Indoor Air Quality Assessment
Garden Place Academy
4425 Lincoln Street, Denver, Colorado
Nov 2017
Prepared for:
Denver Public Schools
Prepared by:
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1.0 INTRODUCTION

PURETi conducted a limited Indoor Air Quality (IAQ) Assessment in Sept-Oct 2017 in specific locations at The Garden Place Academy elementary school in Denver, Colorado. The objective of this assessment was to gather data for the Denver Public Schools to evaluate the indoor air quality improvement benefit of PURETi surface treatments in the schools of Denver.

2.0 PRODUCTS

The products used in this project was PURETi Clear (www.pureti.com).

PURETi products are mineral-based, spray applied photocatalytic products that oxidize organic particulates that come in contact with a treated surface. Benefits of PURETi include improved air quality by actively decomposing Volatile Organic Compounds (VOCs) and fine particulate matter to improve respiratory health, and lowering the total maintenance burden of the treated surfaces.

3.0 METHODOLOGY

The school's stairway was chosen by the school as the test site for the evaluation. Air quality sampling were done both before and after the PURETi application at the test site. A baseline grab air sample was taken on the stairway on Sept 14, 2017 prior to the application of PURETi on Sept 21 2017. A post-treatment grab sample was taken on October 19 2017. In addition, a third baseline grab air sample was taken in one of the school's classroom on October 19 2017. This classroom has not been treated with PURETi. The samples were analyzed by a reputed third-party lab for the presence of 61 most common VOCs. Continuous monitoring of the Total VOC (TVOC) levels were also carried out for a week for both before and after treatment using a handheld portable IAQ device. The post-treatment TVOC monitoring was carried out starting Oct 1 2017. All PURETi application, VOC sample collection and monitoring were performed by members of CleanBeyond, a PURETi affiliate.

4. TEST EQUIPMENT

PURETi utilized SGS Galson Labs (www.sgsgalson.com) as the third party testing laboratory for the analysis of the air samples. All grab samples were collected using SGS's standard Minican® passive air sample collection canisters. Samples were collected for ~24 hours and the canisters were returned to SGS labs for analysis and identification of the VOCs. The test conducted was the VOC 61 panel, which identifies the 61 most common VOCs present in the sample and quantifies them. The analysis can detect up to 1-5 ppb of the individual listed VOCs.

For the continuous monitoring of TVOC, PURETi utilized the AdvanceSense IAQ Meter manufactured by GrayWolf Sensing Solutions for assessing the indoor air quality of the treated room. (http://www.wolfsense.com/directsense-iaq-indoor-air-quality-monitor.html). The meter was compliant with factory calibration requirements and in good working order at the time of the test. Graywolf AdvanceSense IAQ meter utilizes a photoionization detector (PID) of very high sensitivity to measure Total Volatile Organic Compound (TVOC) in ambient air. The resolution of the meter is 1ppb and the measurement range is 1-10,000ppb. The sensor also collects Carbon Dioxide (CO2), Temperature and Relative Humidity (RH) data.

5. SITE OBSERVATION/NOTES

The Garden Place Academy is one oldest operating elementary school in the city of Denver, operating since 1904. The stairway that was chosen for this trial connects the first and second floors of the school, and is located on the north side of the building. There are two long glass windows with a pebble finish on the west facing wall of the stairway. The walls adjacent to the glass windows has murals painted on it. UV-A light intensity through the glass was measured at 0.01mW/cm2.

6. RESULTS

The baseline grab air sample analysis revealed only three VOCs that were above the detection level of the tests for the stairway. The post-treatment analysis showed that there was significant reduction in the two most prominent VOC that was detected – Acetone was reduced by 56% and Toluene by 18% after the PURETi treatment.

Type of VOC	Baseline concentration (ppb)	Post-treatment concentration (ppb)	% reduced
Acetone	41	18	56.09%
Toluene	4.4	3.6	18.18%

The baseline air sample analysis for the classroom showed higher concentrations and higher number of individual VOCs than the stairway. A total of 12 unique VOCs in higher levels were detected in the sample, as well as presence of BTEX (Benzene, Toluene, Ethylbenzene and Xylene), which is commonly used as an indicator for VOC pollution and signify presence of vehicular and industrial emission pollutants. The concentration of Benzene, a known human carcinogen, was found to be nearly 3x higher than the maximum concentration levels allowed by the USGBC LEED v4 standard.

Type of VOC	Baseline Concentration (ppb)	Baseline Concentration (µg/m3)
Acetone	18	42.76
Vinyl Acetate	3.4	11.97
Methyl Ethyl Ketone (MEK)	2.0	5.9
Hexane	4.9	17.27
Ethyl Acetate	5.9	21.26
Benzene	1.8	5.75
Heptane	2.8	11.47
Toluene	26	97.97
Methyl Isobutyl Ketone	2.3	9.42
Ethylbenzene	3.2	13.39
Total xylenes	7.1	30.83

The detailed reports on the VOC panels from SGS Galson labs are attached to the appendix of this report.

Although most of these VOC levels are not considered high (except for Benzene) , treating this and other rooms in the school with PURETi could significantly reduce the concentration of these VOCs (as demonstrated in the stairway) and drastically improve the indoor air quality of the classrooms.

The continuous monitoring data from the Graywolf TVOC meter also showed that the average TVOC level in the stairway was reduced by 14% after PURETi treatment, and the maximum TVOC levels reached was reduced by 32%.

Date	Average TVOC (µg/cm3)	Range TVOC Min (µg/cm3)	Range TVOC Max (µg/cm3)	CO2 (ppm)	Temp F	Relative Humidity % RH	Notes
Sept 14 2017	469.99	312	936.31	468.7	31.71	18.35	Baseline (before treatment)
Oct 1 2017	403.42	291	628.4	475.46	26.34	25.03	Post PURETi treatment

7. CONCLUSION AND RECOMMENDATIONS

Baseline TVOC levels measured at the Garden Place Academy are consistent with levels measured by PURETi at other Class-A commercial office spaces. These baseline measurements indicate that average TVOC levels were very close to the maximum concentration levels outlined in the LEED v4 standard. The presence of BTEX and higher number of unique VOCs in the baseline data from the classroom, specifically Benzene, a known human carcinogen whole level exceeded 3x the LEED v4 maximum limit, is a concern.

The light level in the stairway (0.01mW/cm2) is on the lower side of average, and the ratio of PURETi treated surface area to volume of air is also slightly lower than average. The PURETi treatment proved to be very effective in reducing VOCs and improving IAQ even under such low VOC, low light and lower surface area to volume ratio scenario.

It is reasonable to conclude that corresponding improvements to IAQ could be achieved throughout the building if similar (or higher) light levels and treated surface to room volume ratios are maintained. A more broad application of PURETi would lead to improved IAQ and contribute to an improved, healthier environment for the staff and children at Garden Place.

8.0 VOCs AND HEALTH

According to the U.S. Environmental Protection Agency (EPA), indoor air pollution is one of the top five environmental risks to public health, concluding that immediate symptoms of exposure to polluted air can include throat irritation, dizziness and headaches. The 2009 EPA report to Congress concluded that improved indoor air quality can result in higher productivity and fewer lost work

days. Although many factors of the physical environment have a significant impact on day-to-day health and productivity, the EPA estimates that poor indoor air may cost the U.S. tens of billions of dollars each year in lost productivity and medical care.

According to a White House Summit on Sustainable Buildings, students in schools with healthy air are more proficient at retaining information and teachers have fewer sick days. For employers, improving indoor air quality directly correlates with higher productivity and a more satisfied workforce. Professor David Wyon of the Technical University of Denmark's International Centre for Indoor Environment and Energy, said, "It has now been shown beyond reasonable doubt that poor indoor air quality in buildings can decrease productivity as high as six to nine percent."

In addition, the World Green Building Council summarized that, 'The health and productivity benefits of good indoor air quality (IAQ) are well established. What may appear a modest improvement in employee health or productivity, can have a huge financial implication for employers – one that is many times larger than any other financial savings associated with an efficiently designed and operated building. A comprehensive body of research can be drawn on to suggest that productivity improvements of 8-11% are not uncommon as a result of better air quality'.

Although there is no official U.S. standard for non-industrial settings, various organizations around the world have set their own standards as it relates to VOCs and IAQ. The current USGBC LEED v4 standards for indoor air quality are included in the appendix.