INDOOR AIR QUALITY INVESTIGATION

BENTON ELEMENTARY SCHOOL
1410 HINKSON AVENUE
COLUMBIA, MISSOURI

Prepared for:

COLUMBIA PUBLIC SCHOOL DISTRICT
5909 PARIS ROAD
COLUMBIA, MISSOURI 65202

Prepared by:

NPN ENVIRONMENTAL

Contract C-23018
January 2023

1631 Headland Drive • St. Louis, MO 63026 • (636) 343-1300 • FAX (636) 343-8192

QUALITY ASSURANCE/QUALITY CONTROL

Project: Indoor Air Quality Investigation
Benton Elementary School
1410 Hinkson Avenue
Columbia, Missouri

Project No.: Contract C-23018

This report has been prepared on behalf of and for the exclusive use of Columbia Public School District solely for the purpose of documenting the above-titled project. This report and all documents contained herein shall not, in whole or in part, be disseminated or conveyed to any other party, nor used by any other party in whole or in part, without written consent of NPN Environmental Engineers, Inc. and Columbia Public School District.

It is the professional opinion of the signee that accepted and sound industry practices and standards were employed on this project. As part of NPN Environmental's QA/QC practices and procedures, this report has been reviewed and approved by the following:

Project Manager: Ruth C Mannebach
Ruth C. Mannebach

QA/QC Manager: Kimberly A. Polacek
Kimberly A. Polacek

TABLE OF CONTENTS

	Page No.
QUALITY ASSURANCE/QUALITY CONTROL	i
LIST OF ACRONYMS AND ABBREVIATIONS	iii
INTRODUCTION	1
FIELD INVESTIGATION ACTIVITIES	1
Structure	1
HVAC Systems	3
Sampling Strategy	3
SAMPLING AND ANALYTICAL METHODS	3
Primary IAQ Parameter Sampling	3
Air Contaminant Sampling	3
Swab/Bulk Culture and Surface Sampling	4
SAMPLING RESULTS	4
DISCUSSION OF RESULTS	5
Primary IAQ Parameter Sampling	5
Air Contaminant Sampling	5
Swab/Bulk Culture and Surface Sampling	5
CONCLUSIONS	6
RECOMMENDATIONS	6
LIMITATIONS	6

TABLE

Table 1 Air Sampling Results

APPENDIX

Appendix A Laboratory Results

LIST OF ACRONYMS AND ABBREVIATIONS

ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.
HVAC	Heating, Ventilation, and Air Conditioning
IAQ	Indoor Air Quality
IAQA	Indoor Air Quality Association
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
USEPA	United States Environmental Protection Agency

Introduction

NPN Environmental was engaged by Ms. Christy Serrage (Columbia Public School District) to conduct an IAQ investigation and limited HVAC inspection of the Benton Elementary School facility located at 1410 Hinkson Avenue, Columbia, Missouri.

The investigation was conducted by NPN Environmental at the request of Columbia Public School District personnel to characterize the IAQ of the building. The focus of this investigation was on the general assessment of IAQ parameters and contaminants in the building in response to health issues reported by an office occupant.

Sampling and investigation of the building and components were performed during the morning of January 13, 2023. In addition to a visual inspection of the building and its components, IAQ parameters and air contaminants measured during the investigation included the following:

- Carbon monoxide
- Carbon dioxide
- Temperature
- Relative humidity
- Mold spores
- Pollen, insect fragments, and other miscellaneous particles

Air samples were taken from three separate locations within the building and one outdoor location (near east entrance) for comparative purposes.

This report presents a summary of actions, results, conclusions, and recommendations by NPN Environmental in evaluating the IAQ of the subject building areas.

Field Investigation Activities

Ms. Ruth Mannebach conducted an investigation of the aforementioned areas and building components and collected air samples from the indoor environment.

Structure

The office building is a 1-story brick, concrete, and glass structure constructed in 1988 as an addition to the original 1910 2-story brick school. The office building houses administrative staff, the media center, support staff offices, and a computer lab/office. The extent of the investigation included two offices and the computer lab/office identified by Columbia Public School District personnel as being occupied by staff members reporting health issues or general respiratory concerns. HVAC systems and other building components were also inspected as part of this investigation.

IAQ parameter sampling was segmented to correspond with air contaminant samples. The following noteworthy items were documented during the investigation:

- The Home School Coordinator's office was identified as occupied by an employee with health concerns. This office appeared to be clean and in good condition, with no visible mold observed. Wooden shelves located

along the perimeter wall prevented observations of that wall. A large amount of clothing and shoes is stored in this office.


- The Home School Coordinator's office opens into the Computer Lab/Office. This area appeared to be clean and in good condition. Several ceiling tiles show isolated areas of water staining from roof leaks through roof fasteners and missing roof flashing; however, no suspect mold growth was observed on the tops of the affected tiles.


- The Principal's office is located in the administrative office suite. This area appeared to be clean and in good condition. Caulk around exterior windows of this office (and other windows and expansion joints) is damaged or missing.


- No currently wet building materials were observed or reported in the areas inspected.
- No moldy or musty odors were noted in the areas inspected.
- No visible mold growth was observed in the areas inspected.

HVAC Systems

HVAC system components and ductwork were not specifically evaluated as part of this survey; however, visible ductwork and supply and return air registers appeared to be clean and in good condition. Columbia Public School District personnel indicated the system was functioning in normal operating mode during the investigation and filters are changed every three months.

Sampling Strategy

Based on information provided by Columbia Public School District personnel, visual inspection of the building and layout of the HVAC systems, air samples were collected at strategic locations to evaluate air quality and quantify the magnitude of any potential air contaminants present. Primary IAQ parameter and air contaminant samples were taken in three indoor locations as well as one outdoor location for establishing background parameter and air contaminant levels.

Sampling and Analytical Methods

The following sections describe the sampling and analytical procedures performed in identifying IAQ parameters as well as mold spore, pollen, and other particulate contaminants.

Primary IAQ Parameter Sampling

Carbon monoxide, carbon dioxide, temperature, and relative humidity components of various areas were measured with a TSI Model 8551 Indoor Air Quality Meter. Discrete areas were sampled by allowing the meter to survey the air throughout the area.

Guideline levels of carbon dioxide (<1000 ppm), carbon monoxide (<9 ppm), temperature (68°F to 75°F in winter, 73°F to 79°F in summer), and relative humidity (30 to 60 percent) in indoor air are based on recommendations in the Indoor Air Quality Association, Inc. publication *IAQA 01-2000: Recommended Guidelines for Indoor Environments* and ASHRAE publication *ASHRAE 62-2001*. These guidelines are based on occupant comfort and are not regulatory levels. Regulatory PELs (OSHA) for carbon monoxide (50 ppm) and carbon dioxide (5000 ppm), for example, are much higher than these recommended comfort levels.

Air Contaminant Sampling

Concentrations of airborne mold spores, pollen, and particles were sampled by attaching a Zefon *Air-O-Cell®* sampling cassette to a vacuum pump which pulled ambient air across the cassette's collection plate for 10 minutes at a sampling rate of 15 liters per minute. Sampling pumps were calibrated prior to and immediately following sampling with a calibrated rotameter. The cassette's collection plate is coated with a sticky media to which airborne particles adhere. During analysis, these plates were removed from their cassettes and their surfaces analyzed by light microscopy to determine counts of organisms and various particles deposited on the plates. Airborne concentrations of contaminants were then determined by calculating the counts of particular organisms per a known volume of air sampled. Organism concentrations were then compared to

acceptable guidelines where appropriate. Air samples were submitted to EMSL Analytical, Inc. in St. Louis, Missouri for analysis by light microscopy to determine counts of organisms and various particles deposited on the collection media.

OSHA, USEPA, and other regulatory agencies do not regulate mold spore or pollen concentrations for indoor environments or even suggest acceptable airborne concentration levels. For the purpose of this investigation, the following procedures were used in evaluating indoor air quality. These procedures are based on NPN Environmental's Indoor Air Quality experience; air contaminant guidance levels contained in *Air-O-Cell Method Guide & Particle Atlas* published by Environmental Analysis Associates, January 2013; and portions of *Interpreting Fungal Data*, presented by Dave Gallup, CEO of Environmental Microbiology Laboratory Inc., San Bruno, California. In general, clean buildings typically have less than 1500 spores/m^3 of total spore types, with less than 700 spores/m^3 of Aspergillus/Penicillium. Indoor amplification is likely when indoor spore counts exceed 5000 spores/m^3. It should be noted that spore concentrations may vary significantly both seasonally and depending on facility location.

Currently, there are no government standards, guidelines, or threshold limit values for acceptable levels of fungal spores and fungal spores are a normal component of air. The following indicators and criteria were used in assessing IAQ:

- Visual inspection for indoor mold growth and evidence of water intrusion or water damage
- Outdoor spore levels as compared to indoor spore levels
- Accessibility of indoor air to outdoor air
- Weather patterns
- Indoor activity levels
- Outdoor activity levels
- Presence of normal or "common" indoor spores such as Ascospores, Aspergillus/Penicillium, Basidiospores, or Cladosporium
- Indoor presence of "marker" spores such as Stachybotrys or Scopulariopsis, rarely found in indoor air

Additional air contaminants used in the evaluation were human skin fragments and fibrous particles (primarily from indoor building components) that are reported on a scale from 1 to 4, hyphal fragments (unidentifiable mold spore parts), insect fragments, and pollen.

Swab/Bulk Culture and Surface Sampling

No swab, bulk material, or tape lift samples were procured as no visible suspected mold growth or currently wet materials were found.

Sampling Results

The following is a description of all air sampling locations as referenced in **Table 1 – Air Sampling Results** (located at the end of the text), which is a summary of results of all air samples taken in the building on January 13, 2023.

- Area 1 – Home School Coordinator's Office
- Area 2 – Computer Lab/Office

- Area 3 – Principal's Office
- Area OS – Outdoor, east entrance

A copy of the laboratory analytical report for the air sampling cassettes is attached (*Appendix A – Laboratory Results*).

Discussion of Results

Primary IAQ Parameter Sampling

Results of carbon monoxide, carbon dioxide, and temperature sampling in the areas investigated were within guideline levels for each parameter according to referenced IAQ standards. These levels are not of concern and are indicative of typical indoor levels in a conditioned indoor environment.

Relative humidity levels in the areas inspected were well below referenced IAQ guideline levels, likely due to operation of the HVAC system in heating mode with insufficient makeup air.

Air Contaminant Sampling

The indoor samples collected from the Home School Coordinator's Office, Computer Lab/Office, and Principal's Office at Benton Elementary School indicated acceptable or typical levels of mold spores relative to guideline levels or outdoor concentrations on the day of testing. Based on the observed distribution of indoor mold types, absence of "marker" spores and the low levels of total spores present in each sample, these results are representative of normal indoor mold spore levels in a clean office environment. The sample results do not indicate indoor amplification or concerning levels of airborne mold spores.

Acceptable or typical amounts of other air contaminants (including skin cells, hyphal fragments, insect fragments, and pollen) were observed in the air samples collected from each area during the investigation. Human skin cells are typically highest in the winter when dry skin tends to flake off easily; however, they can be found in indoor air throughout the year. Hyphal fragment particles are partial or non-formed spores dispersed by houseplants, pets, clothing, or viable mold growth. Sources of fiber contaminants are ceiling tiles, carpet, drywall paper, or insulation.

Swab/Bulk Culture and Surface Sampling

No swab, bulk material, or tape lift samples were procured as no visible suspected mold growth or currently wet materials were found.

Conclusions

Based on the sampling results and visual findings of the investigation, the following conclusions have been formulated:

- IAQ parameters were observed at acceptable levels to *IAQA* and *ASHRAE* guidelines in the areas tested on the day of the investigation, with the exception of relative humidity.
- Relative humidity levels in the areas inspected were well below referenced IAQ guideline levels, likely due to operation of the HVAC system in heating mode with insufficient makeup air.
- Air sampling results exhibited acceptable levels of mold spores relative to guideline levels and outdoor concentrations on the day of testing. These levels are typical of normal levels found in a clean building environment and do not indicate the presence of indoor mold contamination or an atmosphere that may promote mold growth and amplification.
- Stained ceiling tiles in a few locations in the areas tested are likely the result of small leaks from roof fasteners and missing flashing.
- Exterior wall caulk around windows and at expansion joints is missing in some locations.
- No visible mold growth was observed on accessible surfaces at the time of the inspection.

Recommendations

Based on the findings of the investigation, NPN Environmental presents the following recommendations:

- Repair roof leaks, replace missing flashing, and recaulk around windows and expansion joints to eliminate routes of water intrusion. Following completion of repairs, replace water-stained ceiling tiles.
- Verify and adjust if necessary the amount of outdoor makeup air from the HVAC units to increase relative humidity levels. Supplemental humidification may be necessary during heating season, as low humidity levels may decrease occupant comfort levels.
- No additional investigation or air sampling is recommended.

Limitations

This report has been prepared in accordance with generally accepted indoor air quality practices and was performed in a professional manner. The conclusions and recommendations presented in this report are professional opinions based upon visual inspection, evaluation of site conditions at the time of our investigation, and laboratory analyses.

Building materials commonly impacted by water intrusion and microbial growth may potentially contain asbestos fibers. Additional testing may be required prior to mold remediation activities to determine if building materials contain asbestos.

The liability of NPN Environmental with respect to our findings and conclusions is limited to the scope of the indoor air quality investigation as set forth herein. The findings of this report are applicable and representative of conditions encountered at the subject property on the date of the investigation and may not represent conditions at a later date.

TABLE 1
Air Sampling Results

Parameters	Area 1	Area 2	Area 3			Area OS Outdoor
Primary IAQ Parameters						
Carbon Monoxide (ppm)	0	0	0			0
Carbon Dioxide (ppm)	525	502	694			421
Temperature (°F)	72.8	72.7	71.8			24.7
Relative Humidity (%)	**15.6**	**16.9**	**17.0**			75.0
Mold Spores (spores/m^3)						
Alternaria (Ulocladium)	ND	ND	20			ND
Ascospores	ND	ND	ND			ND
Aspergillus/Penicillium	ND	ND	20			ND
Basidiospores	ND	20	20			100
Bipolaris	ND	ND	ND			ND
Chaetomium	ND	ND	ND			ND
Cladosporium	70	100	40			ND
Curvularia	ND	ND	ND			ND
Epicoccum	ND	ND	ND			ND
Fusarium	ND	ND	ND			ND
Ganoderma	ND	ND	ND			ND
Myxomycetes	ND	ND	ND			ND
Pithomyces	ND	7	ND			ND
Rust	ND	ND	ND			ND
Scopulariopsis/Microascus	ND	ND	ND			ND
Stachybotrys/Memnoniella	ND	ND	ND			ND
Unidentifiable Spores	ND	ND	ND			ND
Zygomycetes	ND	ND	ND			ND
Total Spores	70	127	100			100
Air Contaminants (particles/m^3)						
Skin Fragments	1	1	2			ND
Fibrous Particles	ND	ND	ND			ND
Hyphal Fragments	ND	ND	70			ND
Insect Fragments	ND	ND	ND			ND
Pollen	ND	ND	ND			ND

ppm = parts per million
ND = Not detected at the analytical sensitivity level at standard magnification
Notes: (1) Evaluation levels are based on sources cited in this report. Indoor values considerably deviating from "normal" indoor levels or outdoor concentrations are indicated with bold text.

Area 1 – Home School Coordinator's Office
Area 2 – Computer Lab/Office
Area 3 – Principal's Office
Area OS – Outdoor, east entrance

INDOOR AIR QUALITY INVESTIGATION

APPENDIX A

Laboratory Results

EMSL Analytical, Inc.

100 Green Park Industrial Court Saint Louis, MO 63123
Tel/Fax: (314) 577-0150 / (314) 776-3313
http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order: 392300549
Customer ID: NPNE50
Customer PO: 23018
Project ID:

Attention: NPN-IAQ
NPN Environmental
1631 Headland Drive
Fenton, MO 63026

Phone: (636) 343-1300
Fax:
Collected Date: 01/13/2023
Received Date: 01/13/2023 02:45 PM
Analyzed Date: 01/20/2023

Project: C-23018 Benton Elementary School 1410 Hinkson Ave

Test Report:Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods MICRO-SOP-201, ASTM D7391)

Lab Sample Number:	392300549-0001			392300549-0002			392300549-0003		
Client Sample ID:	Area 1			Area 2			Area 3		
Volume (L):	150			150			150		
Sample Location:	S/N 34484383 OFC-Cox			S/N 34484387 Computer Lab			S/N 34484325 OFC-Sicht		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria (Ulocladium)	-	-	-	-	-	-	1	20	20
Ascospores	-	-	-	-	-	-	-	-	-
Aspergillus/Penicillium	-	-	-	-	-	-	1	20	20
Basidiospores	-	-	-	1	20	15.7	1	20	20
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium++	-	-	-	-	-	-	-	-	-
Cladosporium	3	70	100	6	100	78.7	2	40	40
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	-	-	-	-	-	-
Fusarium++	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	-	-	-	-	-	-
Myxomycetes++	-	-	-	-	-	-	-	-	-
Pithomyces++	-	-	-	1*	7*	5.5	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis/Microascus	-	-	-	-	-	-	-	-	-
Stachybotrys/Memnoniella	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Zygomycetes	-	-	-	-	-	-	-	-	-
Total Fungi	**3**	**70**	**100**	**8**	**127**	**100**	**5**	**100**	**100**
Hyphal Fragment	-	-	-	-	-	-	3	70	-
Insect Fragment	-	-	-	-	-	-	-	-	-
Pollen	-	-	-	-	-	-	-	-	-
Analyt Sensitivity 600x	-	22	-	-	22	-	-	22	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	2	-
Fibrous Particulate (1-4)	-	-	-	-	-	-	-	-	-
Background (1-5)	-	1	-	-	1	-	-	1	-

++ Includes other spores with similar morphology; see EMSL's fungal glossary for each specific category.

No discernable field blank was submitted with this group of samples.

Amber Stegmann

Amber Stegmann, Micro Supervisor
or other Approved Signatory

Initial report from: 01/20/2023 02:44 PM

For information on the fungi listed in this report, please visit the Resources section at www.emsl.com

EMSL Analytical, Inc.

100 Green Park Industrial Court Saint Louis, MO 63123
Tel/Fax: (314) 577-0150 / (314) 776-3313
http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order: 392300549
Customer ID: NPNE50
Customer PO: 23018
Project ID:

Attention: NPN-IAQ
NPN Environmental
1631 Headland Drive
Fenton, MO 63026

Phone: (636) 343-1300
Fax:
Collected Date: 01/13/2023
Received Date: 01/13/2023 02:45 PM
Analyzed Date: 01/20/2023

Project: C-23018 Benton Elementary School 1410 Hinkson Ave

Test Report:Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods MICRO-SOP-201, ASTM D7391)

Lab Sample Number:	**392300549-0004**				
Client Sample ID:	**OS**				
Volume (L):	**150**				
Sample Location:	**S/N 34484396 Outside**				
Spore Types	**Raw Count**	**Count/m³**	**% of Total**		
Alternaria (Ulocladium)	-	-	-		
Ascospores	-	-	-		
Aspergillus/Penicillium	-	-	-		
Basidiospores	5	100	100		
Bipolaris++	-	-	-		
Chaetomium++	-	-	-		
Cladosporium	-	-	-		
Curvularia	-	-	-		
Epicoccum	-	-	-		
Fusarium++	-	-	-		
Ganoderma	-	-	-		
Myxomycetes++	-	-	-		
Pithomyces++	-	-	-		
Rust	-	-	-		
Scopulariopsis/Microascus	-	-	-		
Stachybotrys/Memnoniella	-	-	-		
Unidentifiable Spores	-	-	-		
Zygomycetes	-	-	-		
Total Fungi	**5**	**100**	**100**		
Hyphal Fragment	-	-	-		
Insect Fragment	-	-	-		
Pollen	-	-	-		
Analyt. Sensitivity 600x	-	22	-		
Analyt. Sensitivity 300x	-	7*	-		
Skin Fragments (1-4)	-	-	-		
Fibrous Particulate (1-4)	-	-	-		
Background (1-5)	-	1	-		

++ Includes other spores with similar morphology; see EMSL's fungal glossary for each specific category.

No discernable field blank was submitted with this group of samples.

Amber Stegmann

Amber Stegmann, Micro Supervisor or other Approved Signatory

Initial report from: 01/20/2023 02:44 PM

For information on the fungi listed in this report, please visit the Resources section at www.emsl.com

392300549-1

CHAIN OF CUSTODY RECORD

NPN 25 YEARS ENVIRONMENTAL
1631 Headland Drive
Fenton, MO 63026
888-343-1300
www.npnenv.com

Laboratory EMSL-STL

Contract No. C-23018
Facility Benton Elementary School
Site Address 1410 Hinkson Ave

Matrix

- [x] Air
- [ ] Bulk
- [ ] Wipe _____

- [ ] 6-Hour
- [ ] 24-Hour
- [x] 5-Day

Sample Identification

Sample ID	Date	Time	Asbestos PCM	Asbestos TEM	Asbestos PLM	Lead FAA		Fungal Spores	Spores Tape Lift	Fungal Swab	Cultural Fungi	Culturable Bacteria	Bacteria Swab		
Area 1	1/13/23	8:51						X							
Area 2	↓	8:54						X							
Area 3		9:21						X							
OS		9:29						X							

Analysis

Asbestos PCM; Asbestos TEM; Asbestos PLM; Lead FAA; Fungal Spores; Spores Tape Lift; Fungal Swab; Cultural Fungi; Culturable Bacteria; Bacteria Swab

Results Delivery

- [ ] Email npn-acm@npnenv.com
- [x] Email npn-iaq@npnenv.com
- [ ] Other _____

Collected By

Ruth Mannebach

Remarks

150L S/N 34484383 Ofc-Cox
34484387 Computer Lab
34484325 Ofc-Sicht
34484396 Outside

Relinquished By	Date	Time	Received By	Date	Time
Ruth Mannebach	1/13/23	2:45 pm	[signature]	1/13/23	14:45 w/i

OrderID: 392300549

Copies: Laboratory (original), Contract File (yellow), and Project Manager (pink)