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Air Quality Analysis of Merrimack College

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Air Quality Analysis of Merrimack College - Honors Contract

Proposal Narrative

An air quality measuring device will be used to measure the air quality around campus. This device will measure the air quality between the buildings and roads surrounding the test area in order to determine if the proximity to those objects will affect the general air quality minimally, severely, or not at all. The test will also be taken far away from buildings in order to set a benchmark for the cleanest possible air on campus. One site may include the bridge at the rear apartments. The data points should all be taken within a month of starting the project, however, the analysis could take up to a couple of months after. The device to be used is an Air Quality Measuring Device that Dr. Carlson, my contact faculty member and advisor, already has in her possession. In Environmental Design (CEN 5030), we explore the process of designing and submitting proposals that will help increase sustainability in the world around us. There are two proposals done by every student for the semester. This research on the air quality will be done in addition to that. The data that is found could be used by other students for proposals to make a cleaner and healthy change for the campus community. In doing this research and analysis, real-life data analysis collection will be performed which coincides with the "Active Learning" pillar of the honors program. This will also lead to stepping outside my own comfort zone by doing a full project by myself, including public data collection, analysis, and presentation of my findings. The "Transformative Learning" pillar also applies to this project due to the collection, analysis, and presentation of the findings. After finding and analyzing the data, it will be presented to my Environmental Design class. When the project is completed, the final submittal will be a written report to Dr. Carlson. Using the presentation and written report, she will evaluate the work.

Methodology

The air quality measuring device that is used is called the *Staplex Air Sampler*. This device is a high-volume intake fan that has a place for a filter on the front. There are many types of filters that can be used depending on the location and type of particles to be filtered. The filter that is selected for this project is the "TFA41 4" Filter." This filter collects particles in the air at a size of 1 micron at 95% efficiency. The filter can also pick up particles as small as 10 microns. Since the aim for this project is the air quality near and away from major roadways, the particle sizes need to be similar in size to exhaust fumes from vehicles.

According to the Engineering toolbox, combustion-related particles typically are up to 2.5 microns in size. However, on the same chart, auto and car emissions could be as high as 150

microns. These are the size of the particles that this study is looking for and the filter will pick up.

There are standards that the EPA gives for natural air quality for "public health and the environment." These standards were formed as a result of the Clean Air Act that was enacted in 1990. The EPA gives two different criteria for particle pollution (PM): PM2.5 and PM10. The first measures the particles in the air less than 2.5 microns and the latter measures particles 10 microns and less. The maximum values are 35 $\mu g/m^3$ and 150 $\mu g/m^3$ respectively. Since the filter finds particles that are 1 micron or higher and if the density found is near or above these values, then the air quality is not clean enough for breathing. This is because the filter does not account for particles less than 1 micron and it can be assumed that the density will be higher if these values were accounted for. However, the filter also picks up particles greater than 10 microns in diameter which could lead to skewed results.

In order to determine how the analysis would be performed, research needed to be performed. Since the air sampling device hadn't been used before by anyone at the school, some preliminary tests were performed in order to determine the loudness, placement of filters, and other bits. Scouting of the testing sites needed to be done as well due to the power need of the fan. The first few tests were failures because the filters were placed incorrectly inside their housing causing them to rip. However, after several tests, real data points were able to be obtained.

The first location to be tested is by Massachusetts State Route 125. This location sees thousands of cars a day due to its radial approach to Boston. Many people commute by Merrimack College. This location was selected because it borders Merrimack College on the east side and many students walk by or across to Royal Crest Apartments. The air surrounding this road would constantly be breathed by students and faculty. There are also several power points due to the light poles along the sidewalk. Since this location is near Mendel Hall, this enables the air testing while performing other collegiate duties within a sight distance.

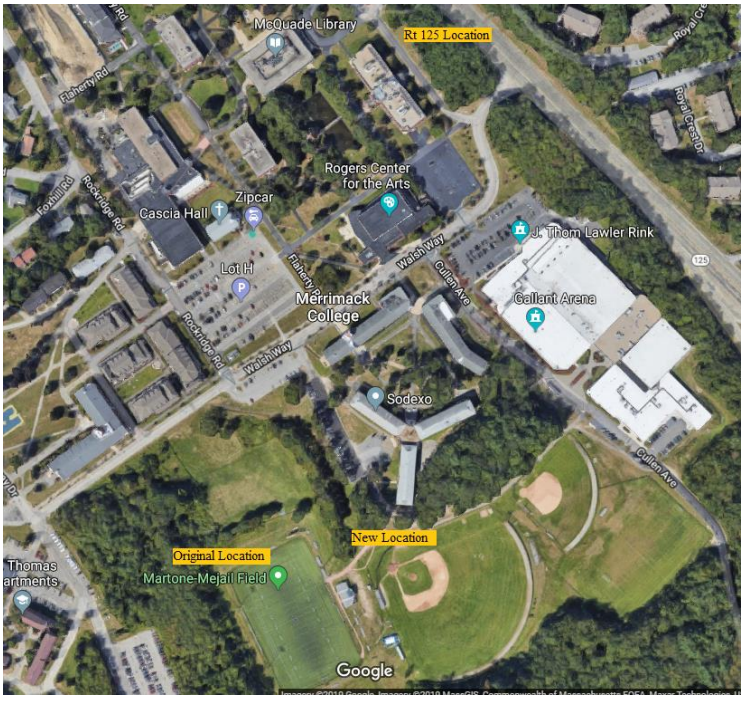

Figure 1. Location of Testing Sites

The other location to be tested is towards the back of campus away from the main roads. This location was difficult to determine due to the limited power points in the back of the campus. Originally, the location was intended to be by the pedestrian bridge that connected Lot K to Martone-Mejail Field. However, due to

the lack of power outlets, the location needed to be moved the entrance to Martone field. There is a problem with this because it is close to Lot M, which is the gravel lot used by commuters. However, since not as many cars travel this area compared to Route 125, the data should still be lower.

The procedure of the collection consisted of the following steps. Filters were measured for their mass on a scale that was accurate up to 0.0001 grams. The filter is either placed straight into the air volume sampler or placed into a plastic bag labeled with the sample number. The opening of the sampler is then covered with a plastic "shower cap" device. The sampler is then brought to the sampling location and setup. The setup includes extending and spreading the legs to form a tripod. The time is recorded and the device is turned on. There is a flow rate display on the back that should be noted to make sure the flowrate matches the flowrate mentioned for that filter in the manual. In this case, the flow rate should be between 20-26 CFM. After an hour, the device is turned off and the filter can be removed and placed in its plastic bag. The filter is then measured for its mass.

Results and Analysis

Location	Sample	mass (g)	Density (ug/m^3)	Average Density	Standard Deviation
Mendel/	3	0.0043	130.9	75.9	48.96269097
Route	4	0.002	59.9		
125	6	0.0013	37.0		
Stadium/	15	0.0006	22.4	33.8	15.1669689
Back	16	0.0007	27.9		
Campus	17	0.0013	51.0		

Table 1. Results of Air Quality Analysis

After seventeen samples were taken, only six data points ended up with a normal result. Luckily, those six consisted of three from each site. The average density from the Route 125 location was 75.9 ug/m^3 while the average density of the back of campus was 33.7 ug/m^3. These results show a considerable difference due to the location from campus. However, since the amount of data points are so small, it should be replicated in order to determine its accuracy. The Route 125 data is less accurate and has a standard deviation that

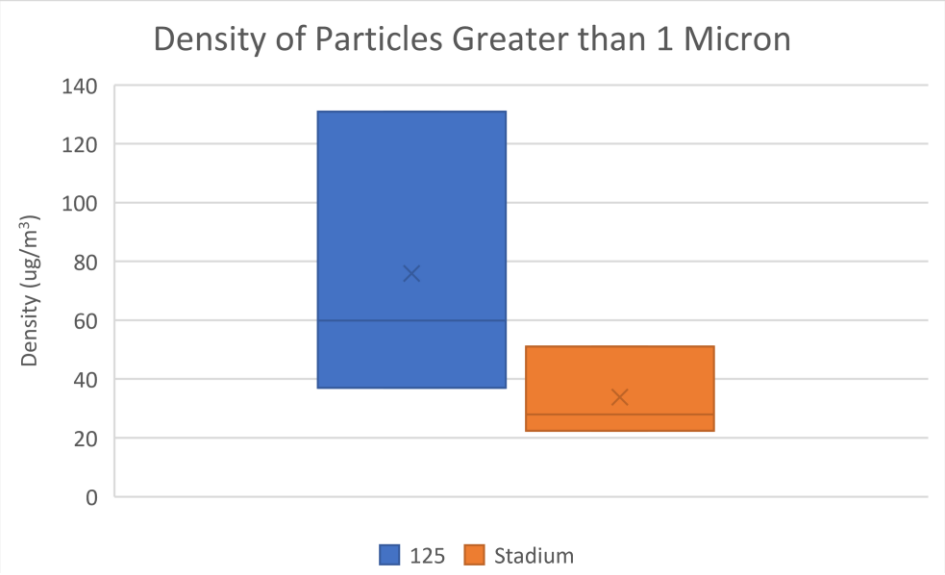

Figure 2. Density of Particles by Location with Mean

is so big that it includes the average of the back of campus.

If this data is accurate enough to represent all of the air around campus, then it would healthier for students to breathe air away from the major roads. As mentioned earlier, the maximum desired density of particles with a diameter of 10 microns is 150 $\mu g/m^3$. Since all of our data is below this number, the campus is safe according to the EPA. However, the maximum density for particles of a diameter of 2.5 is 35 $\mu g/m^3$. We cannot directly assume that all of the route 125 data points are above this value because this number contains particles that are over that diameter size. Another test with a filter that only traps 10 microns and above would be needed to be subtracted from the values found in this test in order to determine the particles that have a diameter of 2.5. However, it does show that there are more particles in the air closer to roads and buildings compared to fields.

Sources of Error

As with many data collection projects, there can be many sources of error that could have contributed to bad or wrong data. In this project alone, there were eleven filter data points that were incorrect on the second measuring. There were many things noted to have happened that may have caused the data points to be incorrect. The biggest issue came with the filters. They are made of glass fiber and act like a cloth. Several times when the filters were placed in the apparatus and the fan tuned on, some of the material was seen blown out the other side. This mass was originally measured before and in turn, ruined the test. These were easy to fix though because they were noticed at the beginning of the test. However, sometimes when removing the filter from the screen after the test had been performed, some of the filter was stuck in the mesh resulting in lost mass. In order to combat both of these towards the end of the testing, the filters were placed in the device and run for a few seconds in order to get any loose parts out and then were measured for their initial mass. There were also several filters that had gnats in them when the test was completed. The bug was removed but this could have affected the mass.

There were also errors that could have happened that were not able to be seen. When handling the filters, any small particle on the hands or plastic bags could have found its way on the filter or filter could have lost some material. Other things that could have affected the filter could include time of the day, day of testing, humidity of the air, wind, wind direction, temperature, cloudiness, or previous rain.

Conclusion

The objective of this project was to analyze the air quality around campus and determine if the location relative to major roads has an effect on this. During the project, the *Staplex Air Sampler* was used for the first time on campus and samples were taken near route 125 and the Martone-Mejail Field. The data showed that the location near the major road had a higher density of microparticles than the other location and that it may be healthier to breathe the air farther away from major roads.

Citations

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