Background

Beatrice Public Schools wanted to evaluate the air quality and outside air adequacy/air exchanges in each of the elementary schools. The schools were built in the mid 1950's and three of the four have similar ventilation systems. This information will be used to evaluate potential future expenditures on HVAC systems in the future. To complete a preliminary evaluation of the air quality, three indoor air quality (IAQ) monitors were placed in each elementary school in random classrooms.

Results and Discussion

Heating, Ventilating and Air Conditioning (HVAC) System

Cedar Elementary utilizes uninvent heating systems in the classrooms. The other schools utilize a forced air tunnel system with a 1950's boiler providing initial tempering of the air and additional hot water fins in the rooms. Return air vents are located in the hallway. These systems handle most or all of the rooms in the three schools. Rooms with outdoor access have univents for heating. Outdoor air is supplied to the forced air system through a plenum and louvers located on the roof. The univents generally bring outdoor air through louvers in the back of the unit. It was not determined whether the four ceiling mounted univents in Cedar Elementary incorporate outdoor air into the classrooms. Air conditioning is supplied by individual rooftop units which are not thought to incorporate outside air into the classrooms.

Indoor Air Quality Monitoring

Annually calibrated Gray Wolf IQ-410, Gray Wolf IQ-604, or IQ-610 IAQ monitors were installed in in classrooms from March 17 to March 19. The monitors recorded and averaged data every 15 minutes for carbon dioxide (CO_2) in parts per million (ppm), relative humidity(%), temperature (°F or C), and carbon monoxide (CO) (ppm). Data listed as average are calculated using all data collected by the monitors. Data listed as average occupied times are defined as from 8:00 a.m. to 4:00 p.m. Max values are the maximum fifteen minute reading recorded on the monitors during the entire monitoring period.

Carbon dioxide is helpful in evaluating air exchanges in classrooms. The CO_2 results are compared to a recommended level, determined using the ANSI/ASHRAE method of the background level (350 ppm was used for this survey) plus 700, giving a recommended maximum level of 1050 ppm. Additionally, ANSI and ASHRAE have developed temperature and relative humidity recommendations for the comfort of the occupant. Relative humidity should be under 50 percent year-round, with a corresponding temperature range of 68˚ to 80˚F. Graphical representations of the data can be seen in Appendix A. Additional information on the recommended guidelines for indoor air quality monitoring is available upon request.

Table 1: Cedar Elementary IAQ Data Summary

Location	Average CO_2 (ppm)	Average Occupied CO_2 (ppm)	Max CO_2 (ppm)	Average Relative Humidity (%)	Average Temperature (°F)
Room 105	820	1160	2860	25	74
Room 122	1030	1660	2690	24	79
Room 133	1070	1710	2410	26	72

The average occupied CO_2 levels were above the ANSI and ASHRAE recommended guideline, indicating additional outside air is needed to accommodate the number of occupants.

Table 2: Stoddard Elementary IAQ Data Summary

Location	Average CO_2 (ppm)	Average Occupied CO_2 (ppm)	Max CO_2 (ppm)	Average Relative Humidity (%)	Average Temperature (°F)
Room 105	900	1250	2310	25	77
Room 123	1230	1540	2630	26	78
Room 136	1060	1270	1820	22	79

The average occupied CO_2 levels were above the ANSI and ASHRAE recommended guideline, indicating additional outside air is needed to accommodate the number of occupants.

Table 3: Lincoln Elementary IAQ Data Summary

Location	Average CO_2 (ppm)	Average Occupied CO_2 (ppm)	Max CO_2 (ppm)	Average Relative Humidity (%)	Average Temperature (°F)
Room 101	1300	1490	2180	28	80
Room 123	1080	1250	2250	28	76
Room 130	1370	1490	1880	28	78

The average occupied CO_2 levels were above the ANSI and ASHRAE recommended guideline, indicating additional outside air is needed to accommodate the number of occupants.

Table 4: Paddock Elementary IAQ Data Summary

Location	Average CO_2 (ppm)	Average Occupied CO_2 (ppm)	Max CO_2 (ppm)	Average Relative Humidity (%)	Average Temperature (°F)
Room 105	670	1060	1750	24	74
Room 123	750	1000	1480	26	76
SE Portable 202	1630	2560	4050	26	76

The average occupied CO_2 levels in the main building were under or very near the ANSI and ASHRAE recommended guideline. This may be due to the number of occupants per classroom, or the outside air louvers may be adjusted to incorporate more outside air in this building. The average occupied CO_2 level in the SE Portable 202 room was significantly above the recommended levels, indicating additional outside air is needed to accommodate the number of occupants. The portable classrooms do not currently have controllable outside air, so the louvers on those units are shut.

The average temperature and relative humidity levels in all buildings were within recommended guidelines over the monitoring period.