Improving Health in Communities Near Highways:

A Study of the Reggie Wong Park in Chinatown

April 2017

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Executive Summary

Current site of Reggie Wong Park circled in red.

The Community Assessment of Freeway Exposure and Health (CAFEH) project includes a series of community-based participatory research projects studying localized air pollution near highways and major roadways in the Boston area and developing design approaches to protecting human health. The collaboration is led by Tufts University with partners from local communities, other universities, and municipal and regional agencies.

The CAFEH study recruited participants in Chinatown, Dorchester, Somerville and other neighborhoods. We found that people who are exposed to higher levels of ultrafine particles in traffic-related air pollution also have higher levels of molecules in the blood that are associated with higher risk of cardiovascular disease.

Besides studying the problem of traffic pollution and health, we are interested in helping communities address the problem by finding ways to reduce exposure. We have identified numerous tactics that a community could use to reduce exposure, including building sound walls and siting recreational areas farther from heavily trafficked roadways, or equipping buildings with high efficiency air filters.

The work leading up to this report was funded by the Kresge Foundation. Continued work is currently supported by the National Institute of Environmental Health Sciences.

Boston Chinatown lies at the junction of the Massachusetts Turnpike and I-93 Expressway, and there are very high levels of pollution from traffic inside the I-93 tunnels. Because most of the time the tunnels do not have active ventilation, pollution is vented out of the tunnels as vehicles exit.

Chinatown's primary outdoor recreational site, the Reggie Wong Park, lies between highway on and off ramps along Kneeland Street. Working with Tufts University, we conducted air monitoring at the Reggie Wong Park to assess the levels of ultrafine particulate (UFP) pollution there that might be affecting residents' and park users' health.

We monitored the site for a brief period of about 2 weeks. Our monitoring revealed significantly elevated levels of UFP pollution at the park, particularly for the summer when such levels are generally lower than in the colder months. We did not however see particularly elevated levels of pollution from the tunnel exit. We found that UFP levels were highest when the wind was from the southeast, toward the northbound lanes and exits from I-93. While this data contributes to our understanding of the community's health risks, the relatively brief study limits the conclusions we can draw.

The Reggie Wong Park lies on one of the Massachusetts Department of Transportation sites, known as Parcel 26, that are currently in the bidding process for development. We worked with Linnaean Solutions to coordinate a design charrette through which community members and park users learned about mitigation measures to address air pollution and came up with creative ideas for redesign of the park. We hope that some of these mitigation concepts might be considered in upcoming development proposals for the site, alongside other important community priorities such as development of affordable housing.

Ambient Air Quality at Reggie Wong Park

The Chinese Progressive Association retained Tufts University to measure and evaluate air quality at Reggie Wong Park (RWP) in Boston, MA. Reggie Wong Park consists of three basketball/volleyball courts and is situated on the southeast corner of Kneeland Street and Lincoln Street. It is one of only two parks in Chinatown. With a proposal by the Massachusetts Department of Transportation (MassDOT) to sell Parcels 25 and 26 for redevelopment (which includes RWP), there was increased public interest in understanding the air quality near the Parcels and what the impact is of the traffic along nearby Interstate-93 (I-93).

The main objectives of this project were to provide a baseline understanding of the air quality at RWP and the impact due to I-93 traffic. To accomplish this, researchers from Tufts University measured air pollutants at RWP over two weeks from June 23 – July 8, 2016. The study focused on measuring locally elevated ultrafine particulate (UFP; <100 nanometers diameter) concentrations, but benefited from having a suite of instruments available to measure additional pollutants.

In general, pollutant concentrations were elevated during the day, often during rush hour periods and with winds from the southeast. Daytime oxidative processes, possibly in conjunction with an evening collapse of the boundary layer, likely led to higher concentrations of some pollutants late into the evening. Much of the time, if one pollutant was increasing the other pollutants were also increasing. Wind direction played a major role in the pollutant concentrations measured at RWP. Winds from the southeast saw the highest concentrations of all pollutants measured, while northwest winds saw the lowest. It should be noted that southeast winds occurred approximately 50% of the time, which is not typical for the summer in Boston. Typically, southeast winds occur only about 10% of the time, with the majority of winds having a westerly component to them.

Monitoring Study Design

Tufts resesarchers deployed their mobile laboratory (Tufts mobile Air Pollution monitoring Laboratory; or TAPL) to RWP for continuous monitoring (Figure 1). The TAPL was parked on MassDOT property next to RWP (Figure 2). All instruments were connected to a sampling tube that drew air from an inlet at the top of the TAPL. Instruments were powered through an electrical connection from a nearby lamp post (provided by Mass DOT).

Sampling instruments employed in the study included:

- A chemiluminescence analyzer (Thermo Scientific 42i) to measure oxides of nitrogen (NO, NO_2, and NO_X);
- A laser photometer with a particulate matter (sized <2.5 micrometers in diameter; $PM_{2.5}$) selective inlet (TSI Sidepak AM510) to measure $PM_{2.5}$;

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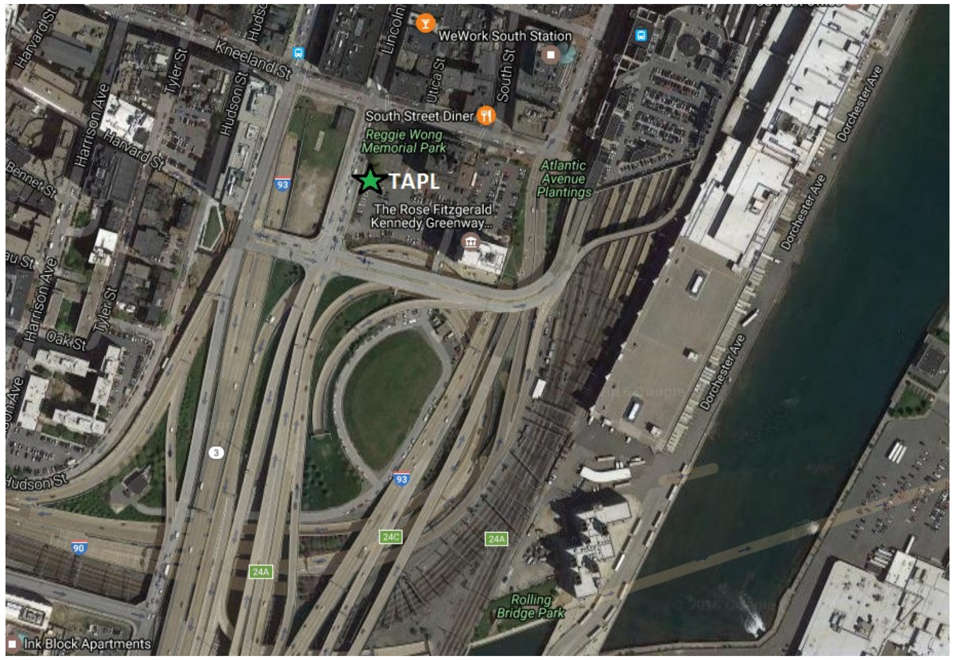
Figure 1: Air monitoring equipment setup inside Tufts Air Pollution Laboratory, or TAPL (below), and TAPL at Reggie Wong Park (above right).

- A condensation particle counter (CPC; TSI Model 3775) to measure particle number concentration (PNC; a proxy for UFP);
- An aethalometer (Magee Scientific AE-16) to measure black carbon (BC);
- A photoelectric aerosol sensor (EcoChem Analytics PAS2000) to measure particle-bound polycyclic aromatic hydrocarbons (PAH);
- A gas filter correlation analyzer (Thermo Scientific 48i-TLE) to measure carbon monoxide (CO);
- A carbon dioxide (CO_2) analyzer (LI-840A); and
- A fully integrated weather station (Davis Vantage Vue) to measure meteorological conditions.



Instruments were calibrated on-site prior to the start of monitoring. The gas analyzers were calibrated against reference gases at specified concentrations, including zero air (i.e., air free of the monitored gases). The Sidepak was calibrated with a zero-particle filter. The CPC underwent a flow rate and zero-concentration check prior to installation. All instruments have completed routine annual calibration with the equipment manufacturers. Data collection began at 1:45 PM on Thursday, June 23, 2016, and finished at 12:00 PM on Thursday, July 8, 2016. The initial sampling period was designed to provide one week of continuous coverage for each pollutant of interest, but an additional week was added on due to unfavorable wind conditions during the first week of monitoring. Measurements were taken every 10 seconds to every minute for different instruments over the sampling period. Data were downloaded from the instruments and compiled in an MS-Excel spreadsheet. Data analysis was completed with the statistical package R (version 3.3) and data visualization package *openair* (Carslaw and Ropkins, 2012).

Data Processing and Reduction

Tufts researchers examined the RWP data to eliminate outlying values judged to result from sampling and instrumentation errors. The method used to measure particulate matter depends on the relationship between the particulate matter concentration in air and the measured light attenuation. An adjustment factor of 0.6 was applied to the $PM_{2.5}$ measurements to account for the difference between the particle density used to calibrate the instrument versus particles in the metropolitan Boston area (Masri *et al.*, 2015). The RWP data were then time-averaged over hourly and longer periods (up to 24 hours). In constructing each one-hour average, 50% data coverage was required for validity, *e.g.*, at least 30 of the 60 possible observations over each individual hour for an instrument recording data every minute were required to develop a one-hour average (otherwise, no hourly average was calculated).

Air Quality at Reggie Wong Park (Summer Case)

Air pollutant measurements collected over the study period are depicted in a stacked time series plot for comparison (Figure 3). Data has been aggregated to each hour. Gray bars represent weekends (Saturday and Sunday combined). For reference, typical rush-hour times during the week fall between 6:00-9:00 AM and 4:00-7:00 PM. Midnight falls on

Table 1: 1-Hour average concentrations at RWP for particle-based pollutants.

	PNC (particles/cm^3)	$PM_{2.5}$ (µg/m^3)	Black Carbon (µg/m^3)	PAH (ng/m^3)
Count (hours)	340	329	312	312
Average	28,000	8.0	0.84	11.8
Min	6,400	1.2	0.19	1.76
Max	94,000	21	3.0	54.3

Table 2: 1-Hour average concentrations at RWP for gas-based pollutants.

	NO (ppb)	NO_2 (ppb)	NO_X (ppb)	CO (ppb)	CO_2 (ppm)
Count (hours)	293	293	293	270	330
Average	9.21	17.0	26.4	263	404
Min	0.20	5.14	6.48	26.2	386
Max	188	45.8	219	815	445

the date tick mark. It should be noted that July 4 was a national holiday, which fell on a Monday.

Many days, if one pollutant was increasing other pollutants were also increasing, likely due to pollutants originating from the same source. In some cases, though, one or more pollutant was increasing while others were not. One example of this is midday on Sunday, June 26. There was observable spike in PNC, but no corresponding spikes in PAH or BC concentrations. We have not been able to identify the reason behind the diverging pollutant concentrations; doing so would require additional data collection and analysis. One possible reason for a diverging trend, such as when PNC was increasing but BC was not, is a difference in the local fleet of vehicles. A higher proportion of gasoline-powered vehicles would generate less BC than would a higher proportion of diesel-powered vehicles, but PNC would be elevated in both cases.

Qualitatively, the temporal patterns of concentrations are similar across all pollutants measured. Most of the diurnal spikes are observed in the day, although not all spikes aligned with one another perfectly. Comparative summaries of the measured air pollutant concentrations are provided in Tables 1 and 2. These tables are constructed from data collected only during the sampling period at RWP. Count represents the number of hours available for data analysis.

Three of the pollutants measured fall under the U.S. Environmental Protection Agency's (EPA) established National Ambient Air Quality Standards (NAAQS) designed to protect public health:

- ★ CO, with NAAQS of 35,000 parts per billion (ppb) over a 1-hour averaging period and 9,000 ppb over an 8-hour averaging period, neither to be exceeded more than once per year;
- ★ NO_2, with NAAQS of 100 ppb over a 1-hour averaging period and 53 ppb over an annual averaging period; and
- ★ $PM_{2.5}$, with NAAQS of 35 micrograms per cubic meter (µg/m^3) over a 24-hour averaging period and 12 µg/m^3 over an annual averaging period.

The highest 1-hour average concentration of CO measured at RWP was 815 ppb, well below the NAAQS of 35,000 ppb. NO_2 measured at RWP – on average 17 ppb and at most 46 ppb – are well below the NAAQS of 100 ppb. Daily average concentrations of fine particulate are all below the NAAQS of 35 µg/m^3, with the highest value observed at RWP (15 µg/m^3) over a factor of two lower.

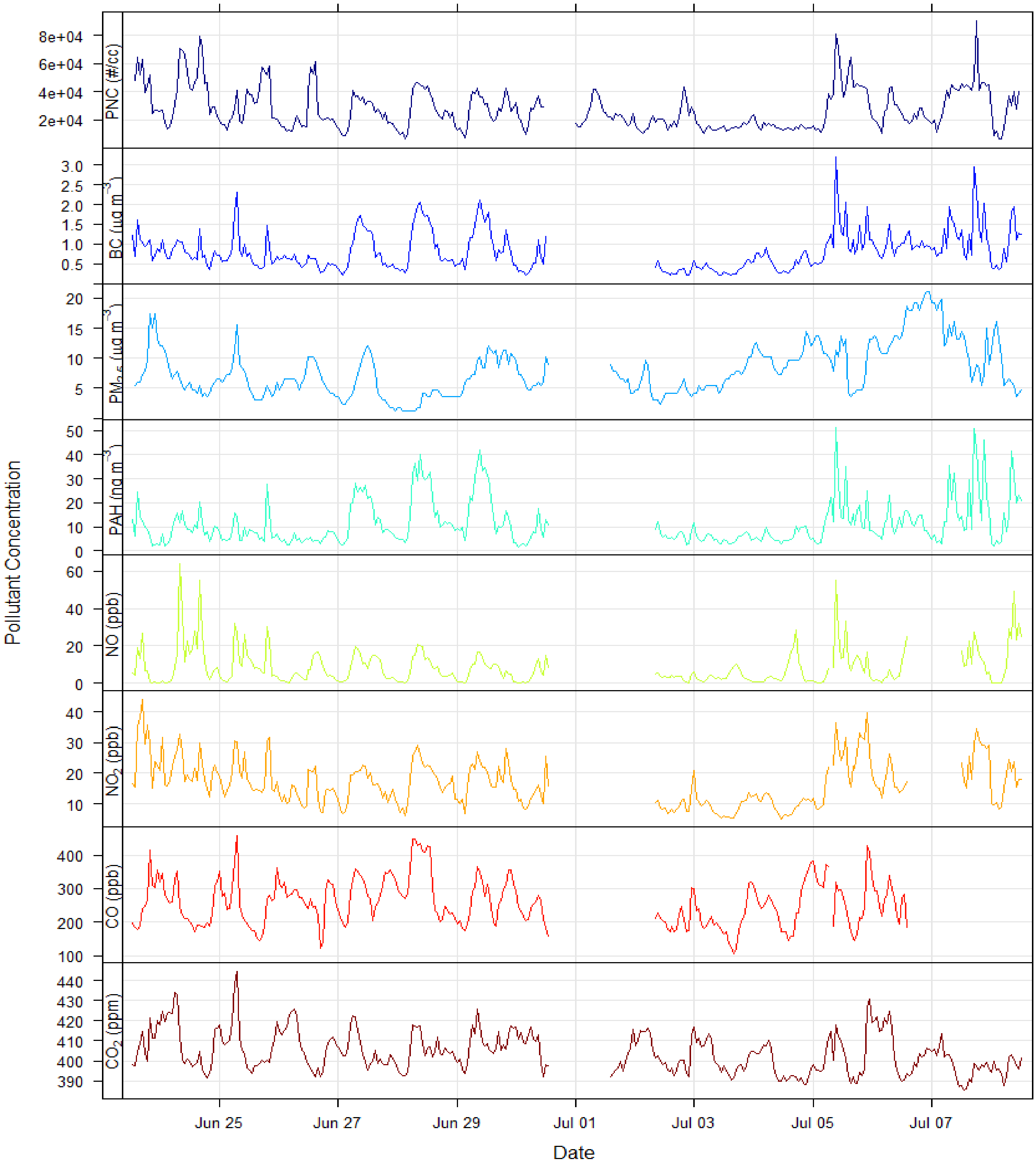


Figure 3: Hourly time series of measured pollutants at RWP. Gray bars represent weekends.

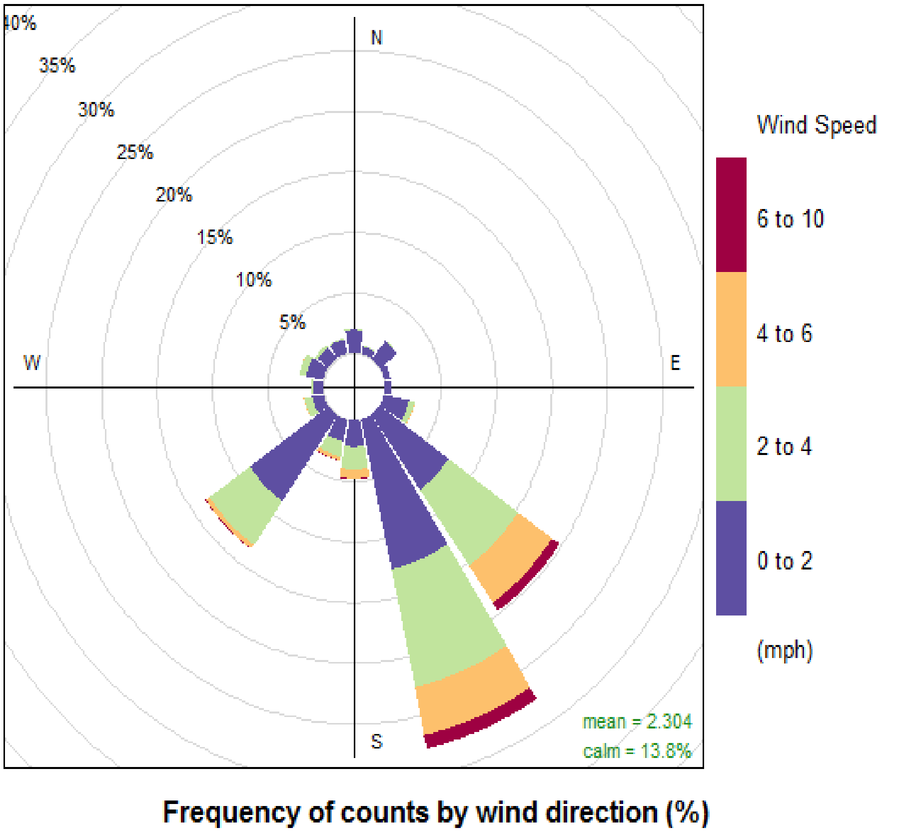


Figure 4: Wind rose during monitoring period at RWP as measured on-site with the TAPL weather station. Data are composed of 5-minute measurements.

Wind speed and direction had some influence on the pollutant levels measured at RWP. Figure 4 details the wind variability in both speed and direction over the entire monitoring duration. The colors represent a range of wind speeds, while wind direction is represented by the position of each wedge. A wedge with the outer edge pointing north represents wind coming *from* the north. The thickness of each color within a wedge represents the percentage of time those wind speeds are from that direction. For example, ~12% of the wind from the SSE was blowing at 0-2 mph. Mean wind speed at RWP was 2.3 mph. Approximately half of winds originated from the southeast, which is not typical during the summer months. Typically, southwest winds in the summer account for ~10% of all wind directions. The lowest wind speeds and least frequent wind directions occurred in both the west to north and north to east directions.

Figures 5-13 merge meteorological factors and measured pollutants into single plots. The annulus plot (always on the left) merge time, wind direction, and measured pollutant concentration. Similar to the wind rose in Figure 4, the location around the annulus represents the direction from which the wind is blowing. Time starts at 00:00 at the center and ends at 23:59 at the outer edge.

Pollutant concentration is represented by a color gradient, each figure with its own color gradient key. For example, in Figure 5 the highest PNC concentrations (not accounting for wind speed) were observed when winds were from the northeast late into the evening (approximately 8:00 PM). To the right of each annulus is a polar plot that merges wind speed and direction and measured pollutant concentration. Again, the location around the plot represents the direction from which the wind is blowing. As one moves out from the center of the plots wind speed increases. For example, in the polar plot of Figure 5 PNC were elevated during ~4 mph winds from the southeast. Data were smoothed across the plotting surface. Because wind directions were comprised of 16 distinct bins (instead of 36 as with other meteorological stations), larger wind speeds in the plot produced a finger-like effect. This is not a limitation due to the data but rather a limitation due to instrumentation. Since monitoring was only conducted for two weeks, some of the hours did not have wind from all directions. To account for the lack of all wind directions for all hours, missing data were interpolated. All data in the following figures have been aggregated to the hour (by median).

See figures on ensuing pages

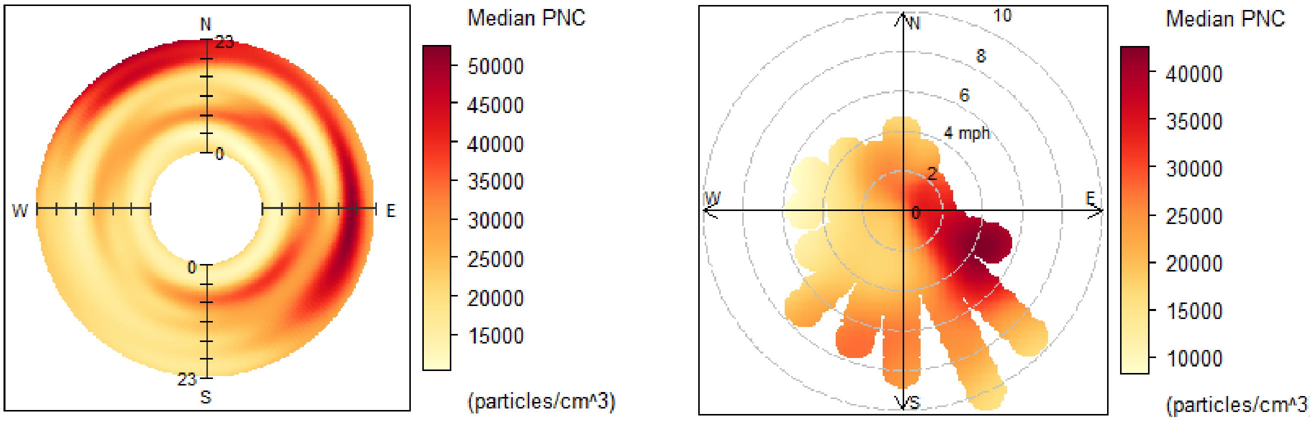


Figure 5: Polar annulus (left) and polar plot (right) for PNC. The highest concentrations occurred during the later hours during winds with an easterly component, particularly winds more southeast at ~4 mph.

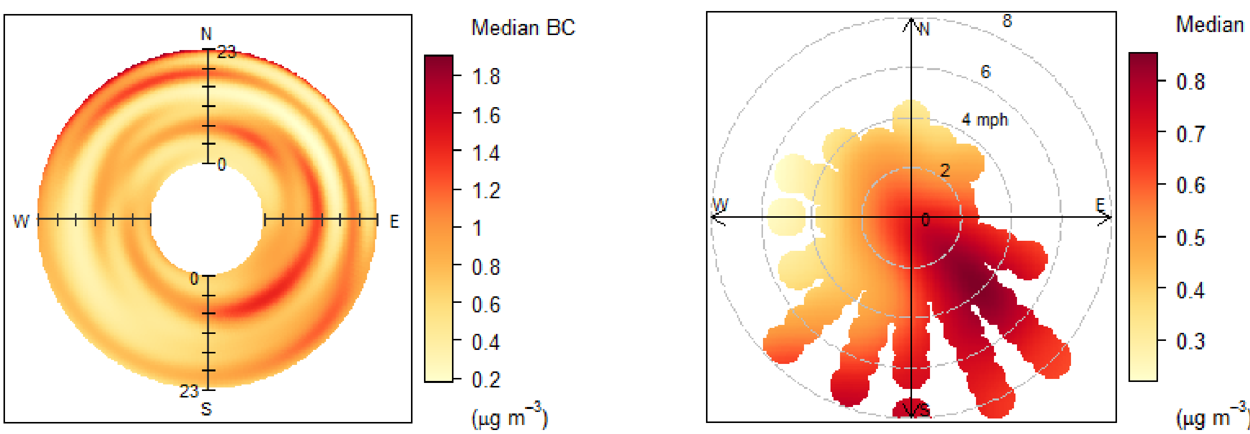


Figure 6: Polar annulus (left) and polar plot (right) for BC. The highest concentrations occurred in the mornings during southeast winds.

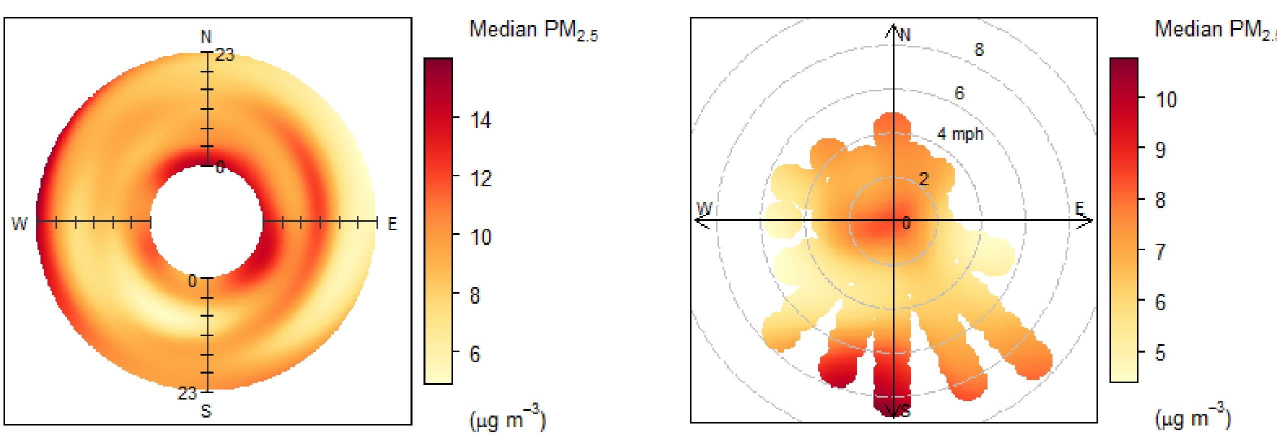


Figure 7: Polar annulus (left) and polar plot (right) for PM$_{2.5}$; concentrations were below the NAAQS for all wind directions and hours.

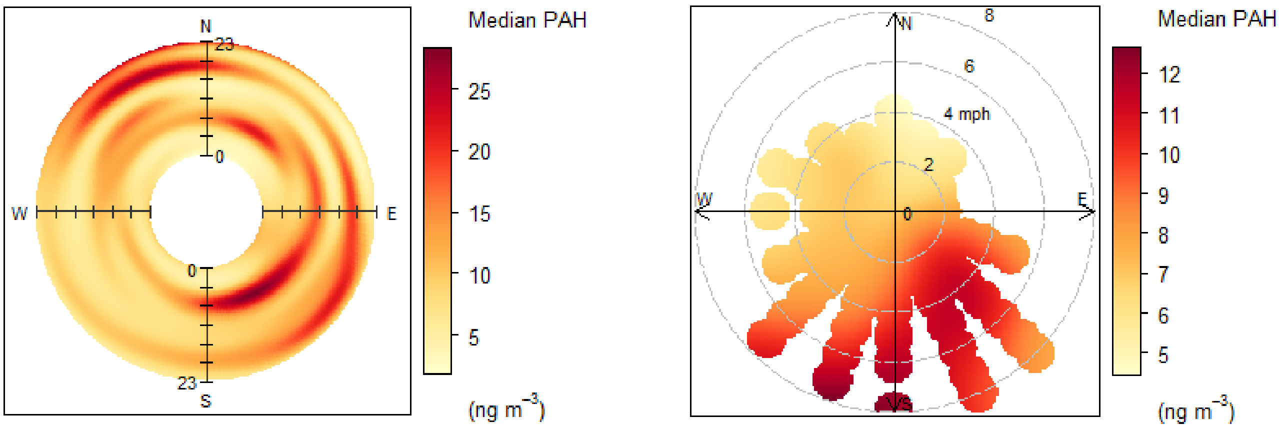


Figure 8: Polar annulus (left) and polar plot (right) for PAH. Elevated concentrations were measured during the mornings when winds were from the southeast.

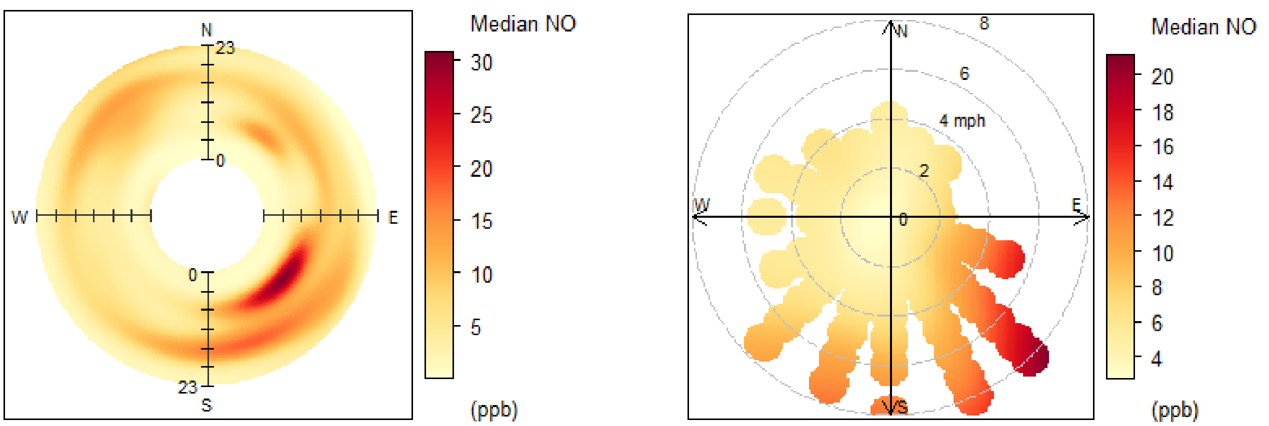


Figure 9: Polar annulus (left) and polar plot (right) for NO. Concentrations were highest during the mornings, with the strongest signal during winds from the southeast. Evening rush hours also saw a slight increase.

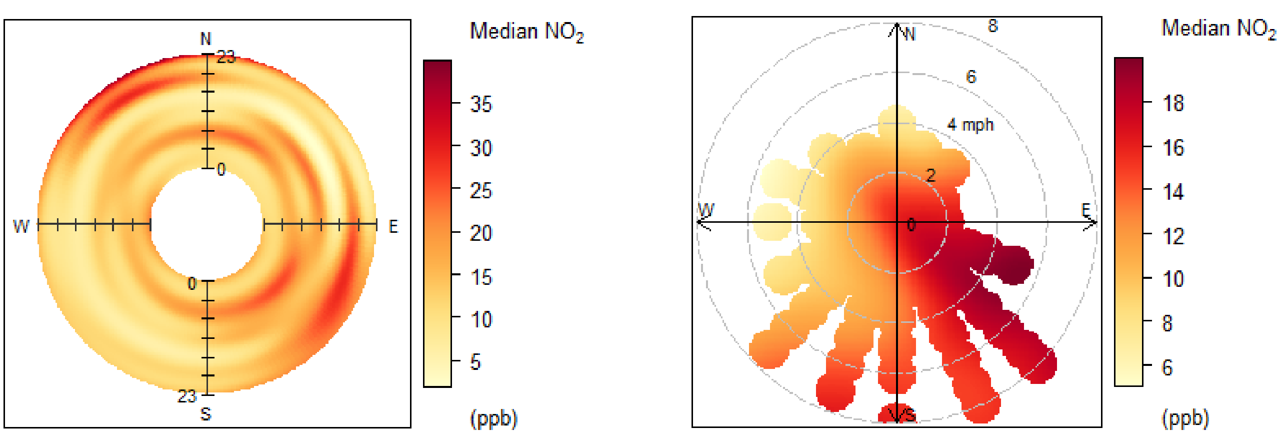


Figure 10: Polar annulus (left) and polar plot (right) for NO_2. Elevated concentrations were present during south-east winds during both the morning and evening, as well as the evenings from the northwest. Somewhat higher concentrations were also present during low wind speeds.

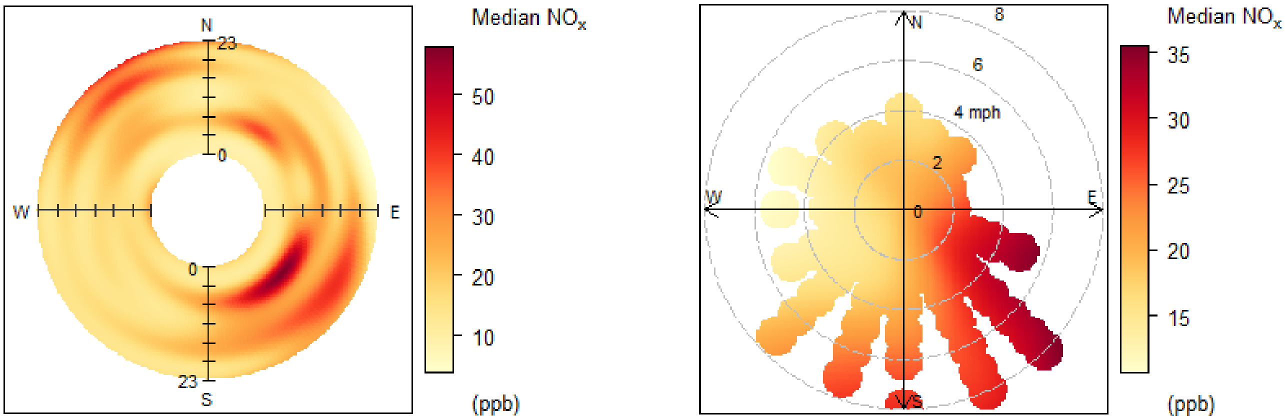


Figure 11: Polar annulus (left) and polar plot (right) for NO_X. The highest concentrations were observed in the morning during southeast winds.

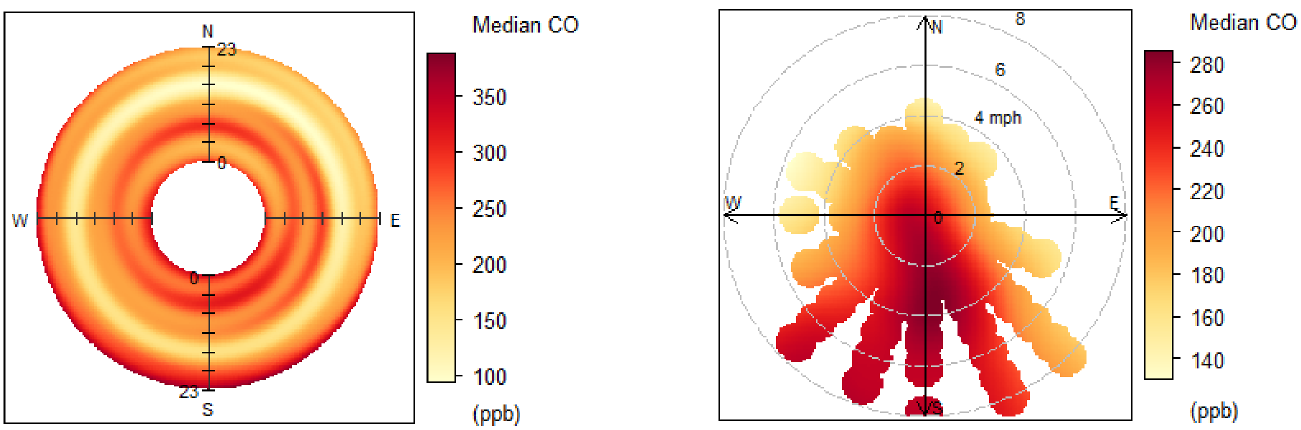


Figure 12: Polar annulus (left) and polar plot (right) for CO. Higher concentrations were observed from all wind directions in the morning and late into the evening. Low wind speeds also had higher CO concentrations.

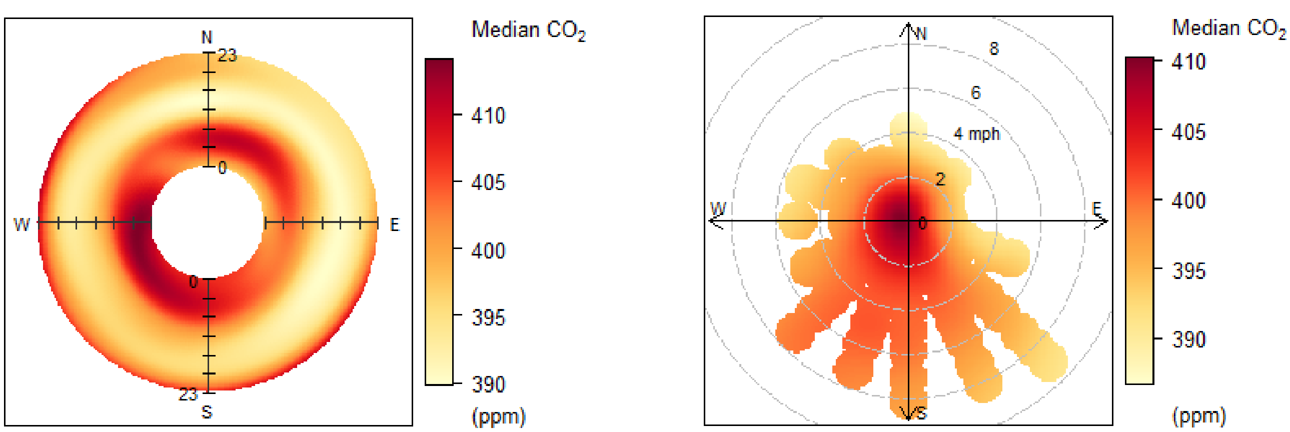


Figure 13: Polar annulus (left) and polar plot (right) for CO_2. Elevated concentrations were observed during the morning from all wind directions and also late in the evening. Low wind speeds observed the highest concentrations.

Interpretations

The limited duration of monitoring at RWP introduces some uncertainty over the long-term representativeness of the data. It is likely that higher pollutant levels will be present on some days than those observed during the monitoring study. As was observed, a higher than normal percentage of wind originated from the southeast and thus the average pollutant concentrations measured during the two-week campaign may not necessarily be typical for the summer. Since this monitoring campaign was completed during summer, typically corresponding to the lowest pollutant concentrations of the pollutants measured; higher concentrations are expected for other seasons, especially winter. Figure 14 highlights PNC measured across a one-year time period at the EPA Speciation Trends Network (EPA-STN) site in Roxbury. There are two main takeaways: 1) median PNC at RWP is elevated compared to the EPA-STN site and 2) PNC in general is observed to be much higher during colder temperatures, a trend that is expected to be observed at RWP as well.

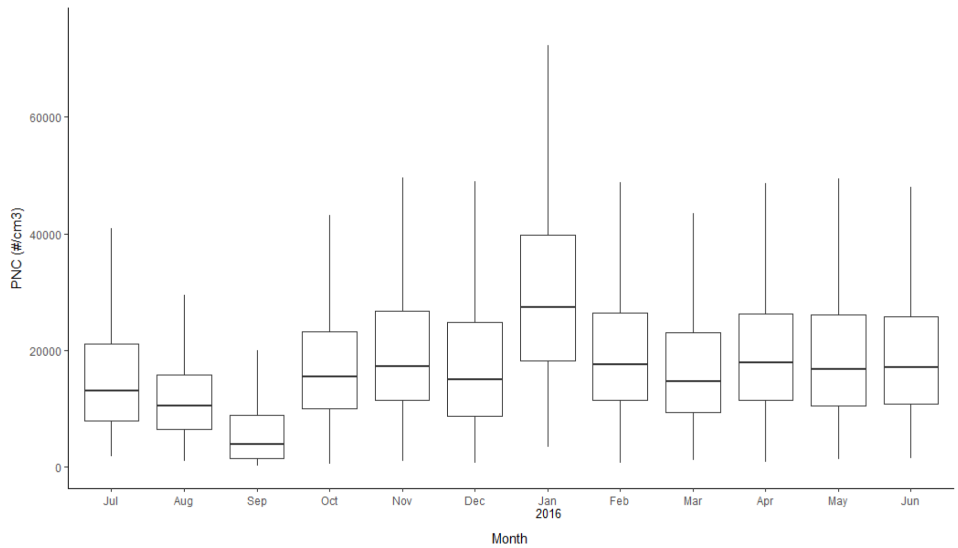


Figure 14: Monthly boxplots of PNC measured at the EPA-STN site between July 2015 and June 2016. Bold centerlines represent the monthly median with the upper and lower bounds of the boxes (i.e., the interquartile range) representing the 75th and 25th percentiles, respectively. Whiskers extend up to 1.5 times the interquartile range. Outliers are not shown but were not removed from the data set.

Looking at seasonal NO_2 concentrations measured at the EPA-STN site in Roxbury also highlight the higher pollutant concentrations that can be observed in winter (Figure 15). As with PNC, summer concentrations are significantly lower than winter concentrations and have lower variability in the measurements. The average NO_2 concentrations at RWP was ~17 ppb, which was higher than that measured at the EPA-STN site in summer 2015 (summer 2016 data was not available). The higher NO_2 concentration at RWP is likely due to the increased influence of nearby traffic (i.e., from I-93). It is expected RWP would observe the same seasonal trends in pollutants – higher winter concentrations.

Air pollutant concentrations measured at RWP were found to be below the NAAQS. Given the large margin between observed levels and the NAAQS it seems unlikely that CO, NO_2, or $PM_{2.5}$ levels at RWP will exceed the NAAQS, although it cannot be ruled out, especially with this monitoring campaign completed in summer (i.e., a best-case scenario). Winter-time monitoring would help to confirm this. It should be noted that these are the only three pollutants measured during the monitoring campaign that are regulated by the EPA, and their compliance does not necessarily qualify the air as being "healthy." The other pollutants measured (not regulated by the EPA) have shown associations with various negative health effects and should be considered when looking at the overall ambient environment at RWP. Near-roadway research often uses NO_2 not as a single pollutant of concern, but rather as a marker of the larger mixture of traffic-related pollutants that are elevated near busy roads and highways. Additionally, $PM_{2.5}$ is usually a regional pollutant and is thought to present health risks below the EPA standard. Measured $PM_{2.5}$ at RWP is very likely to be similar to other measurements of $PM_{2.5}$ within the Boston metropolitan area, whereas PNC (not regulated) is highly dependent on nearby sources, and sources further away during higher wind speeds. Focusing on the NAAQS is generally not the best method for assessing locally-sourced air pollution hazards.

The highest concentrations for oxides of nitrogen were mostly during winds from the southeast quadrant, while CO and CO_2 had elevated concentrations during more southerly winds. The slight difference in wind impact on CO versus other pollutants may be an artifact of removing some data from the middle and end of the monitoring period during the data cleaning process. Missing data over a short, two-week monitoring period may have a noticeable effect on pollutant roses because there are fewer days to average over each wind direction. Stagnant air (i.e., low to no wind) substantially contributed to higher concentrations of the measured gases at RWP. The most significant pollutant source at RWP is probably a mix of traffic and rail (Figure 2). Just south of the park is the I-93 and I-90 interchange. I-93 northbound is 500-ft to the southeast, I-93 southbound is 250-ft to the west, and I-90 is about 1,200-ft to the southwest. Both these freeways that see a large amount of traffic (>100,000 vehicles/day each). Additionally, buses frequently drive along the South Station Connector (a raised road just 230-ft to the south) heading to nearby South Station. South Station, the beginning and end of all MBTA and Amtrak routes south of Boston, is just 1,300-ft to the northeast, although the train engines can be idling even closer to RWP as some of the trains are positioned with their engines as the southern-most car. Wind with a southerly or easterly component will blow pollutants from nearby vehicles and/or trains into RWP. Sources further away, such as Logan International Airport (2.5 miles to the northeast), are also likely contributing to the measured pollutant levels at RWP (Figure 17).

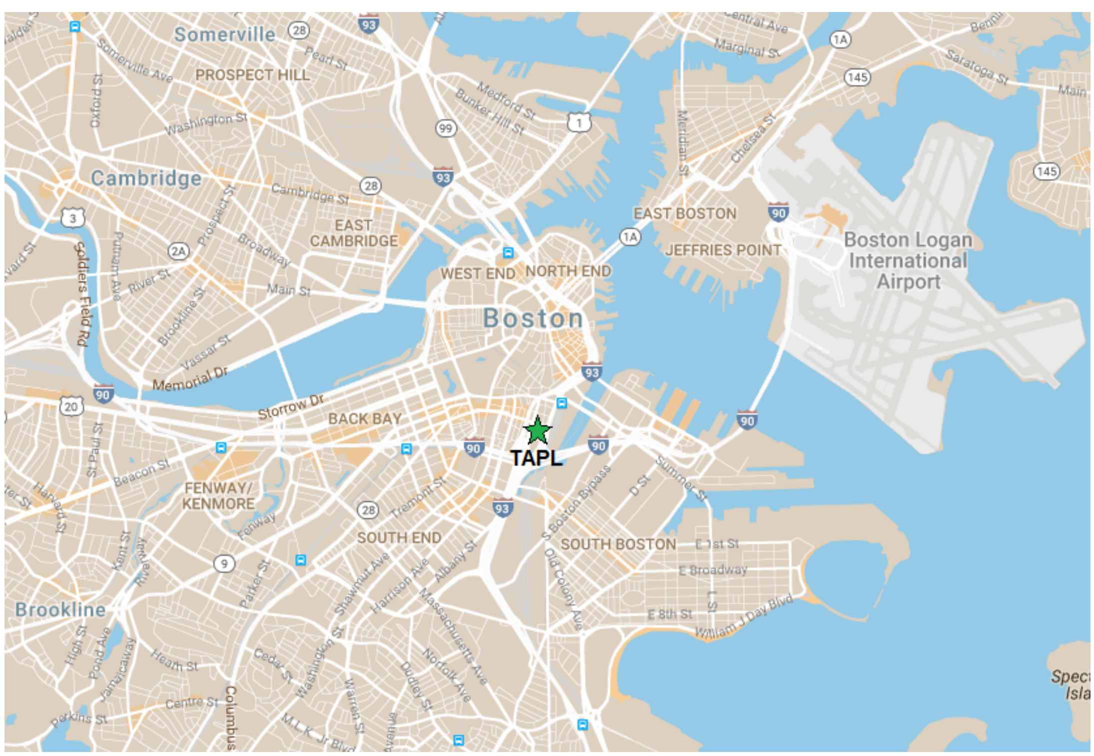


Figure 17: Map of TAPL monitoring location and view greater Boston area.

Temporally, NO was highest during the morning rush period (specifically from the southeast), while NO_2 peaked later in the afternoon and evening. In the summer, NO is easily converted to NO_2 later in the day due to high levels of solar radiation. CO was also elevated in the morning, but again later in the evening, mostly during southerly winds but also when there was little to no wind. It seems likely the elevated CO concentrations are due to traffic along the interstates. It is also possible the mixing layer height may be substantially lower in the evening (Kang et al., 2010) trapping pollutants into a smaller volume. In fact, other measured pollutants (gases and particulates) tended to have an increase in concentration later into the evening, after the typical rush hour period. CO_2 was slightly elevated above background levels with southerly winds in the mornings and late evenings, again possibly due to lower mixing heights during these times.

The particulates showed a story similar to the monitored gases – concentrations were generally highest with winds from the southeast quadrant. Both BC and PAH concentrations were highest during the morning rush hours, with another elevated band later in the evening. As with the gases, local vehicle and train traffic is likely driving these concentrations. The BC signal was very strong during winds from the southeast, which was not surprising given the close proximity of I-93. $PM_{2.5}$ remained within a small band of concentrations regardless of wind direction, which was expected given that $PM_{2.5}$ generally behaves like a regional pollutant. Concentrations of $PM_{2.5}$ are likely to be similar across urban areas – $PM_{2.5}$ levels in Boston are indicative of $PM_{2.5}$ levels across the greater Boston area. $PM_{2.5}$ was somewhat elevated in the mornings, though, and at high enough wind speeds from the south. This may be due to winds being near parallel to I-93, which tends to increase near-highway concentrations than during other wind conditions.

PNC had a noticeable increase in concentration during the morning rush hour during southeast winds, but also in the evenings during other wind directions. A number of factors may be at play causing these high evening concentrations. One factor is the local traffic. Both I-93 and I-90 have a fair amount of traffic throughout the day and into the evening hours. Under certain wind conditions, other sources may also be contributing to the total concentration, such as winds from Logan or downtown Boston. Another possible factor is secondary particle formation processes, which can occur frequently in the summer. When primary gaseous pollutants, such as NO, undergo chemical changes throughout the day they can form new particles that are observed later in the afternoon and early evening. It is possible the transport of pollutants from further away is partially impacting the PNC levels observed in RWP at night. A third factor is the possibility of an evening collapse of the boundary layer, or mixing height, mentioned earlier. As the mixing height decreases, pollutants become trapped closer to the surface. Combined with local traffic and secondary particle formation, it would be expected that evening hours see much higher concentrations than other times in the day and may be what is being observed at RWP on some evenings. Two separate evenings saw hourly PNC levels at or above 80,000 particles/cm^3. These concentrations are very high, even for near-highway neighborhoods. Two other nights saw hourly PNC peaking above 50,000 particles/cm^3. Additionally, local street traffic in Chinatown can be very high in the evenings, especially on Fridays and Saturdays. This may partially explain some of the higher PNC (and other pollutant) levels in the late evenings during northwest winds.

One interesting observation from these data, was a lack of a strong signal from the I-93 southbound tunnel exit. Given the close proximity of RWP to the tunnel exit it might be expected that winds from the west would bring substantially higher observed pollutant concentrations, but this was not the case. Although winds from the west accounted for less than 5% of the two-week monitoring period, when wind was blowing from the west the observed pollutant concentrations at RWP were not elevated as they were from other directions, such as the southeast. The lack of a signal also does not seem to be an artifact of west winds only occurring during low-traffic periods, as some west winds occurred during weekday heavy-traffic hours. One possible explanation for this is the plume coming out of the tunnel exit was buoyant and rose up into the atmosphere first (above our air monitors) before coming back down to the ground somewhere further away than RWP. This is similar to plumes exiting smoke stacks where the plume right at the exit of the stack is rising straight up. Once the plume is a little higher and begins to cool then the wind begins to play a more substantial role in its transport. Additional monitoring would be needed to confirm that this is what was occurring at RWP.

When reviewing this report, it is important to keep in the mind the percentage of wind typically coming from directions correlated with the greatest pollutant concentrations measured at RWP. While the southeast quadrant did show high concentrations of all pollutants, typically winds in the summer have a more southwesterly component in Boston. It is also important to keep in mind these pollutants were monitored during the summer. In addition to diurnal and wind direction patterns, pollutants have seasonal patterns as well with winter typically experiencing higher pollutant concentrations.

Recommendations

The main reason for this monitoring campaign was to provide insight into exposure levels near Parcels 25 and 26, which includes RWP. A second monitoring campaign could provide useful pollution information during other seasons, especially winter. This monitoring campaign was completed during summer when it is likely that pollutant levels are at the lowest. Monitoring for a period of time over the winter, for example, would provide a better estimate for a worst-case scenario. It would also provide an opportunity to explore the seasonal trends in pollutant concentrations at the site and rough estimates of spring and fall concentrations (assuming monitoring was conducted in winter when pollutant concentrations are typically highest). Also, the prevailing winds shift slightly as the seasons change and could impact the overall average concentration observed at RWP.

Conclusions

Through a two-week summer monitoring campaign, Tufts researchers were able to provide a baseline understanding of the air quality conditions at RWP (for the summer case).

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January 11, 2017

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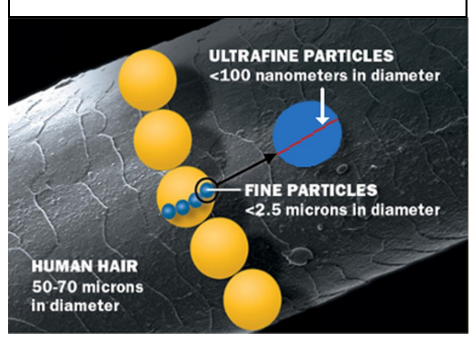
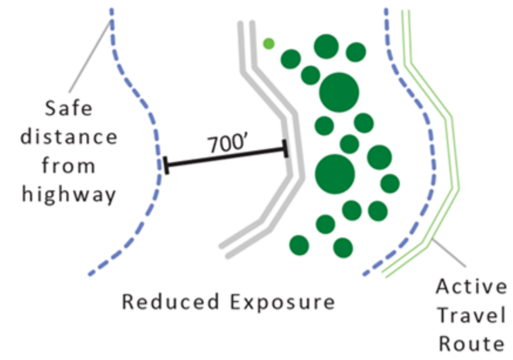
Ambient Particulate Matter

Ultrafine particles (UFPs) are less than 100 nanometers in diameter. The below figure compares the size of UFPs to the width of a single human hair.

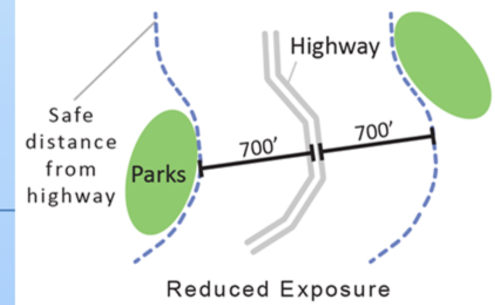


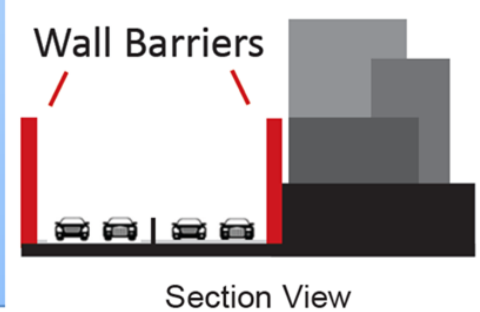
Summary of Air Pollution Reduction Tactics

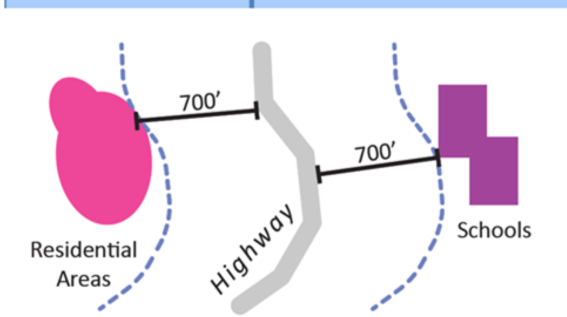
By Allison Patton



	Effectiveness		
Location	**Good**	**Moderate**	**Inconclusive**
On-Site	• Filtration • Air intake location • Sound proofing	• Healthy placement of buildings and parking structures • Trees and Plantings	• Healthy vegetables
Off-Site	• Park locations • Land use buffers	• Built or vegetative barriers • Active travel locations • Decking over highways	







Reggie Wong Park Design Charrette

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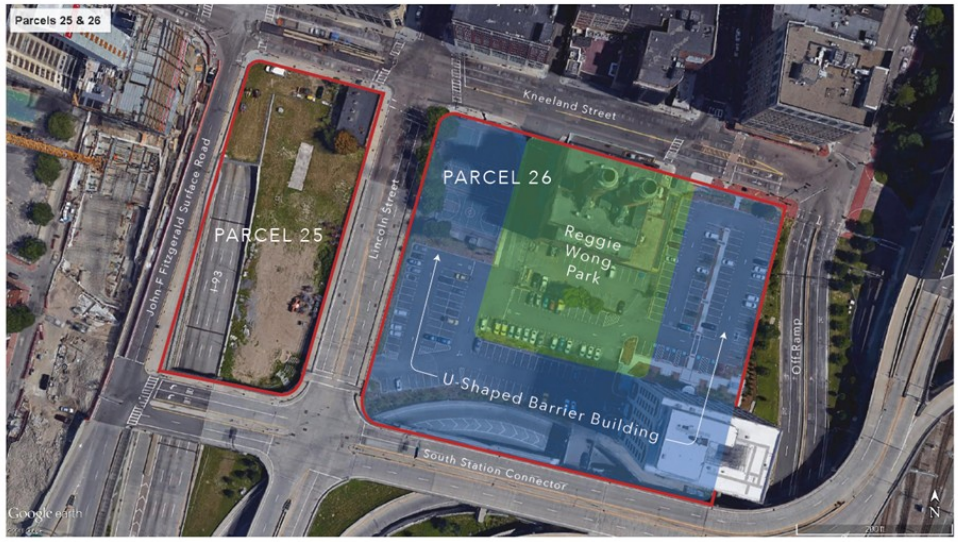


A design charrette held on June 4, 2016 invited participants to reimagine the development of Reggie Wong Park located in the Chinatown neighborhood of Boston. Outcomes and ideas from group discussions centered around three main themes including (1) protection of park visitors from harmful air pollution, (2) connection of the park and its identity to the surrounding neighborhoods, and (3) development of park services for current and future community members.

The charrette process successfully developed the following ideas:

1. PROTECTION

Barrier Building:

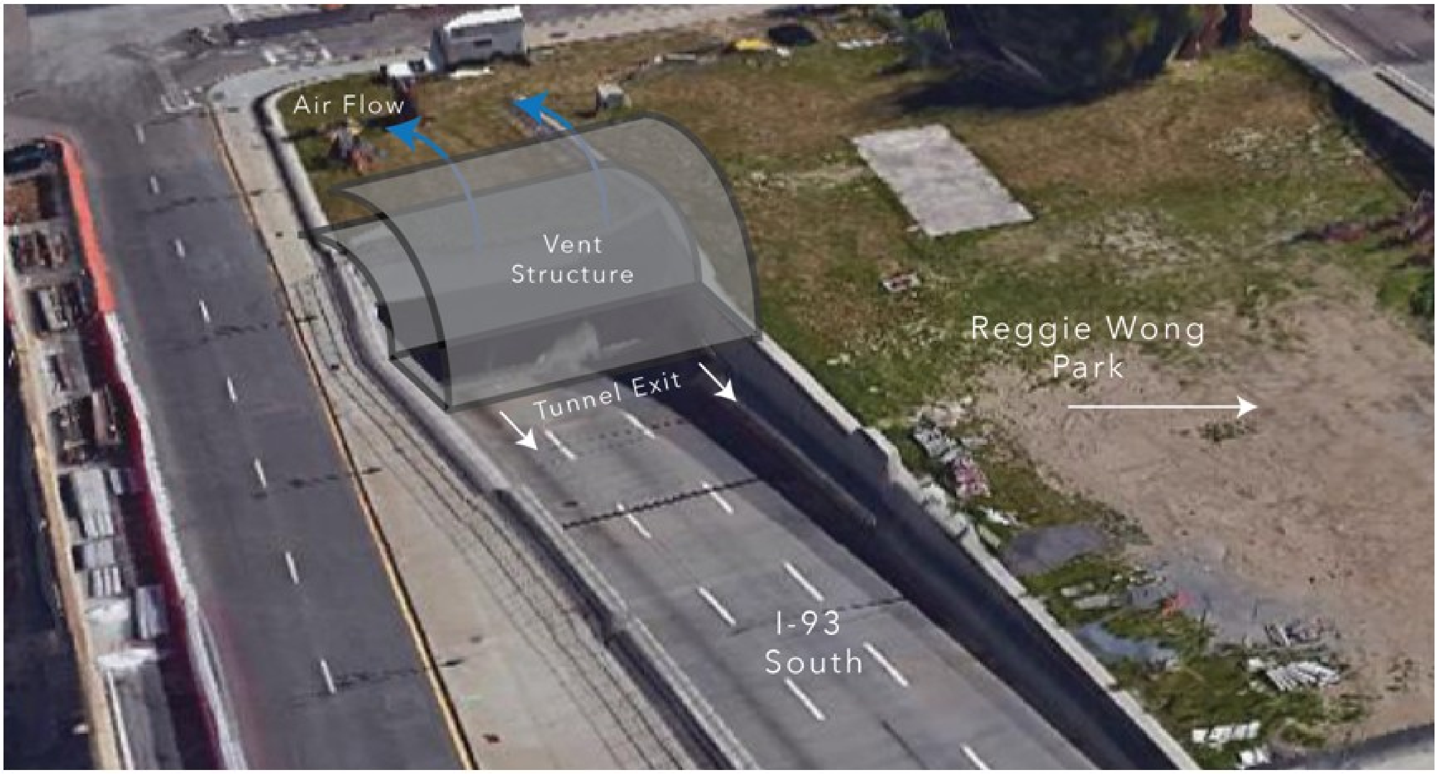
Significant sources of air pollution threaten residents and visitors of Reggie Wong Park from three sides. With the exit of the I-93 South tunnel bordering on the west, the I-93 North off-ramp to the east, and the heavily-traveled South Station Connector directly to the south, there is concern over the safest location of the park within the boundaries of Parcels 25 & 26. One solution includes the strategic construction of a U-shaped building to act as a barrier to highway-related pollutants.

The barrier building solution relocates the Reggie Wong Park in the center of Parcel 26, with the park entrance bordering Kneeland Street. A U-shaped building surrounding the park from the west, east, and south creates a protective shield from harmful air pollution while decreasing unwanted traffic-related noise and potential road hazards. Air pollution from Kneeland Street still poses a threat and will need further consideration, however the reduction of exposure from the three most offensive sides of the park is a significant improvement.

Indoor and Outdoor Features:

The current Reggie Wong Park is known as a destination for activity. Community members are often found actively exercising on the park's volleyball and two basketball courts. However, research from the CAFEH team has shown that increased physical activity in areas exposed to highway-related air pollution increases the risk of health problems such as a heart attack or stroke. A proposed solution to address this even greater risk to active park visitors includes enclosing a portion of the park area indoors.

The indoor/outdoor solution protects the most physically active of park visitors by providing an indoor space, shielded from surrounding air pollution. To maintain connection with nature and the outdoors, this option includes an open-air plaza intended for more passive park visitors and events. In addition, the incorporation of "operable walls" will allow the indoor space to be open to the outside on particularly nice days with low pollution levels.



Tunnel Exhaust Control:

The most harmful sources of air pollution for Parcels 25 & 26 includes the exit of the I-93 South tunnel which acts as the major highway's exhaust point, located adjacent to Reggie Wong Park. In addition to creating protective structures around the park area, air quality problems should be tackled at the source location. One solution to the constant supply of tunnel exhaust includes the construction of a curved vent structure located at the exit point. This structure will work to force the air in a particular direction, ideally up and away from the visitors of Reggie Wong Park.

Additional protection from harmful traffic-related air pollution includes the installation of air intake and filtration units. Designed and tested in Denmark, this solution provides large-scale air purification through attractive and quiet stand-alone units. These units are capable of filtering ultra-fine particles with relatively low energy consumption.

2. CONNECTION

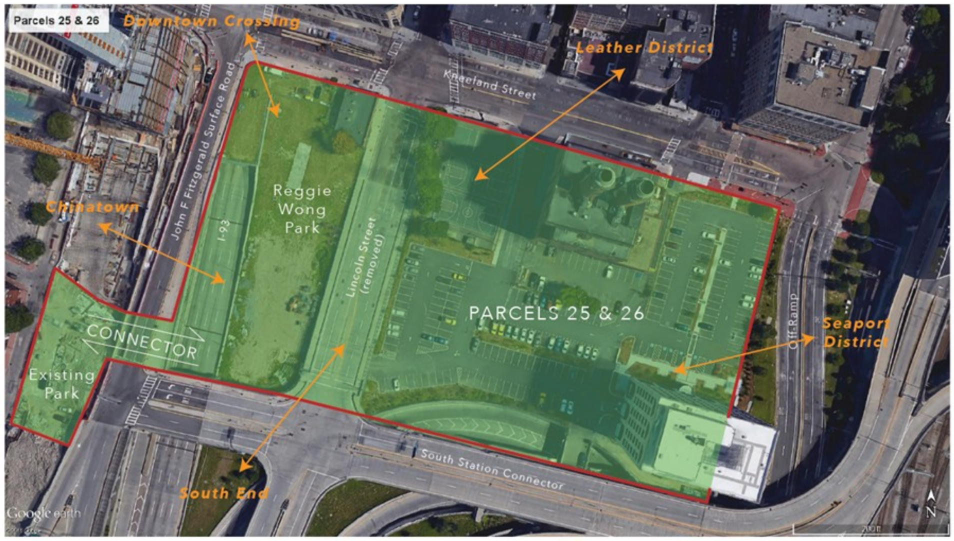
Relocation and Expansion:

Parcels 25 & 26 and Reggie Wong park are centrally positioned between five of Boston's downtown neighborhoods including the Chinatown District, the South End, the Leather District, the Seaport District, and the Downtown Crossing area. This central site creates a unique opportunity to function as a physical and social connection among the surrounding diverse areas. However, in order to give Reggie Wong Park the identity as a multi-neighborhood destination, the size and services of the park will need to be improved.

Relocation of Reggie Wong Park to Parcel 25 is a strategic solution that will generate new opportunities for growth in the area. A portion of Parcel 25 is consumed by I-93 South, however the installation of decking over the highway will create more green space and prevent a significant portion of the polluted tunnel exhaust from entering the park area. The construction of a barrier on the southern end of Parcel 25 will further prevent exposure to air pollution and will provide a surface to display the history of the park and Reggie Wong as discussed below.

Additionally, the relocation of the park to Parcel 25 allows for a sequence of construction that will not interrupt park use. Construction on Parcel 25 can begin while the existing park on Parcel 26 is still in use. Furthermore, subsurface utilities beneath Parcel 26 make construction on Parcel 25 easier and safer.

Expansion of the parcels will provide necessary space and services for the surrounding area. This solution includes combining Parcels 25 & 26 by removing the underused and unnecessary portion of Lincoln Street located between the two parcels. This expansion of the site will allow for more dedicated green space, including basketball and volleyball courts, a children's playground, elderly exercise stations, a dog park, bathrooms and more. These additional services offered by the park will create a more desirable location for visitors.



Pedestrian Green Connector:

For Reggie Wong Park to be a destination for residents from all surrounding neighborhoods, it is necessary to provide welcome and safe access for visitors. The pedestrian connector solution includes construction of a green connector between Parcel 25 and the existing (under construction) park located on the southern end of Parcel 24. Although construction of this connector will require further consideration due to varying surface elevations, it will also provide a means of easy access between the parks and the western side of the site. The pedestrian connector will be wide, well maintained, and inviting for community members, and will additionally provide information to educate visitors about the history of Reggie Wong and the Chinatown District.

Identity:

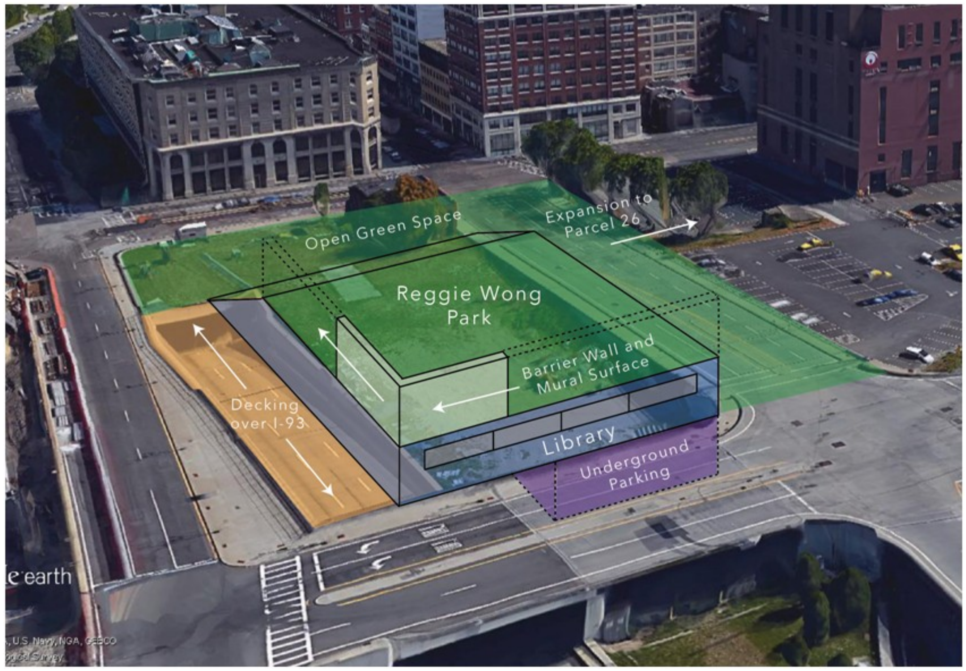
In 2012, the formerly Pagoda Park was dedicated in honor of Reggie Wong, a community leader and great friend to Boston's Chinatown neighborhood. Reggie Wong's contributions to the community through business development and community organization are a centerpiece in the neighborhood's history. He remains a symbol of friendship and connection for residents, and his life will be memorialized through the identity of the park that served as his second home.

In honor of Reggie Wong, images and information about his story will be displayed within the park. An idea to incorporate this history includes the construction of a barrier on the southern end of Parcel 25. The barrier will serve to redirect harmful exhaust from the I-93 tunnel while also providing a surface for photographic images or a community-designed mural.

3. SERVICES

Community Ownership:

Just as Reggie Wong Park is an essential piece of the neighborhood, it is envisioned that the park will be owned by the community and organized through a non-profit. This structure will give residents the ability to maintain the park as a vital community asset. The non-profit will be responsible for the service, maintenance, and operation of the site, including a proposed underground parking garage. The garage solution serves multiple functions including generating funds for park service and maintenance and providing needed parking space for future residents of the proposed affordable housing nearby. By locating the parking garage underneath the park, there is no loss of land for green space and physical activity.



Library Rooftop:

Maintaining a safe and clean space for the Chinatown community's volleyball traditions is a priority for the development of Parcels 25 & 26, however, there are opportunities for additional services that could enhance the operations and identity of Reggie Wong Park. A plan to build a library on the site has been proposed in the past and was reimagined to incorporate the needs of the community. A library will bring with it not only new amenities for the park including bathrooms and storage space, but will broaden the park's services, drawing new visitors of every age and interest.

To further optimize the site's potential, the library solution includes the construction of the library building with the park developed above and an open green space connecting the raised park to the street level. This solution creates greater opportunities for park visitors, distances physically active visitors from street-level air pollution, and increases the site's vegetation, which will have a positive effect on air quality.

The Community Assessment of Freeway Exposure and Health (CAFEH) study is a series of community-based participatory research projects studying localized pollution near highways and major roadways in the Boston area (http://sites.tufts.edu/cafeh/) and developing design approaches to protecting human health. The partners in the collaboration led by Tufts University come from universities, local communities and municipal agencies.

The work described here was funded by the Kresge Foundation to develop policy and practice approaches, specifically for the City of Somerville and the Chinatown neighborhood of Boston, and potentially for wider application.

Partners to the many CAFEH projects include: