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environmental consulting

# INDOOR AIR QUALITY ASSESSMENT

**Blue Ridge Elementary School**
**1150 West Chestnut**
**Walla Walla, Washington 99362**

Project Number: 09989

January 11, 2009

**Prepared for:**

Walla Walla School District
Attn: Lowell Schneider
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Walla Walla, Washington 99362

**Prepared by:**

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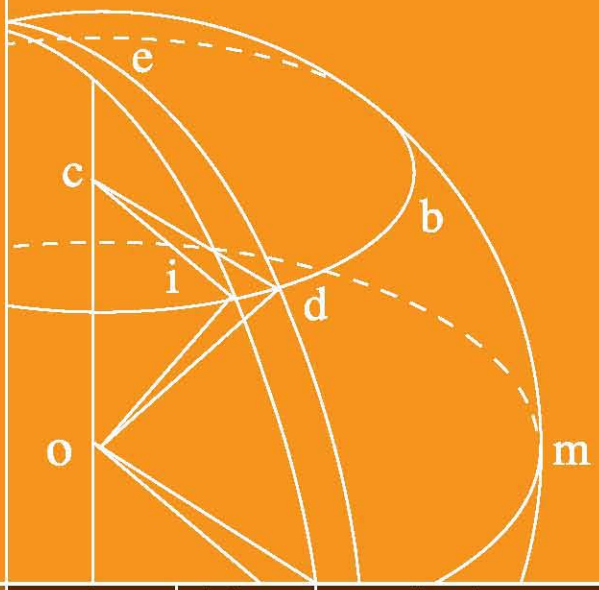

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## 1.0 INTRODUCTION

Fulcrum Environmental Consulting, Inc. (Fulcrum) was retained by Walla Walla School District (District) to complete an Indoor Air Quality (IAQ) Assessment of Blue Ridge Elementary School (Blue Ridge) located at 1150 West Chestnut in Walla Walla, Washington. Blue Ridge consists of a two level building constructed in the late 1970s and following a design trend of the time, is constructed with the north face of the building into a sod covered soil berm.

Fulcrum Environmental Consulting, Inc. (Fulcrum) understands that general indoor air quality concerns have been associated with the building since initial construction. Historically, the District's Plan Facilities Department has identified and corrected numerous identified construction and installation errors, including, but not limited to, incorrectly set heating, ventilation, and air conditioning (HVAC) dampeners, etc. No specific concerns are associated with the current period of IAQ awareness, rather a general level of concern of the IAQ quality remains. To facilitate a review of IAQ condition, Fulcrum proposed to complete a review of general IAQ conditions, including temperature, relative humidity, carbon dioxide, airborne particulate concentrations, airborne fungal spore concentrations, other airborne biological particulates, and radon.

## 2.0 SCOPE OF WORK

Fulcrum was retained by Walla Walla School District to complete an Indoor Air Quality Assessment in the Blue Ridge Elementary School located at 1150 West Chestnut in Walla Walla, Washington. Fulcrum's assessment is designed to gather whole building indoor air quality data data and does not specifically focus on any areas of the building. Following are the specific tasks included in Fulcrum's scope of services:

- Completed a visual inspection of Blue Ridge for indications of malodors and malodor sources.
- Utilized GE Sensing Telaire 7001 carbon dioxide monitors with Onset Computer Corporation HOBO U-12 temperature and relative humidity data loggers to measure basic indoor air quality conditions in fourteen separate locations, each an approximate one-week period, for a total length of about three weeks of monitoring.
- Collected nineteen air samples for non-viable fungal spore and other biological particulate analysis from within the building.
- Completed monitoring for radon from sixteen locations within the building each for mentoring periods from 90 hours to 330 hours.
- Collect samples of suspect mold growth for laboratory analysis to determine presence of mold growth and determine asbestos presence.

Fulcrum's services were provided within the entirety of Blue Ridge Elementary located at 1150 West Chestnut in Walla Walla, Washington. Each portion of the building was accessed expect for select closet and storage spaces that are not used for learning or office spaces. Fulcrum's assessment did not include evaluation of non-readily accessible areas such as sealed wall cavities, beneath wall or floor coverings, crawlspaces, attic spaces, other rooms of the building, etc. except those specifically identified in this report. Results are specific to the time and day of inspection and may not reflect conditions at other times.

## 3.0 INDOOR AIR QUALITY GUIDELINES

An expectation of indoor air quality is that temperature will be comfortable; relative humidity controlled to a point where condensation and subsequent mold growth do not occur; and where contaminant presence is below applicable permissible exposure limits (PEL) and within acceptable The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) guidance, and if feasible below exterior conditions.

Acceptable temperature conditions are specified in the American National Standards Institute (ANSI)/American Society for Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE) Standard 55-2004: *Thermal Environmental Conditions for Human Occupancy*. Under 55-2004, temperature conditions are evaluated by a number of factors including activity rate, clothing, air speed, and humidity. Generally, the standard specifies the combinations of indoor thermal environmental factors and personal factors that will produce thermal environmental conditions acceptable to a majority of the occupants within the space. For practical purposes, an initial evaluation range of 68 degrees Fahrenheit (°F) to 75°F was used to identify conditions that are likely to be unacceptable to building occupants.

General HVAC system functionality and the system's ability to provide fresh air and dilute or remove potential contaminants from the building are evaluated with the tools provided in the ANSI/ASHRAE Standard 62.1-2007: *Ventilation for Acceptable Indoor Air Quality*. Typically HVAC system effectiveness at providing fresh air and diluting or removing potential contaminants from the building can be evaluated by monitoring carbon dioxide. Production of carbon dioxide within buildings is generally limited to respiration of building occupants. As such, carbon dioxide can be used to evaluate the relative population of occupants and whether sufficient fresh air is being provided to prevent excessive accumulation of carbon dioxide. Effective removal of carbon dioxide concentrations from the building is representative of effective removal of other biological or chemical contaminants that may be present.

The ANSI/ASHRAE Standard, *Appendix B: Rational for Minimum Physiological Requirement of Respiration Air Based on $CO_2$ Concentration* specifies a general guideline of no more than 700 parts per million (ppm) steady state concentration greater then exterior background air conditions. Formal constructed buildings generally speaking, where background concentrations are 400 ppm, interior concentrations of 1,100 may be suggestive of inadequate fresh air introduction into the area for new construction. Where existing facilities are present, evaluation of carbon dioxide by the Standard serves as a reference to present conditions not as a requirement for change or modification.

Physical and chemical constituents within a building where employees work are specified by industrial hygiene and labor standards including the Washington Industrial Safety and Health Act (WISHA). These regulations have been adopted in Washington State and are required by federal law to meet or exceed the standards promulgated by the Department of Labor's Occupation Safety and Health Administration (OSHA) standards. Additionally, Washington State has adopted the more stringent American Conference of Governmental Industrial Hygienists (ACGIH). Under OSHA, WISHA, and ACGIH, the PEL for carbon dioxide is 5,000 ppm.

Acceptable relative humidity is not evaluated under the comfort guidelines of ASHRAE 55.1. ASHARE 62.1-2007 reports that relative humidity must be maintained below 65% to prevent mold growth. No other relevant guidelines have been adopted as an industry standard for reference to acceptable relative humidity. Generally, as relative humidity changes from very low to very high, occupant sensations will vary from comments of dry and stuffy to balmy or sweaty. Both relative humidity extremes can lead to occupant discomfort.

## 4.0 SITE SETTING

The Blue Ridge Elementary School is located within a mixed commercial, light industrial and residential setting in Walla Walla, Washington. Blue Ridge is bordered on the south by the Jonathan M. Wainwright Memorial Veterans Administration Medical Center, on the west by a movie theater, to the north by light industrial/commercial buildings, and to the east by residential homes.

The building was designed and built in the late 1970s for the operation as an elementary school and is aligned northeast to southwest. Following a design trend of the time, the building is constructed with the north face into a sod covered soil berm and the south face consisting primarily of windows designed for daylight introduction. The structural elements largely consist of concrete. The building base consists of a concrete slab foundation. Plumbing systems servicing the lower level appeared to run beneath the slab foundation.

Typical interior finish materials include gypsum wallboard walls; suspended ceiling tiles; ceramic tiles in bathroom and locker rooms, and carpet, sheet vinyl, and vinyl tile flooring coverings.

HVAC services in the building consist of four separate primary mechanical rooms and associated towers, each with multiple separate HVAC systems. The HVAC units servicing the gymnasium and cafeteria spaces are accessible from the main level. The mechanical rooms and HVAC systems for the remaining portions of the building are located in tower structures above the upper level and are accessible from a ladder within boys' restroom closets. HVAC systems service localized regions of the building with temperature demand the primary driver of conditioned air delivery. Supply-side air was observed to be ducted and return air a combination of ducted and above plenum return pathways. HVAC systems are set on an energy conservation schedule to reflect the periods of occupant loading and generally are operational from 6:00 am to 4:00 pm.

## 5.0 SITE OBSERVATIONS

The building was occupied and operating under a normal schedule during the assessment. Site inspection activities were completed by or under the direction of Ryan Mathews, a Council-certified Microbial Consultant (CMC) and Council-certified Indoor Environmental Consultant (CIEC) with Fulcrum. During the IAQ assessment, field services were assisted by Jason Stewart, an Environmental Technician with Fulcrum. See Appendix A for professional certification.

The building's two floors consist of classroom spaces, identified by number, on the upper level, and spaces on the lower level, identified by letter designation. The gymnasium and cafeteria spaces are on the southwest end of the school building and occupy both the lower and upper level spaces. Use of the lower level includes classrooms, offices, meeting rooms, the music room, and library. See Appendix B for site photographs.

## 5.1 Observed Spaces

As is typical of school settings, Fulcrum assessed individual work spaces for sources of malodors and chemicals, including cleaners, personal hygiene care, air fresheners, and hand sanitizers. In general, observed items were not sufficient in quantity and/or nature to be identified as a probable source of adverse IAQ impact. However, presence of fragrance sources was observed to be used in nearly all classroom locations and at differing scent and intensity. Fulcrum identified multiple fragrance sources ranging from reed diffusers to timed air fresheners in classroom 11 that have the potential to cause adverse indoor air quality.

Accesses to the HVAC systems for the classroom portions of the building were identified to serve as cleaning supply closets associated with upper level boys' restrooms. The ceiling access hatch was observed to be open to the HVAC space which allows the air handler to pull make-up air from the closet spaces and thus pulling air with cleaners and fragrances from the stored products.

Classroom spaces were observed to be typical of a school building settings. Common potential sources of adverse IAQ include printers and copy machines, plug-in or battery operated timed air fresheners, candles, scent diffusers, dry erase boards, cloth furniture, markers, white out, and paper goods. Observed materials were consistent with those in similar office spaces and were not observed in quantity or use likely to present an individual IAQ concern. However, in multitude, the presence of compounding IAQ conditions may result in adverse indoor air quality.

## 5.2 Moisture Sources

No water staining was observed associated with any of the window or exterior doors. No releases from facility plumbing systems were observed during the assessment. Historic impact associated with roofing system failures during the winter of 2008/2009 were observed in the building. The District reported that all roofing failures were repaired and none are presently allowing water intrusion.

Areas of water staining were identified on ceiling tile in nearly all rooms and spaces of the building, including classroom 1, classroom 2, classroom 4, classroom 5, classroom 6, classroom 7, classroom 8, classroom 11, classroom 12, classroom 16, classroom 17, classroom 18, classroom A, classroom B classroom C, classroom E, classroom G, classroom J, classroom K, classroom M, the library, and the upper and lower level hallways. Water staining was also identified on the gypsum wallboard in the ladder access way between the HVAC tower mechanical room and in the ceiling and walls in the entrance of the girl's bathrooms on the upper level.

Three areas of water staining and mold growth were identified in the building, each assonated with wall corners in the three HVAC towers servicing the classroom portions of the building. Water staining along the corners of the HVAC towers had resulted in visible water staining to the underlying students' restrooms on the upper level of the building. No areas of excessive moisture were identified within the building at the time of inspection.

Visual inspection identified localized mold growth on sprayed-on insulation in the HVAC mechanical tower spaces. No other areas of mold growth were observed in the building.

## 6.0 MONITORING EVENTS

Fulcrum completed monitoring of facility indoor air quality, including carbon dioxide, temperature and relative humidity, air sampling for mold spores and other biological particulates.

### 6.1 Carbon Dioxide

Monitoring of carbon dioxide concentrations was completed using GE Sensing Telaire 7001 carbon dioxide monitors attached to Onset Computer Corporation (Onset) Hobo U-12 model data loggers. Temperature and relative humidity conditions, presented in Section 6.2, were also collected by the Onset data loggers within each tested area.

Carbon dioxide monitoring was completed in seven separate functional areas during the initial period of testing. Carbon dioxide data from these surveys are found in Table 1. See Appendix C for carbon dioxide graphs.

**Table 1: Carbon Dioxide Monitoring, Surveys**

| Location | Start Date | End Date | Carbon Dioxide (ppm) | | |
|---|---|---|---|---|---|
| | | | Lowest | Highest | Difference |
| Classroom 8 | 09/18/09 | 09/25/09 | 229 | 454 | 225 |
| Classroom 13 | 09/18/09 | 09/25/09 | 392 | 1,117 | 725 |
| Classroom 17 | 09/18/09 | 09/25/09 | 292 | 1,018 | 726 |
| Library | 09/18/09 | 09/25/09 | 371 | 665 | 294 |
| Office N | 09/18/09 | 09/25/09 | 330 | 935 | 605 |
| Classroom K | 09/18/09 | 09/25/09 | 436 | 762 | 326 |
| Classroom H | 09/18/09 | 09/25/09 | 503 | 893 | 390 |
| Classroom 5 | 09/25/09 | 10/01/09 | 261 | 803 | 542 |
| Classroom 11 | 09/25/09 | 10/01/09 | 320 | 681 | 361 |
| Classroom 15 | 09/25/09 | 10/01/09 | 346 | 735 | 389 |
| Classroom A | 09/25/09 | 10/01/09 | 374 | 655 | 281 |
| Classroom M | 09/25/09 | 10/01/09 | 323 | 559 | 264 |
| Music Room G | 09/25/09 | 10/01/09 | 498 | 926 | 428 |
| Cafeteria/Kitchen | 09/25/09 | 10/01/09 | 428 | 748 | 320 |

All carbon dioxide concentrations observed during the September 18 to October 1, 2009 monitoring event were below PEL and ASHRAE recommendations. In general, carbon dioxide concentrations did not exceed the ASHARE recommended action level of 700 ppm. In two areas, Classrooms 13 and 17, difference in carbon dioxide was measured at 725 ppm and 726 ppm, respectively. In both cases, the elevated periods of carbon dioxide concentrations were not representative of long periods of time and are likely the result of one or more staff or students in the immediate area of the monitor for a brief period of time.

## 6.2 Temperature and Relative Humidity

Concurrent with carbon dioxide monitoring, Fulcrum completed monitoring of temperature and relative humidity conditions. Onset Computer Corporation Hobo U-12 model loggers were used to measure temperature and relative humidity during the September 18 to September 25, 2009 and September 25 to October 1, 2009 survey periods. Typically monitoring in rooms with exterior windows, was conducted by placing the unit on built-in cabinetry along the window wall of the classroom. Minimum, maximum, and average temperatures for each area during the data logging period are presented in Tables 2 and 3 for the two surveys. See Appendix C for temperature and relative humidity graphs.

**Table 2: Temperature and Relative Humidity, September 18 to September 25, 2009**

| Location | Temperature | | | Relative Humidity | | |
|---|---|---|---|---|---|---|
| | Minimum | Maximum | Average | Minimum | Maximum | Average |
| Classroom 8 | 66.8 | 78.7 | 73.4 | 30.2 | 48.3 | 39.2 |
| Classroom 13 | 69.9 | 76.2 | 73.6 | 31.4 | 48.8 | 39.5 |
| Classroom 17 | 69.5 | 83.6 | 75.0 | 27.9 | 44.8 | 36.8 |
| Library | 72.7 | 75.8 | 74.4 | 31.6 | 43.8 | 38.1 |
| Office N | 71.9 | 79.8 | 74.4 | 27.6 | 44.8 | 38.1 |
| Classroom K | 70.3 | 75.0 | 73.4 | 32.1 | 46.8 | 39.1 |
| Classroom H | 70.5 | 79.6 | 75.2 | 29.3 | 44.4 | 38.4 |

Review of temperature and relative humidity data during the September 18 to September 25, 2009 monitoring events found both parameters to be within normal anticipated ranges for general commercial building-type spaces in the Walla Walla area at the time of the sampling. Measured upper temperatures occurred primarily on weekends during which the HVAC system was not operational.

Relative humidity conditions were measured from 27.6-percent (%) to 48.8% during the September 18 to September 25, 2009 survey, with the lowest and highest relative humidity identified in office N and classroom 8, respectively. Measured relative humidity levels were below ASHRAE's guideline of 65% within a building space to prevent mold growth.

**Table 3: Temperature and Relative Humidity, September 25 to October 1, 2009**

| Location | Temperature | | | Relative Humidity | | |
|---|---|---|---|---|---|---|
| | Minimum | Maximum | Average | Minimum | Maximum | Average |
| Classroom 5 | 69.8 | 96.2 | 79.6 | 16.7 | 33.8 | 26.0 |
| Classroom 11 | 64.8 | 77.5 | 70.6 | 24.6 | 38.8 | 32.5 |
| Classroom 15 | 67.8 | 77.8 | 72.2 | 23.3 | 36.8 | 30.4 |
| Classroom A | 69.1 | 77.2 | 73.0 | 27.1 | 37.2 | 31.9 |
| Classroom M | 64.5 | 88.3 | 72.2 | 17.3 | 39.4 | 30.6 |
| Music Room G | 67.2 | 76.1 | 69.5 | 30.6 | 42.4 | 35.4 |
| Cafeteria/Kitchen | 69.6 | 76.0 | 72.8 | 28.8 | 42.4 | 34.4 |

Review of temperature and relative humidity data during the September 25 to October 1, 2009 monitoring events found both parameters to be within normal anticipated ranges for general commercial building-type spaces in the Walla Walla area at the time of the sampling.

Temperature conditions on average within observed locations of the building did not exceeded 85°F during the monitoring survey. However, in Classroom 5 and Classroom M, both southeast facing with large window walls, temperatures exceeded 80°F.

Relative humidity conditions were measured from 16.7% to 42.4% during the September 25 to October 1, 2009 survey, with the lowest relative humidity recorded in the classroom 5 and the highest in the music room and cafeteria-kitchen. Measured relative humidity was below ASHRAE's guideline of 65% within a building space to prevent mold growth.

### 6.3 Airborne Particulates

Fulcrum used a six-channel (0.3, 0.5, 1.0, 2.5, 5.0, 10.0 microns (µm)) Lighthouse Worldwide Solutions model 3016 handheld particulate meter to evaluate airborne particulate concentrations. The purpose of the survey was to evaluate potential for elevated concentrations within the building. Particulate testing does not differentiate between mold spores and other airborne particulates of respirable size. See Appendix D for particulate data.

In general, total particulate within the building was present at concentrations below exterior concentrations. Lowest interior particulate concentrations on September 18, 2009 were present in classroom B. The highest interior particulate concentrations on September 18, 2009 were present in classrooms 13, O and P. Lowest interior particulate concentrations on September 25, 2009 were present in the cafeteria area. The highest interior particulate concentrations on September 25, 2009 were present in classrooms 6, 7, O and P.

### 6.4 Air Sampling

Fulcrum collected nineteen air samples for non-viable mold spore and other particulate analysis from within and outside of the building. Interior samples were collected from the office, classroom 3, classroom 7, classroom 8, classroom 11, classroom 13, classroom 17, classroom 18, cafeteria, classroom G, classroom E, classroom I, classroom O, classroom C, classroom M, library. Exterior samples were collected from the north, east, and west sides of the building. See Figure 1 for sample locations. Samples were collected to evaluate general fungal spore concentrations within the school at the time of sampling.

Samples were collected at a rate of 15 liters per minute using Air-O-Cell cassettes. Samples were shipped under chain-of-custody to EMLab P&K in Phoenix, Arizona, for non-viable mold spore analysis. Laboratory results are summarized in Table 1; only those spore types identified during laboratory analysis are listed in the table. See Appendix E for complete laboratory report.

**Table 4: Air-O-Cell Laboratory Sample Analysis, September 18, 2009**

| Sample Number and Location | 091809-01 N. Exterior | 091809-02 E. Exterior | 091809-03 S. Exterior | 091809-04 Office | 091809-05 Classroom 3 | 091809-06 Classroom 7 | 091809-07 Classroom 8 | 091809-08 Classroom 11 | 091809-09 Classroom 13 | 091809-10 Classroom 17 | 091809-11 Classroom 18 | 091809-12 Cafeteria | 091809-13 Classroom 6 | 091809-14 Classroom E | 091809-15 Classroom I | 091809-16 Classroom O | 091809-17 Classroom C | 091809-18 Classroom M | 091809-19 Library |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Volume (liters) | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Debris Rating | 4+ | 4+ | 4+ | 2+ | 2+ | 2+ | 3+ | 2+ | 2+ | 2+ | 2+ | 2+ | 3+ | 3+ | 3+ | 3+ | 3+ | 2+ | 2+ |
| Mycelial Fragments | 310 | 140 | 240 | 27 | 7[1] | < 7 | < 7 | < 7 | 7[1] | 7[1] | 20 | 7[1] | 7[1] | 13 | < 7 | 27 | < 7 | 7[1] | < 7 |
| Pollen | 60 | 60 | 7[1] | 13 | < 7 | 7[1] | < 7 | 7[1] | < 7 | 13 | 7[1] | 7[1] | < 7 | < 7 | 13 | 13 | 7[1] | < 7 | < 7 |
| Chenopods (Chenopodiaceae) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cotton Fibers | 0 | 13 | 0 | **33** | **80** | **33** | **47** | **80** | **47** | 7[1] | **67** | **13** | **73** | **80** | **140** | **127** | **87** | **80** | **47** |
| Epithelial Skin Cells | 120 | 87 | 20 | **430** | **550** | **310** | **480** | **470** | **580** | **330** | **210** | **270** | **550** | **690** | **1,400** | **1,800** | **950** | **710** | **630** |
| Feather Barbs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 0 | 0 | 0 | 0 |
| Insect Parts | 27 | 13 | 13 | 13 | 7[1] | 7[1] | 0 | 7[1] | 0 | 0 | 0 | 0 | 7[1] | 7[1] | 0 | 0 | 0 | 0 | 0 |
| Fiber Glass | 0 | 0 | 0 | 0 | 0 | **7[1]** | 0 | 0 | 0 | 0 | 0 | 0 | **7[1]** | **7[1]** | **7[1]** | 0 | **13** | **13** | 0 |
| **Spore Type** | **Spores per cubic meter ($m^3$) of air** | | | | | | | | | | | | | | | | | | |
| Alternaria | 80 | 140 | 80 | 7[1] | 0 | 0 | 7[1] | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 7[1] | 0 | 0 |
| Ascospores | 47 | 20 | 33 | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 0 | 0 | 0 | 0 |
| Basidiospores | 700 | 720 | 270 | 47 | 33 | 53 | 33 | 13 | 20 | 0 | 0 | 0 | 20 | 0 | 0 | 7[1] | 0 | 0 | 0 |
| Bipolaris/Drechslera group | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 0 | 0 |
| Chaetomium | 0 | 7[1] | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cladosporium | 840 | 1,500 | 2,000 | 160 | 40 | 40 | 87 | 33 | 27 | 27 | 47 | 33 | 53 | 27 | 0 | 73 | 20 | 13 | 27 |
| Epicoccum | 27 | 7[1] | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oidium | 7[1] | 0 | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Brown | 33 | 20 | 13 | 13 | 7[1] | 0 | 0 | 13 | 0 | 0 | 7[1] | 0 | 7[1] | 0 | 13 | 0 | 0 | 0 | 0 |
| Other colorless | 7[1] | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aspergillus/Penicillium-Like | 110 | 67 | 130 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 0 | 7[1] | 0 | 7[1] | 7[1] | 0 | 0 | 0 |
| Pithomyces | 33 | 0 | 7[1] | 0 | 0 | 0 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7[1] | 0 | 0 |
| Rusts | 67 | 7[1] | 7[1] | 0 | 0 | 7[1] | 0 | 13 | 0 | 7[1] | 0 | 0 | 7[1] | 0 | 13 | 7[1] | 0 | 27 | 0 |
| Smuts/Myxomycetes/Periconi | 490 | 290 | 1,100 | 27 | 47 | 0 | 33 | 27 | 7[1] | 20 | 40 | 20 | 27 | 13 | 20 | 0 | 0 | 0 | 0 |
| Torula | 13 | 110 | 100 | 7[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Spores** | 2,500 | 2,900 | 3,700 | 270 | 130 | 100 | 170 | 100 | 60 | 53 | 100 | 53 | 120 | 40 | 67 | 100 | 40 | 40 | 27 |

1 Represents one spore/pollen identified during sample analysis
Interior mold spore concentrations in excess of reported exterior concentrations are identified in **Bold**

Laboratory results identified all fungal spore concentrations consistent with normal variations in fungal ecology. Laboratory analysis for other particulates identified cotton and epithelial skin cells within the interior of the building at concentrations greater than exterior background. Elevated concentrations of cotton particles and epithelial skin cells are expected to exceed exterior concentrations within an occupied building. Airborne concentrations of fiberglass and insect parts were not suggestive of a pervasive concern within the building.

### 6.5 Initial Radon Monitoring Results

In late September and into October 2009 Fulcrum conducted radon monitoring in twelve representative locations in Blue Ridge. The locations were selected by Fulcrum and were observed to be representative of occupant spaces within the building. All areas were occupied and under typical use during the monitoring period. Units were placed in the cabinet beneath the sink in each classroom space as a likely route for radon gas migration from beneath the building slab foundation.

Radon concentration data was collected from select representative locations using Sun Nuclear Corporation Professional Continuous Radon Monitors (model 1027). The model 1027 monitor uses a diffused-junction photodiode sensor to measure the concentration of radon gas and has been evaluated and accepted by the EPA. The units provide real-time monitoring of radon concentrations and were set to collect and data log radon concentrations once per hour over the testing period.

The twelve areas monitored included the cafeteria kitchen, classroom M, library, office N, classroom A, classroom G, classroom H, classroom K, classroom 18, classroom 7, teachers lounge and east classroom wing HVAC tower. Locations were selected to represent the most likely route for potential radon gas infiltration. All areas were occupied and under typical use during the monitoring period.

Four of the locations were selected from additional monitoring following review of radon concentrations identified by the initial monitoring event. The four locations included the cafeteria kitchen, classroom 7, office N and the music room G. See Table 5 monitoring dates October 19 to October 23, 2009 for radon data associated with additional sampling.

A summary of radon measurements collected from locations is provided in the following table. Complete radon monitoring data collected during the initial monitoring is presented in Appendix F.

**Table 5: Initial Radon Monitoring Summary**

| Location | Start Date | End Date | Days Monitored[1] | Average Radon Concentration[2] |
|---|---|---|---|---|
| Classroom H | 9/18/09 | 9/23/09 | Friday pm to Monday am | **4.7** |
| Classroom K | 9/18/09 | 9/23/09 | Friday pm to Monday am | 2.3 |
| Office N | 9/18/09 | 9/23/09 | Friday pm to Monday am | **4.6** |
| Library | 9/18/09 | 9/23/09 | Friday pm to Monday am | 3.9 |
| Cafeteria Kitchen | 9/25/09 | 9/29/09 | Friday pm to Monday am | **5.0** |
| Classroom A | 9/25/09 | 9/29/09 | Friday pm to Monday am | **4.6** |
| Classroom M | 9/25/09 | 9/29/09 | Friday pm to Monday am | **4.8** |
| Music Room G | 9/25/09 | 9/29/09 | Friday pm to Monday am | **6.0** |
| Classroom 18 | 10/01/09 | 10/05/09 | Thursday pm to Sunday am | 2.1 |
| Classroom 7 | 10/01/09 | 10/05/09 | Thursday pm to Sunday am | **10.0** |
| Teachers Lounge | 10/01/09 | 10/05/09 | Thursday pm to Sunday am | 2.2 |
| East HVAC Tower Mech. Room | 10/01/09 | 10/05/09 | Thursday pm to Sunday am | 1.2 |
| Classroom 7 | 10/19/09 | 10/23/09 | Monday pm to Thursday am | 1.0 |
| Office N | 10/19/09 | 10/23/09 | Monday pm to Thursday am | 3.8 |
| Cafeteria Kitchen | 10/19/09 | 10/23/09 | Monday pm to Thursday am | 3.7 |
| Music Room G | 10/19/09 | 10/23/09 | Monday pm to Thursday am | **13.8** |

1 Each unit was monitored for an approximate period of five days for a total of 90 hours per unit.
2 Results presented in pCi/l
Results above the EPA benchmark are shown in **Bold**.

Average radon concentrations were identified in excess of the EPA benchmark of 4.0 pCi/l in classroom H, office N, cafeteria-kitchen, classroom A, classroom M, classroom G and classroom 7. Results are specific to the time and day of inspection and may not reflect conditions at other times.

Following receipt and review of radon monitoring data, Fulcrum recommended to the District that HVAC system function be adjusted to remain operational from 5:00 am to 11:00 pm. Following Fulcrum's recommendation, the District made the HVAC system adjustments and Fulcrum recommended that additional radon monitoring be completed to evaluate effectiveness of HVAC system function on the reduction in radon concentrations.

### 6.6 Post-HVAC System Adjustment Radon Monitoring Results

In late December 2009, Fulcrum conducted radon monitoring in seven representative locations at Blue Ridge Elementary. The locations were selected by Fulcrum and were observed to be representative locations throughout the school.

The seven areas monitored included two monitoring periods classroom M, library storage, classroom I, classroom 7, music room and locker room. Locations were selected to represent the most likely route for potential radon gas infiltration. All areas were occupied at the time of monitoring.

Radon concentration data was collected from select representative locations using Sun Nuclear Corporation Professional Continuous Radon Monitors (model 1028). The model 1028 monitor uses a diffused-junction photodiode sensor to measure the concentration of radon gas and has been evaluated and accepted by the EPA. The units provide real-time monitoring of radon concentrations and were set to collect and data log radon concentrations once per hour over the testing period.

A summary of radon measurements collected from locations is provided in the following table. Levels above the EPA benchmark are shown in bold. Complete radon monitoring data collected during the Post-HVAC Adjustment cornering is presented in Appendix G.

**Table 6: Post-HVAC Adjustment Radon Monitoring Summary**

| Location | Start Date | End Date | Days Monitored[1] | Average Radon Concentration[2] |
|---|---|---|---|---|
| Classroom M | 12/10/2009 | 12/21/2009 | Thursday pm to Monday am | **23.5** |
| Music Room | 12/10/2009 | 12/21/2009 | Thursday pm to Monday am | **5.7** |
| Locker Room | 12/10/2009 | 12/21/2009 | Thursday pm to Monday am | 2.9 |
| Classroom 7 | 12/10/2009 | 12/21/2009 | Thursday pm to Monday am | 1.8 |
| Library Storage | 12/23/2009 | 01/04/2010 | Wednesday am to Monday am | **6.9** |
| Classroom I | 12/23/2009 | 01/04/2010 | Wednesday am to Monday am | 3.7 |
| Classroom M | 12/23/2009 | 01/04/2010 | Wednesday am to Monday am | **13.9** |

1 Each unit was monitored for an approximate period of eleven days for a total of 260-280 hours per unit.
2 Results presented in pCi/l
Results above the EPA benchmark are shown in **Bold**.

While effective in reducing the overall radon concentrations and effectively eliminating the potential exposure to facility occupants, the calculated average radon concentrations, due to overnight conditions remain above the EPA benchmark of 4.0 pCi/l in select spaces.

## 7.0 BULK SAMPLE COLLECTION

Fulcrum collected samples of suspect mold growth from select locations within the HVAC mechanical tower spaces. While not highly suspect, the samples were also submitted for asbestos analysis.

### 7.1 Bulk Mold Sampling

Fulcrum collected two samples of building materials with suspect mold growth. All samples were placed into separate, labeled, and resealable plastic bags and shipped by commercial carrier, under chain-of-custody, to EMLab P&K (EMLab) in Phoenix, Arizona for analysis. Samples were analyzed for non-viable fungal spore identification by EMLab method B001. See Appendix H for a copy of the laboratory analysis.

**Table 7: Bulk Sample Laboratory Analysis**

| Sample Number | 100109-01 | 100109-02 |
|---|---|---|
| ***Location*** | **Cellulose Insulation HVAC Room – East Tower** | **Cellulose Insulation HVAC Room – East Tower** |
| Hyphal Fragments | 2,100 | 270 |
| ***Spore Type*** | ***Spore Count*** | |
| Bipolaris/Drechslera group | 0 | 45 |
| Stachybotrys | 23,000 | 5,300 |
| **Total Spores** | 23,000 | 5,345 |

Laboratory analysis confirmed present of elevated Stachybotrys and Bipolaris/Drechslera group fungal spores in the cellulose insulation impacted by water intrusion collected in the East HVAC tower mechanical room. See Attachment C for complete laboratory analysis.

### 7.2 Limited Asbestos Sampling

Blue Ridge Elementary sustained water damage and visible mold growth to localized areas in the HVAC rooms.

Suspect material identification and sample collection methodology were consistent with AHERA regulations (40 CFR 763). All materials sampled during the inspection were shipped by common carrier, under chain of custody, to Seattle Asbestos Test, LLC, located in Lynnwood, Washington. Samples were analyzed using Polarized Light Microscopy (PLM) method EPA 600/R-93/116. While the selected methodology is principally for asbestos identification, per the methodology the presence of other fiber sources and matrix materials are identified. Final analytical results are in Appendix H.

**Table 8: Analytical Results for Asbestos Analysis**

| Index | Sample | Result | Location | Description |
|---|---|---|---|---|
| MISC-01 | 100109-01 | None detected | HVAC Room – East Tower | Spray on insulation; White fibrous material with yellow adhesive |

Laboratory analysis confirmed that the sampled material contains cellulose. Cellulose is a processed wood fiber and will support mold growth.

## 8.0 CONCLUSION

Fulcrum's Indoor Air Quality Assessment included a visual inspection of all accessible portions of the building for conditions that are known to contribute to adverse IAQ. The investigation included assessment of temperature, carbon dioxide, and relative humidity over a two week time period; sampling for air borne particulate concentrations; air samples for non-viable fungal spore and other particulate analysis; bulk sampling for fungal spore analysis, bulk sampling for asbestos analysis; and monitoring for radon.

The visual investigation identified water stained ceiling tile throughout the school. Water staining was also identified on the walls below the windows in the stairwells, in the main floor of the girl's bathroom, and localized areas in the HVAC rooms. Locations of water intrusion in the girls bathrooms appear associated with the HVAC water intrusions. Potential sources contributing to adverse indoor air quality include printers; laminators; copiers; cleaning supplies in the janitorial closets with the access to circulated air into the HVAC system; and timed scented air fresheners.

Observed carbon dioxide levels were below ASHRAE acceptable levels and significantly below the PEL of 5,000 ppm. Measured relative humidity was below ASHRAE's guideline of 65% within a building space to prevent mold growth. Temperature conditions within observed locations of the building averaged between 69.5°F and 79.6°F. Classroom 5, a southeast facing classroom, had a highest recorded temperature of 96.2°F.

Particulate concentrations were all identified below exterior concentrations and non-viable mold spore air sampling identified concentrations consistent with normal variations in fungal ecology.

Bulk sampling of discolored spray-on insulation identified elevated fungal spore concentrations within water impacted portions of the HVAC tower mechanical rooms. No indications of impact the building air quality from localized areas of mold growth was identified.

Radon concentrations were identified above the EPA benchmark of 4.0 pCi/l in portions of the building prior to adjustment of the HVAC system operation. Monitoring results indicates that increased HVAC system function has effectively reduced the potential for radon exposure the building occupants to levels below the EPA benchmark in the majority of tested locations.

## 9.0 RECOMMENDATIONS

As a result of this assessment, Fulcrum recommends that the District consider the following:

1. During the assessment a number of odor sources were observed in classroom spaces. Fulcrum recommends that the District reduce the allowed level of odorizes, fragrance sprays, etc. to not more than one per room and that the District keep HVAC room access doors closed.
2. Restroom spaces in the building were observed to be in poor cleaned condition. Fulcrum recommends that additional effort be made to complete a more thorough cleaning on a more frequent schedule.
3. Water damaged ceiling tiles and localized areas of water damaged wallboard are present throughout the building. Fulcrum recommends that these areas be repaired or replaced.
4. Mold growth is present in HVAC tower mechanical rooms. Fulcrum recommends that mold growth be abated.
5. While extended HVAC operation has been effective at reducing radon concentrations in the building, operation of the HVAC systems in this manner is likely to lead to higher HVAC maintenance costs and operation costs. Fulcrum recommends that a long term radon mitigation solution be designed and installed, including:
   - Evaluate installation of an exterior building or sub-concrete foundation slab radon mitigation system.
   - Evaluate use of additional exhaust ventilation to mitigate radon concentrations and increase exhaust of trapped indoor air.

## 10.0 LIMITATIONS

Fulcrum Environmental Consulting, Inc.'s scope of service for this project was limited to those services outlined in the Scope of Work for this report. Fulcrum's investigation did not include inspection of non-readily accessible areas, such as sealed wall cavities, beneath wall or floor coverings, crawlspaces, etc. except those specifically noted in the scope of work. Results are specific to the time and day of inspection and may not reflect conditions at other times. Fulcrum makes no warranties, expressed or implied as to the accuracy or completeness of other's work included herein. Fulcrum has performed these services in accordance with generally accepted industrial hygiene standards of care at the time of the inspection. No warranty, expressed or implied, is made.