site is located close to the area of underserved populations. The zone is in a significant area of changing terrain that would limit the number of places where a site could be located near the interchange. The best locations would be on the west side of the interchange. The site would have to be located on private property and would be near one of several stadium parking lots that would increase opportunities for vandalism. This area is also scheduled for reconstruction, but is only in the early planning stages. This zone is not recommended because of difficulty in finding a site and securing that site.

The State Fair zone is not recommended because physical features including a frontage road that would set the site back from the I94 roadway and sound barrier walls that would block winds.

Establishing a site in the Marquette Interchange zone would be technically challenging because the interchange is a primarily a series of elevated ramps and roadways.

The I43 zone has a lower traffic numbers and has physical features that would make siting difficult.

Background

On February 9, 2010, EPA promulgated new minimum monitoring requirements for the nitrogen dioxide (NO_2) monitoring network in support of a newly revised 1-hour NO_2 National Ambient Air Quality Standards (NAAQS) and the retained annual NAAQS. State and local air monitoring agencies are required to install near-road NO_2 monitoring stations at locations where peak hourly NO_2 concentrations are expected to occur within the near-road environment in larger urban areas.

The criteria for determining where a near road site is required are in Section 4.3 of Appendix D to Part 58, Code of Federal Regulations (CFR). The CFR specifies that there must be one micro-scale near-road NO_2 monitoring station in each Core Based Statistical Area (CBSA) with a population of 500,000 or more. An additional near-road NO_2 monitoring station is required if the CBSA population is 2,500,000 or more, or if any CBSA with a population of 500,000 or more and has one or more road segments with 250,000 or greater annual average daily traffic (AADT). Based on these criteria the Metropolitan Statistical Area (MSA) 33340, Milwaukee, Waukesha, West Allis, is required to install and operate one near road monitoring site.

The federal guidelines for identifying target monitoring sites are in Section 4.3.2, Appendix D, Part 58, CFR. The guidelines require that state and local air agencies consider traffic volumes, fleet mix, roadway design, traffic congestion patterns, local terrain or topography, and meteorology in determining where to best locate new near-road NO_2 monitoring stations. Wisconsin will also consider additional factors that include satisfying basic monitor siting criteria, site logistics (e.g., access to property and site safety), and nearby population exposure.

The Wisconsin DNR has evaluated areas along the I94\I894 traffic corridor in the Milwaukee Urban Area along with roadways feeding traffic into or taking traffic from the I94\I894 corridor.

This report reviews the work done to narrow the possible locations for the monitoring site and suggests several possible sites for review by stakeholders and other interested parties.

Review Process

The primary tool used for site selection is the traffic counts. This daily average number is determined from Wisconsin DOT traffic count operations and is the most objective parameter for site assessment. In addition to traffic count consideration was given to the fleet make-up, an estimate of the total traffic count attributed to trucks and other heaver duty vehicles.

Secondary and more subjective parameters include the local terrain and roadside structures that may affect monitoring. Terrain features include the elevation of the roadway relative to the monitoring site. Roadway structures that will affect selection are the presence of sound barrier walls, ramps and frontage lanes.

The third set of criteria is selected population features which were sampled from EPA's EJ View, formerly known as the Environmental Justice Geographic Assessment Tool. These parameters are available in census tracts that provide less than ideal spatial resolution. The tool does allow a look at affected and underserved populations and information is included in this review.

Traffic Volume and Fleet Mix

A preliminary road segment selection was made using the traffic numbers provided by Wisconsin DOT traffic counts maps. The selection was the I 94 corridor between the Highway 45 interchange traveling east through the Marquette interchange and then south on Interstate 43 to the Interstate 94 south corridor ending at the College Avenue. The I894 corridor was excluded except for points of intersection with the

I94 corridor. The maps suggest that the highest traffic counts along I894 are in the sections that intersects the I94 corridor.

The Wisconsin DOT provided traffic counts for 45 roadway segments associated with the I94 corridor. A total of 22 sections with greater than 80,000 AADT where included in the ranking. These segments were associated into six zones for further study. Table 1 list the zone and the average and maximum count in each zone.

Table 1: Study Zones and Traffic			
Zones	Zone Description		
Zoo	The highway 45 and I94 interchange		
State Fair Park	Between Stadium and Zoo interchanges		
Stadium	The highway 41 and I94 interchange		
Marquette	Major interchange in the Milwaukee Urban area		
I43	South of Marquette and above the I894 and I43 interchange		
College	Located south of the I894 and I43 interchange and the airport		
Zone	Average AADTx1000	Max AADTx1000	Estimated Truck Traffic(*)x1000
Zoo	149	158	12
State Fair Park	149	153	12
Stadium	143	155	11
Marquette	126	133	8
I43	112	138	7
College	133	153	8

*- The truck count is based on the Wisconsin DOT recommendation that truck traffic is 8% on the east-west I94 corridor and 6% on the north south I43 corridor.

Roadway Features

Each of the six zones was assessed by roadway features. Features included in the assessment were elevations near the roadway, ramps, and obstructions.

Table 2: Roadway Design and Topography				
Zones	Elevation	Ramps	Obstructions	Total
College	1	2	2	5
I43	2	2	2	6
Marquette	3	3	1	7
Stadium	2	3	1	6
State Fair Park	1	1	2	4
Zoo	2	3	1	6
Key				
Parameter	Description	Criteria		
		1	2	3
Elevation	Is the area where a monitoring site could be located above or below the roadway?	Roadway is similar in elevation to the surrounding area.	Roadway is elevated above or is below the surround.	Roadway is at a significantly different elevation from the surrounding area.
Ramps	Entrance or exit ramps at the location. Cars on the ramps will be either accelerating or decelerating.	No entrance or exit ramps.	Ramps limited to simple exit from one roadway to a second roadway.	Multiple ramps in the interchange to funnel traffic to one or more high speed roadways
Obstructions	Sound barrier walls or earthen embankments.	No obstructions	obstruction on one direction	Multiple obstructions along the highway.

Meteorology

To assess the importance of the prevailing wind direction, an analysis of three years of wind data was made for three air monitoring sites in the Milwaukee Area and the National Weather Service (NWS) site at the General Mitchell Airport. The air monitoring sites analyzed included the Waukesha Cleveland Avenue site located on the west side of the study area, the Milwaukee South East Region Headquarters site located north of the Marquette Interchange and bracketing the east side of the study area, and the Milwaukee Sixteenth Street Community Health Center site located in the north south middle of the east side of the study area. The NWS site at the airport is near the SE corner of the study area.

Wind speed and wind direction data from the three air monitoring sites were downloaded from the Wisconsin DNR's WISARDS database. The data selected was collected from the start date of 01/01/2010 to and end date of 12/31/2012. The NWS airport data was also from 01/01/2010 to 12/31/2012. Invalid or missing data was not analyzed. The wind rose plot shows the frequency of the winds along 16 directions with the percentage for that direction labeled. Within each wind bar, box size and color shading are used to represent the percentage of the wind speed.

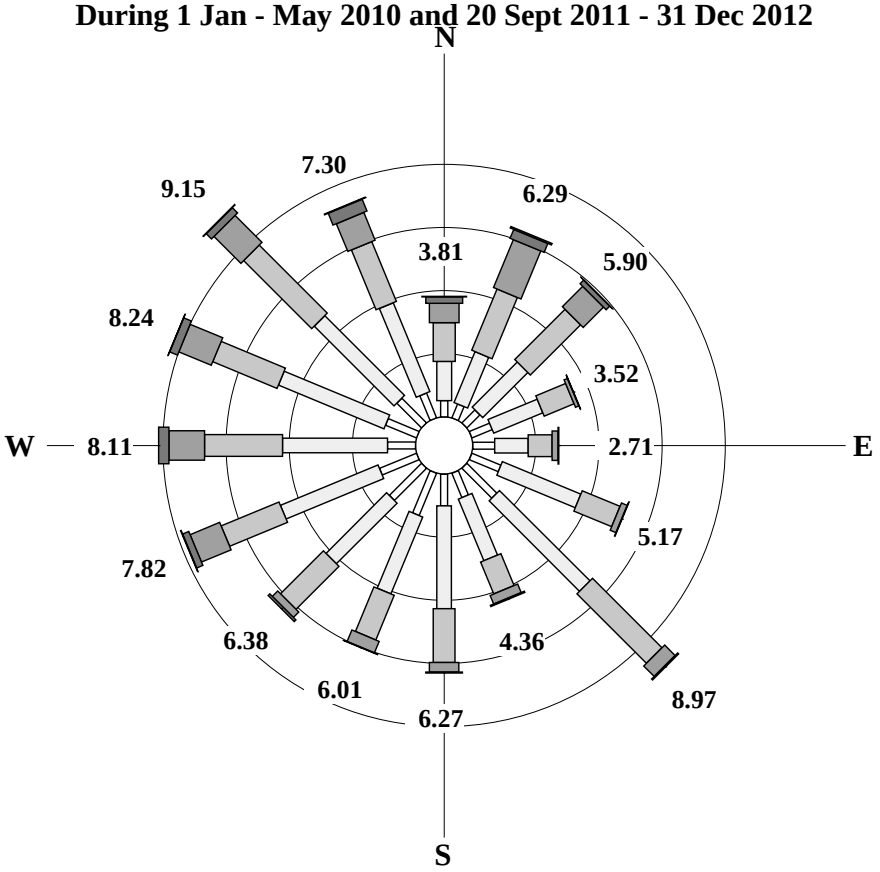
The majority of weather systems impacting the Milwaukee area have a westerly component. This is supported by the data from the WDNR sites and the NWS airport site. Westerly winds dominate at the Waukesha site outside the western edge of the study area. The most prevalent wind is from the northwest with the next most from the southwest. The SER Headquarters site shows westerly winds dominate with the most prevalent wind coming from the northwest. While easterly winds impact the site far less, there is a second prevalent wind from the southeast. The Milwaukee SSCHC site shows prevailing north winds with dominate wind from the northeast and secondary prevailing winds from the southeast. The NWS airport wind rose is similar to that for the WDNR sites. The winds generally prevail from the flow sectors south southwest clockwise to northwest.

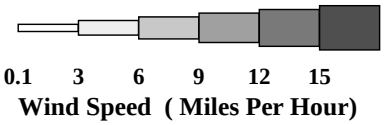
Wind Rose

Milwaukee-DNR Southeast Regional Headquarters Site

14187 Hrs of Wind Speed and Direction

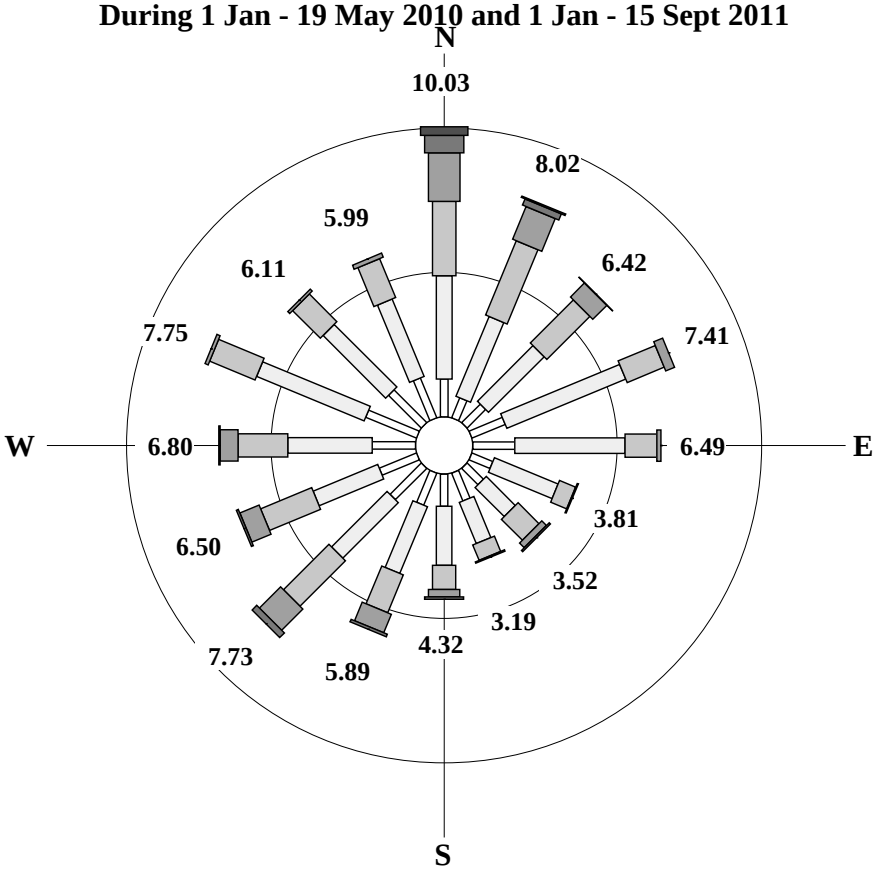
During 1 Jan - May 2010 and 20 Sept 2011 - 31 Dec 2012

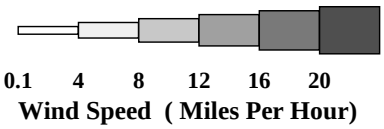




Calms excluded.
Rings drawn at 2% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

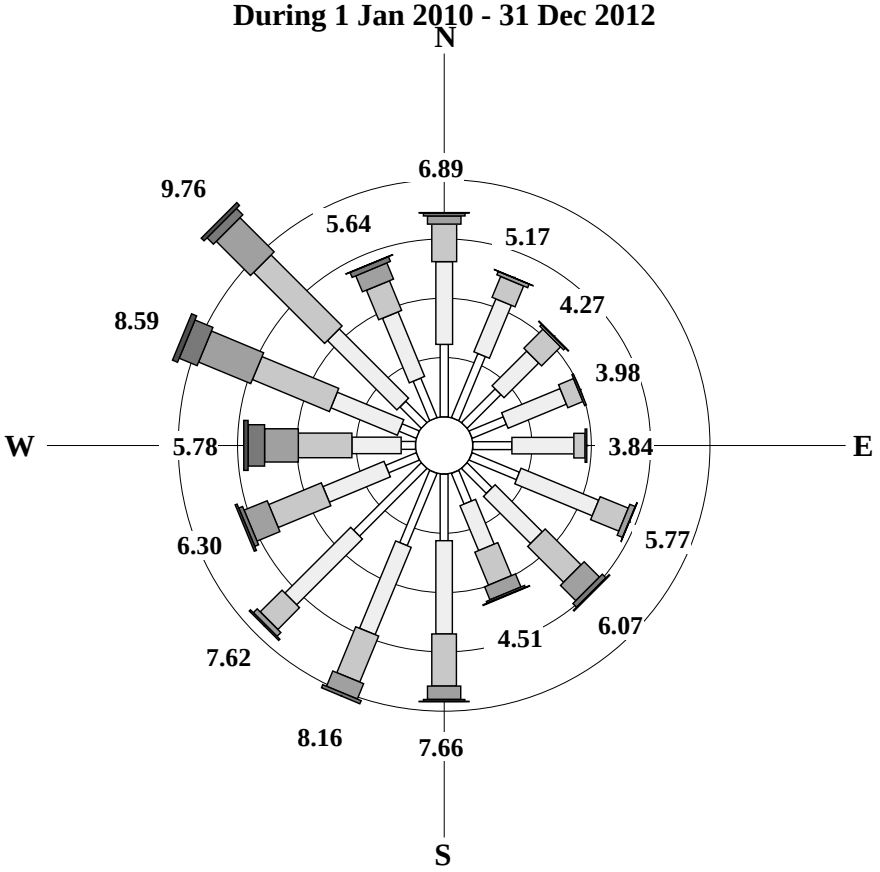
Wind Rose
Milwaukee-16th St. Health Center
9489 Hrs of Wind Speed and Direction
During 1 Jan - 19 May 2010 and 1 Jan - 15 Sept 2011

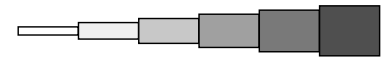




Calms excluded.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

Wind Rose
Waukesha-Cleveland Ave Site
25729 Hrs of Wind Speed and Direction
During 1 Jan 2010 - 31 Dec 2012

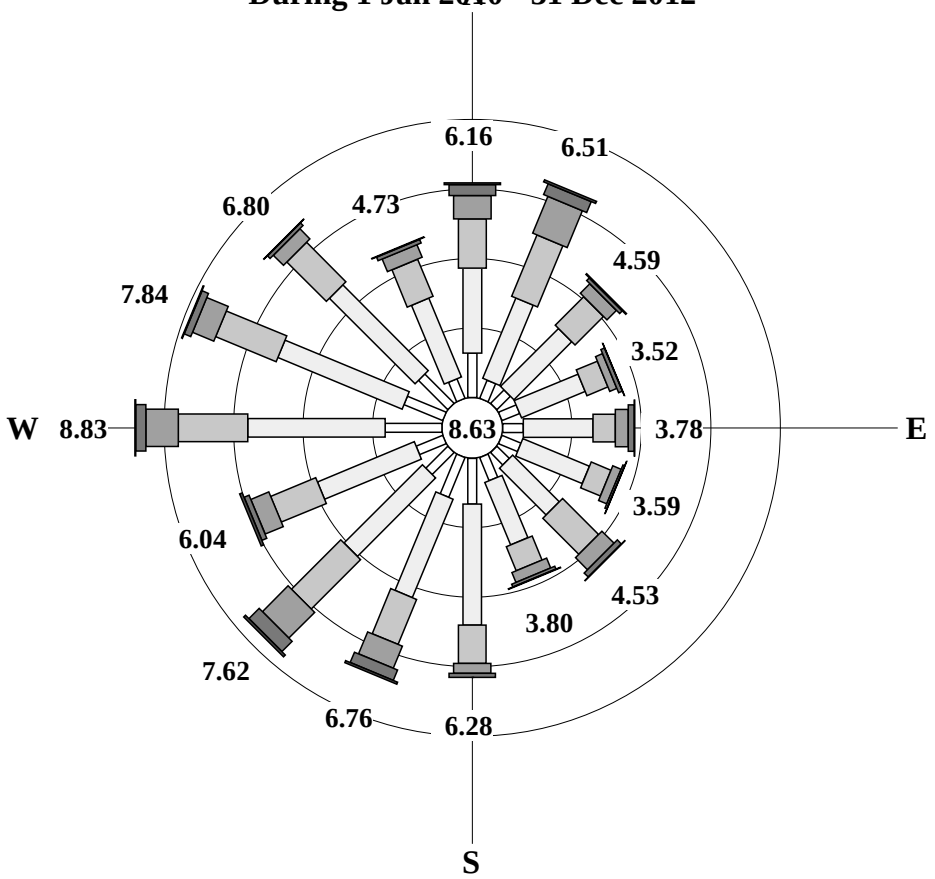


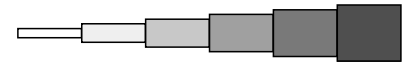


Wind Speed (Miles Per Hour)

Calms excluded.
Rings drawn at 2% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

Wind Rose
National Weather Station
Milwaukee Mitchell Field Airport(a)
Hrly Wind Speed and Direction Data
During 1 Jan 2010 - 31 Dec 2012





Wind Speed (Miles Per Hour)

Calms included at center.
Rings drawn at 2% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

Population

Affected populations were assessed using EPA's EJ View software. This software allows the user to superimpose data layers over a map. At this time, most EJ population data is available only by census tract and this limits the spatial resolution of the data. The software does offer opportunity to examine some population parameters. EJ View's population data is most often provided as a range percentage. For example at the College Avenue zone EJ View reports that 20 to 30 percentage of the population is below 18 years of age. Other population parameters are reported directly as numbers. Finally some like the "Medically Underserved" are report as 'yes' or 'no'. To compare zones the highest number for a parameter is assigned a value of 1, the second highest assigned 2 and so forth. The ranking in each parameter is then summed in the total and the totals are sorted in ascending order.

Environmental Justice Population Information								
Zones	Medically Under-served	Cancer Risk	Respira-tory Risk	Infant Mor-tality	Minority	Below Poverty Limit	<18 years	Total
I43	1	1	1	1	1	2	1	8
Marquette	1	1	2	1	1	1	2	9
Stadium	1	1	1	1	1	3	2	10
Zoo	2	1	1	1	2	4	1	12
State Fair Park	2	1	1	1	3	5	2	15
College	2	2	1	1	3	6	1	16

The I43 and Marquette zones are closest to the urban core where the population is more diverse and has less wealth. The stadium is on the edge of the urban core. State Fair Park is located in the suburban community of West Allis. College Avenue is an area with relatively new development.

Appendix A:

GPS Map of Proposed College Avenue Near Road Site

The distance of monitoring sites from the roadway is a critical parameter for near road monitoring stations. USEPA criteria require that the site is within 50 meters of the monitored roadway.

The roadway at the College Avenue exit was mapped using a simple GPS system and then distances were calculated. The mapping was done with a Garmin GPS 18 Antenna and using a laptop computer for logging data. The GPS antenna was fixed to the roof of a Wisconsin DNR vehicle. The mapping was started by parking for several minutes at the home point to establish a location baseline. The home point, shown below in Figure 1, is very close to the proposed location of the new monitoring station. After establishing a baseline, the WDNR vehicle with the attached GPS unit was driven in a series of loops along the north south I94 highway. On each successive loop a different lane of the highway was used to pass the home point. All eight lanes and the exit and the entrance lane to the highway were mapped as a series of GPS latitude and longitude points. The data was downloaded to an EXCEL spreadsheet for analysis. With the latitude fixed at the home point, the longitude for each of the highway lanes was selected by picking the longitude values paired with the latitude value closest to the home point latitude value.

A series of 11 longitude points were selected. These points corresponded to the home point, the eight highway lanes, the exit and the entrance lanes. Distances from the home point were calculated using the Haversine Formula for two latitude/longitude pairs. The first pair was the location of the home point. The second pair was the home point latitude and the longitude of the highway lane. The earth's radius was taken as 6367 km. The estimated distances are shown below in Figure A1.

While this is an estimate, the mapping study strongly supports the claim that the proposed location will meet USEPA criteria to be within 50 meters of the roadway. The study suggests that most of the north bound traffic will be within the 50 meter goal. It also shows that the entire highway system at that location will be within 85 meters of the proposed monitoring station.

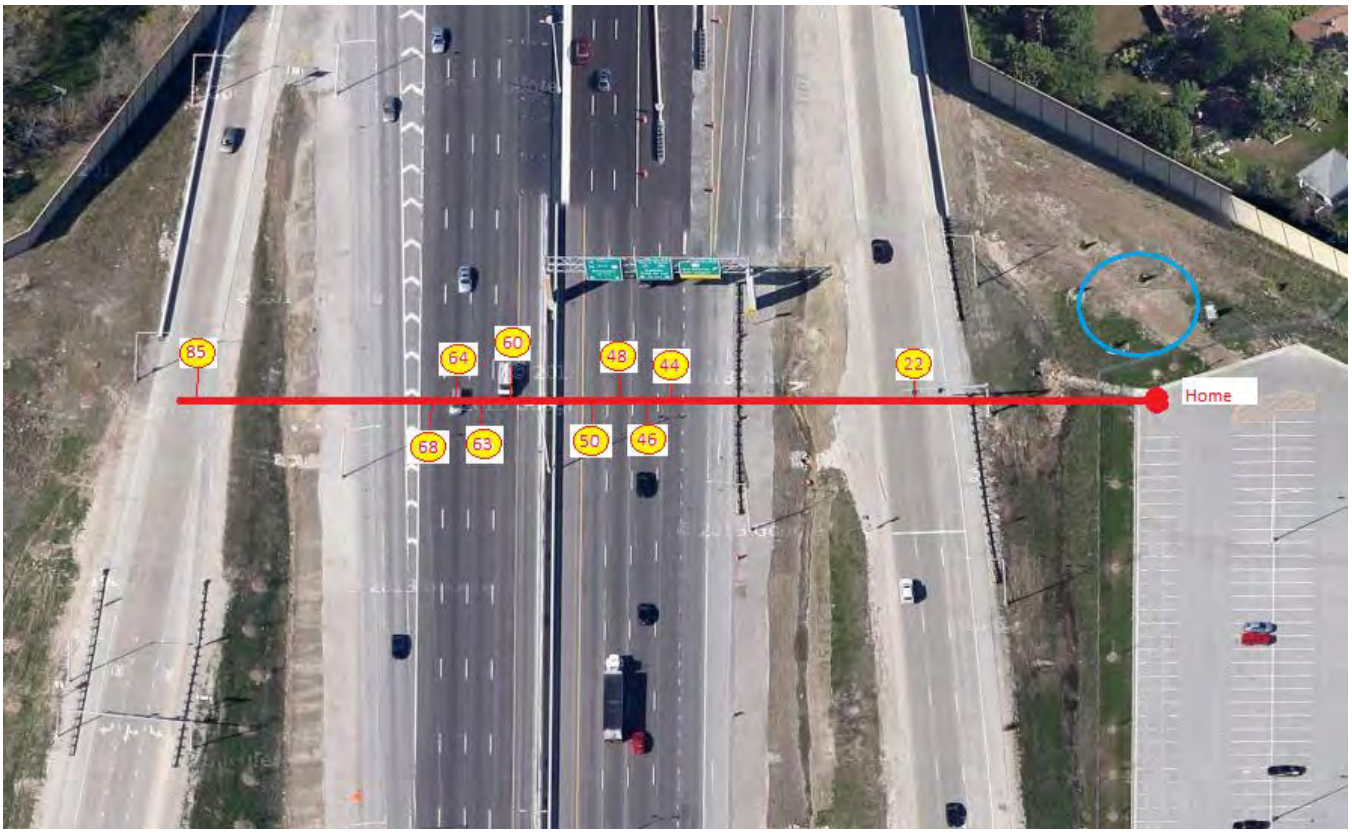


Figure A1: GPS map of distances at the College Avenue exit along highway I94 south in Milwaukee. The red dot is the home point for the map and the red line shown is a transect line of the highway system. Distance values in meters are shown in red the yellow circles. The blue circle is the approximate location of the planned new near road air monitoring station.

Appendix B: College Avenue PM2.5

The recommended location for the new air monitoring station is within the area of the College Avenue Park and Ride lot. The new station will be adjacent to the I94 roadway and is not expected to be influenced by car and bus traffic in the lot. An examination of seven southeast Wisconsin sites including an existing air monitoring station at the College Avenue Park and Ride lot shows any local PM2.5 effect are insignificant to regional influences.

There is an existing air monitoring station located at the College Avenue Park and Ride lot. The existing station is located too far from the I94 roadway to meet criteria for near roadway monitoring. Data from the existing site was used to test for any significant effects from vehicles in the Park and Ride lot.

Three year data from October 2009 to October 2012 was downloaded from the Wisconsin DNR's WISARD database. Data from a total of seven sites were included. In addition to the existing College Avenue site, three Milwaukee sites were included, the Fire Department site, the Sixteenth Street Health Center site, and the DNR Headquarter site. Three additional sites outside of Milwaukee were included Chiwaukee Prairie to the south, Harrington Beach to the north, and Waukesha to the west. The College Avenue samples on a 1 in 6 day schedule and only data from the 1 in 6 day schedule were used for the test. Data from1 in 3 schedule day collected at other sites were excluded from the analysis.

Data was examined using two methods. The first a time series plot to show PM25 concentrations at all test sites. The second analysis was a summary of the data shown in a Box and Whisker Plot. Fine particulate matter is mostly influenced by region wide conditions and this is seen in the Figure B1 and B2. The time series plots shows all sites track well. The summary Box and Whiskers show the similarity of data at all seven sites.

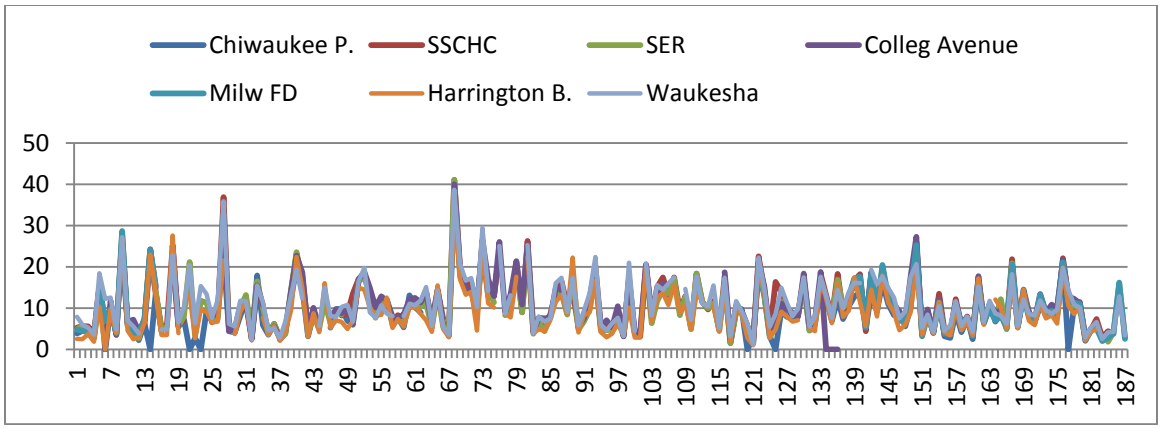


Figure B1: Time series plot of three year data for seven sites in southeast Wisconsin.

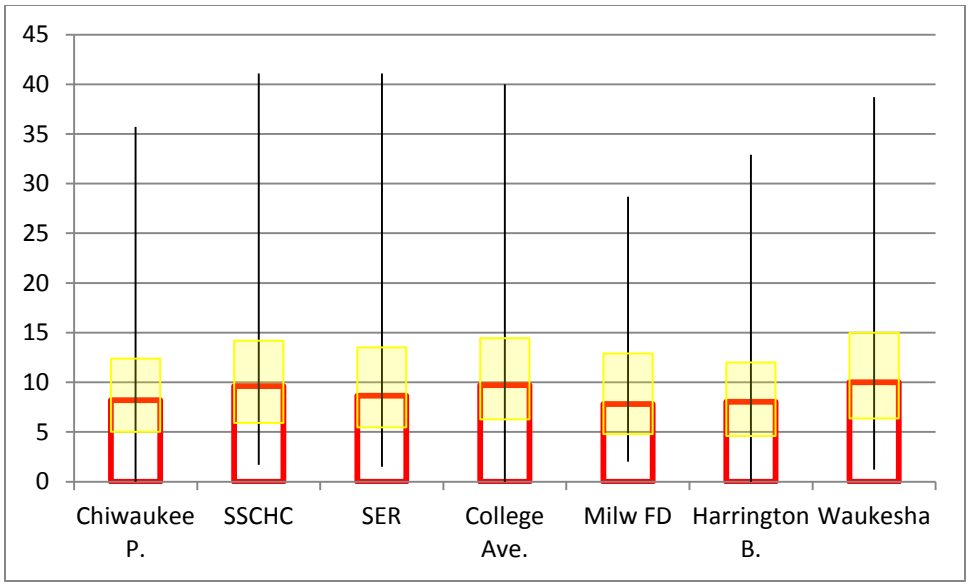
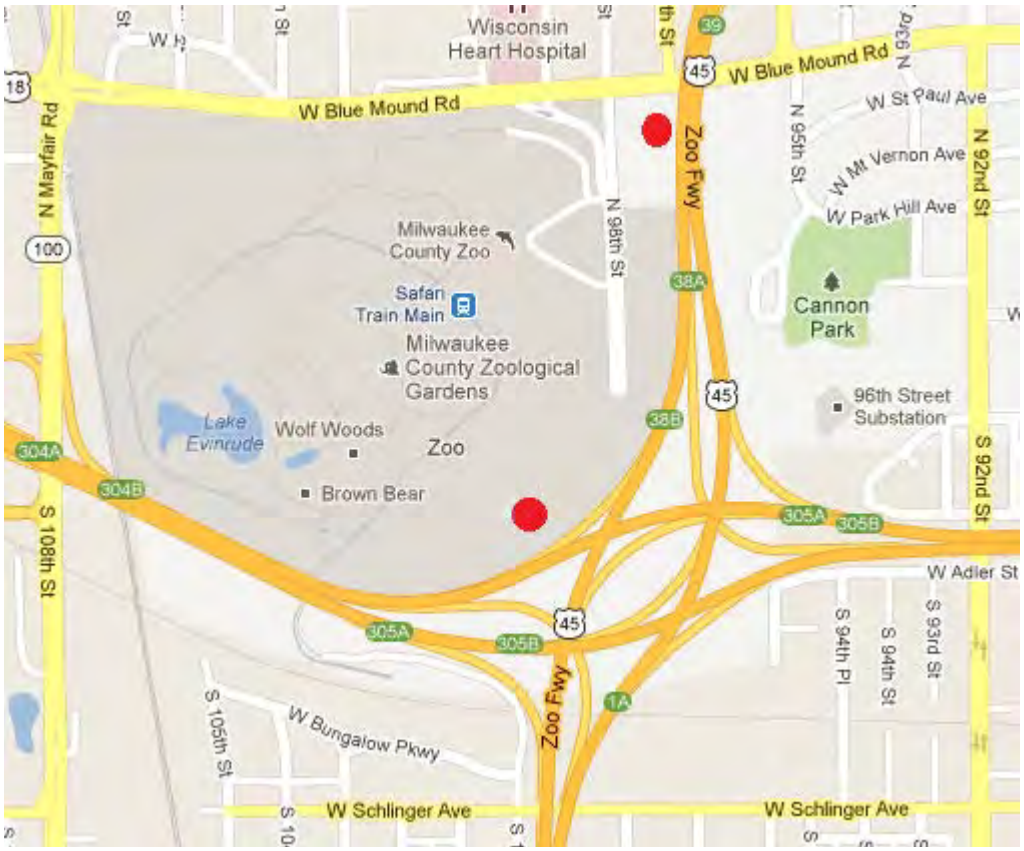


Figure B2: Box and Whisker summary plot of the data from seven sites in southeast Wisconsin. Red box is median, yellow box the 25th to 75th percentile, and black line the range from minimum to maximum concentration.

Appendix C: Location Information

A1: Zoo



Zoo Interchange – Red dots are possible monitoring locations. First is at the Zoofari center along the Highway 45 entrance to the interchange. The monitoring location is elevated above the roadway. Second is located on the WE Energy properties adjacent to the Milwaukee County Zoo. Monitoring location varies in elevation relative to the adjacent roadway.

Zoofari site located west of highway 45 before the Zoo interchange. Picture is looking NNE from WDNR site.

Zoofari site looking SSE.

Zoofari site looking E.

WE Energy property looking E.

WE Energy property looking E.

WE Energy property looking SW.

100 Street looking NNW across I94 at WE Energy property.

100 Street looking N at WE Energy property.

A2: State Fair

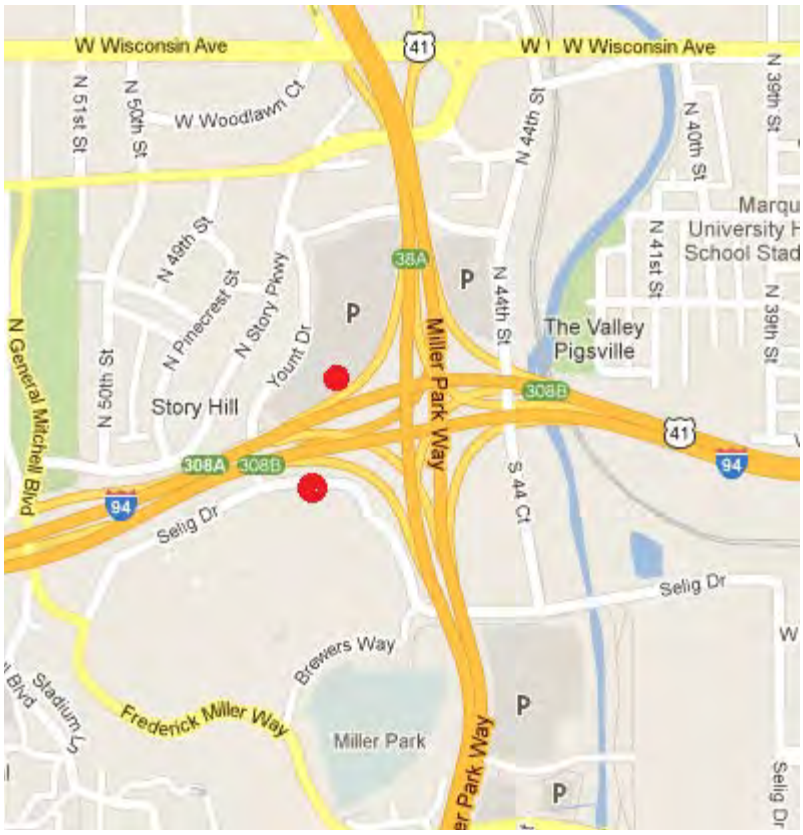
State Fair Park – Monitoring location is located south of the I94 roadway. A monitoring site would be set back by a frontage road. There is a sound barrier wall located along the north side of the highway that may affect wind flow.

State Fair north side parking lot adjacent to I94.

State Fair looking east along I94. Note frontage road and sound barrier wall.

State Fair looking east along I94.

A3: Stadium



Stadium Interchange – Location on the north side of interchange is slightly below the roadway, but would be located in a public parking lot. Location on the south side is below the roadway and would be within the WE Energy right of way.

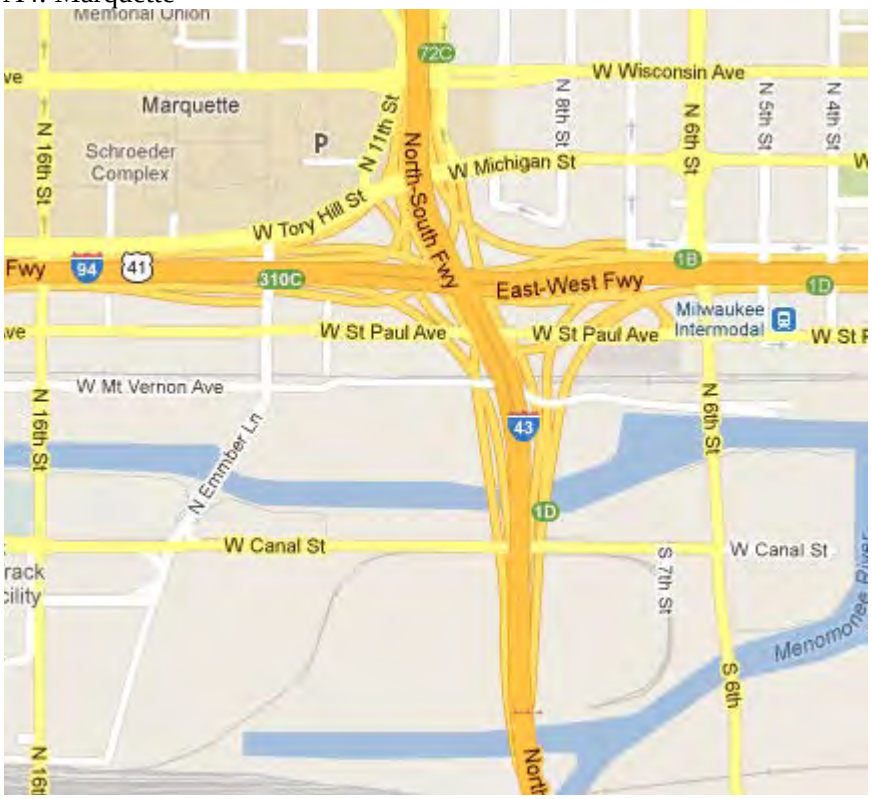
Stadium – North parking lot looking E.

Stadium – North parking lot looking W along I94

Stadium – South parking lot looking W.

Stadium – South parking lot looking E.

A4: Marquette



Marquette Interchange – Most of this interchange is engineered as a series of elevated ramps and roadways. Siting a monitoring station at this location would be technically challenging.

The elevated roadways of the Marquette Interchange make it unsafe to photograph; please see Google Images.

A5: I43

I 43 – The roadway segments in this area vary in elevation relative to the surrounding neighborhoods. The area is mixed use, with neighborhoods to the west and commercial operations to the east. The area is older and significantly built –up which might make siting a monitoring station difficult.

I43 – West side of I43 looking N.

I43 – West side of I43 looking S.

I43 – East side of I43 looking S.

I43 – East side of I43 looking N.

A6: College Avenue

College Avenue – Monitoring sites could be located in the Wisconsin DOT two park and ride lots.

College Avenue – SW Parking lot looking NE.

College Avenue – SW Parking lot looking SE.

College Avenue – SW Parking lot looking E.

College Avenue – NE Parking lot looking NW. Note barrier walls.

College Avenue – NE Parking lot looking SW. Note the entrance ramp to the north bound roadway.