Nauset Environmental Services, Inc.

an Air Quality Company

26 November 2013 **NES** Job #847
Report No. **NES**/IAQ-13/1581

Judith and Carl Smith
2520 Sparrow Loop
Springfield, WA 66352

Re: Mold/moisture inspection and ceiling cavity sampling
at 175 Main Street, #28 (Boston)

Dear Mr. & Mrs. Smith:

Nauset **E**nvironmental **S**ervices, Inc. (**NES**) is pleased to submit this letter report on the mold inspection and sampling at your daughter, Beth's apartment - 175 Main Street, #28. Following written authorization, **NES** sent William Vaughan, PhD, QEP, CIEC to this property on 15 November 2013. This report is CONFIDENTIAL and proprietary and can only be distributed by or with the approval of the Clients to whom it is addressed.

BACKGROUND: In mid-September the washing machine in the apartment above Beth's leaked. That event led to water draining into her apartment though the door framing to the bathroom and the adjacent bedroom where it drained through the ceiling-mounted smoke detector and alarm. Local staff responded quickly and vacuumed up the water and initiated drying activities. **NES** was retained to carry out an inspection of the leak-impacted areas and to take a mold sample in the bedroom's ceiling cavity to look for indication of viable (active) mold spores that would indicate mold growth.

EXECUTIVE SUMMARY: The initial sensory inspection of the apartment found no noticeable moldy odors or readily observable visible mold growth (VMG). The moisture meter found very dry conditions in the impacted walls and ceiling below the leak and dry carpet in Beth's apartment.

The ceiling cavity sampling revealed the presence of elevated levels of *Penicillium*, a common "Indoor mold" that readily amplifies in response to damp conditions.

A Scope of Work is provided to address the removal of the mold in the ceiling cavity.

ON SITE ACTIVITIES – Dr. Vaughan arrived at 175 Main Street, #28 on 15 November 2013 about 09:45. Martha Barnes, Local staff member, escorted D. Vaughan to the leak impacted area and was present during the initial inspection and sampling. Beth was present initially but left with Martha at about 11:00.

During his inspection Dr. Vaughan used a Tramex "Moisture Encounter Plus" non-penetrating moisture meter (MM) to assess the relative dampness of various surfaces to a depth of just over an inch. [This MM is compared to a Tramex "test box" regularly to ensure proper operation.] He also used a calibrated Extech Hygro-Thermometer Pen (Model 445580) to measure temperature and relative humidity. Photographs during the inspection and sampling are found in Attachment A.

HYPOTHESIS TESTING

After inspecting the general conditions in the apartment and considering your concerns, Dr. Vaughan determined that an air sampling strategy was needed to assess the possible of viable (active) mold spores in Beth's impacted bedroom ceiling to address the following hypothesis regarding possible environmental issues:

> A There **are** elevated viable spore levels of concern in Beth's bedroom ceiling, indicative of **Condition 3**, contamination from hidden mold growth.

The ceiling cavity sample was collected on a polycarbonate (PC) filter with a 0.4 µ (micron) pore size for culturing on malt extract agar (MEA) that supports general mold growth.

After the sampling pump flow rate was confirmed for the pump at 20 lpm using a rotometer transfer standard (traceable to NIST via a BIOS DryCal calibrator), the cavity air sample was taken for timed five-minute interval a using digital timer after a sterilized drill bit was used to create a sampling hole to fit a short access tube from the filter cassette. The area of the ceiling out 3-4 feet from the sampling point was repeatedly struck with a rubber mallet to ensure release of spores from any colonies present. The sampling location was documented with photographs seen in Attachment A. A log sheet documented the activity and conditions during the sampling.

The exposed and labeled PC filter cassettes were combined with a completed chain of custody form and shipped to EMLab P&K, LLC. (Marlton, NJ). The cavity sample was designated for "Culturable Air Fungi" analysis using malt extract agar (MEA) that supports general mold growth.. The following perspective indicates why EMLab P&K, LLC was selected:

- "Because there is currently no governmental certification for environmental microbiology laboratories (except for drinking water and wastewater microbiology), EMLab P&K, LLC. is an active participant in the EMPAT (Environmental Microbiology Proficiency Analytical Testing) program sponsored by the American Industrial Hygiene Association (AIHA). P&K has been formally accredited by the AIHA in Environmental Microbiology since July 2000 with a laboratory identification number of 103005."
- "EMLab P&K is staffed by experienced and highly qualified mycologists and microbiologists and EMLab P&K has more than twenty years' experience in sampling, analysis of microbial aerosols."
- "(EMLab P&K) has modeled its quality control system after the ISO guidelines, one of the most stringent sets of international standards in the industry, to ensure that its customers receive the high standard of accuracy, reliability and impartiality that they have come to expect from a leader in the environmental industry."

OBSERVATIONS: Observations at 175 Main Street, #28 during the 15 November site visit are provided below: [NOTE: Directions left-right and front-back refer to viewing the apartment from the driveway outside the front door.]

General

- The weather was sunny and cool with light winds.
- There was no biological/moldy odor sensed on entering the apartment or near the reported leak area. [Moldy odors come from *currently active* "microbial volatile organic compounds (MVOCs)" that are released from active colonies digesting the organic matter on which they are growing.]

- The apartment has wall-to-wall carpet.
- The apartment is heated by a forced air system.

Bathroom/hall

- There was no readily apparent staining or VMG on either side of the bathroom door on ceilings or walls (see photos).
- The MM indicated dry conditions on walls and ceilings in this area (see photos) – reading in the range of 0-5% of full scale on the drywall setting (FS-DW).

Beth's bedroom

- There was no readily apparent VMG on the ceiling or walls (see photos).
- There was a slight light tan stain that followed the ceiling drywall seam from the hall door frame (see photo). [This area between the smoke detector and alarm was eventually chosen for the cavity sampling.]

Table 1 lists the sample locations for the PC filter sampling. Table 2 summarizes the results of the culturing and analysis of the ceiling cavity sample from this round of sampling. The EMLab P&K mold report is found in Attachment B. Attachment C describes the properties of the dominant spores found.

Table 1 – Mold Spore Sampling Locations

Sample #	Location
847-1	Beth's bedroom ceiling

DISCUSSION:

MOLD - There are several terms and concepts that should be explained before looking in detail at the data from these samples:

- CONTAMINATION -The terms Condition 2 and 3 used describe mold contamination are part of the August 2008 American National Standards Institute/Institute for Inspection Cleaning and Restoration Certification (ANSI/IICRC) S520-2008, "Standard and Reference Guide for Professional Mold Remediation." **Condition 2** involves evidence of settled spores from a contaminated area, a condition documented to some

extent by "disturbed" air samples. **Condition 3** refers to "actual mold growth and associated spores … active or inactive, visible or hidden."

- OUTDOOR SPORES - While ALL molds ultimately originate in nature, outdoors, there are some molds that are referred to as "outdoor fungi." This term means that that they are found only outdoors because they depend on plants, other fungi or animals to complete their Local cycle. Others need a complex ecosystem to complete their Local cycle. These outdoor spores *may* be found indoors because they were transported there but hardly ever develop colonies indoors. These include the ascospores, basidiospores (some coming from mushrooms that develop in the wild) and rusts. When found indoors these "outdoor" spores indicate the space has been experienced air exchange with the outdoors, not growth in response to moist conditions.
- INDOOR SPORES - There are some molds that have adapted to a variety of food sources - organic debris, processed wood (i.e. cellulose, paper, etc.) and more - that are commonly found indoors - loosely referred to as "indoor spores," even though they initially came in from outdoors. With the proper level of damp to wet conditions some of them amplify/grow indoors and serve as moisture/leak indicators. In our area of southern New England, **NES** has found that the primary moisture/leak-indicators are the *Aspergillus* and *Penicillium* molds (referred to as "*Asp-Pen* like" when their spores are counted under a microscope since their spores are indistinguishable). Less often **NES** has found that *Cladosporium*, the most abundant spore type found in outdoor air samples, can also amplify under moist conditions indoors and may serve as a secondary moisture/leak indicator.
- STANDARDS - Many people look for standards to compare mold readings to with the desire to define a healthy or unhealthy space. Obviously very high spore readings found by counting spores/structure in a collected sample under a microscope (**S/m^3** - spores/structures per cubic meter sampled) or colony readings found by counting the colonies that develop/grow on a nutrient media after sampled air has impacted that nutrient media (**CFU/m^3** - colony forming units per cubic meter) are undesirable. Because of the wide range of human sensitivities or allergic reactions to the irritants in/on mold spores AND the limited scientific research linking spore levels to various immune system reaction, no scientifically-based "standards" have yet been developed by medical or governmental agencies.

[One medical commentary was issued in May 2004 by the Institute of Medicine (part of the National Academy of Sciences) in its report on "Damp Indoor Spaces and Health," in which they state, "there are no generally accepted health-based standards for acceptable concentrations of fungal (mold) spores, hyphae or metabolites in the air." However, there is informal guidance from industrial hygienists and some allergists to try to keep indoor spore levels below 1,000 S/m^3 in order to minimize the irritation for the *general* population. Some have suggested that a "healthy" level be considered at 500 CFU/m^3 or 500 S/m^3. **NES** uses 1,000 S/m^3 of *Asp/Pen* like spores as its informal guideline for the general population and 500 S/m^3 of *Asp/Pen* like spores for sensitized individuals. Sensitized or allergic individuals may well be irritated and react at levels well below that guideline level. More information can be found on mold and health at the Centers for Disease Control and Prevention website - http://www.cdc.gov/mold/dampness_facts.htm.]

Table 2. Results from Culturing PC Air Filter Samples
[Reporting units are colony forming units per cubic meter of air (CFU/m^3) in the cavity air.]

Sample #	Total CFU/m^3	Overview of species found
847-1 Bedroom ceiling		
MEA	4,300	*Cladosporium* (100) – 2%, *Penicillium* (4,200) – 98%

NOTE: Because of the method of collection of spores onto a polycarbonate filter, not all of the viable spores extracted onto the filter in the brief sample time and interval for shipping to the EMLAB P&K may retain their viability when finally cultured. *Hence these results are an understatement of the actual viable spores present at the time of sampling!* The extent of the understatement is not known and cannot be known.

The ceiling cavity results presented in Table 2 indicate that active mold colonies are present in this ceiling cavity at elevated levels.

This finding constitutes "active mold growth" in the ceiling cavity that is "hidden" and hence is **Condition 3** contamination calling for professional mold mitigation.

For perspective on the above findings, when there were dry cavities in a building with nearby wet cavities, **NES** has found no mold growth in the dry areas.

The types of fungi found are common "indoor spores" and not generally considered toxic but may trigger allergic responses as noted in Attachment C. They are also contained within the intact ceiling cavity and are not posing any immediate exposure concern to occupants of the apartment

NOTE that no colonies of *Stachybotrys chartarum* developed in the MEA cultures where it can grow. Hence this "toxic, black mold," as it is referred to by the media, is not present in these wall cavity samples. Being a slime mold, *requiring extended dampness* to develop its colonies, it is not likely to be found in relatively dry and leak-free wall cavities.

SUMMARY & DISCUSSION:
The sensory/instrumental inspection of the apartment did not indicate any obvious active biological growth (by smell or sight) or damp conditions *within* the occupied space.

The hypothesis testing by sampling the ceiling cavity supported hypothesis A, i.e. the presence of elevated viable spore levels in Beth's bedroom ceiling:

A There **are** elevated viable spore levels of concern in Beth's bedroom ceiling, indicative of **Condition 3**, contamination from hidden mold growth.

This finding warrants professional mold remediation in the ceiling areas impacted by the earlier leak – hall, bathroom and bedroom – per the Scope of Work below

RECOMMENDATIONS:
At the moment, moisture is not of concern since dry conditions were found during the inspection.

In light of the Condition 3 contamination in the ceiling in this unit, there should be focused cleaning of the ceiling cavities in the leak impact area using a professional mold mitigator. An appropriate mold remediation professional would be one with remediation training and individual credentials recognized by the American Council on Accredited Certification (www.acac.org) and/or the IICRC (www.iicrc.org).

In particular:

- Remove the contents/furniture from the vicinity of the impacted ceiling in the hall, bathroom and bedroom. [They can be moved outside the eventual containment area.]
- Cover the wall-to-wall carpet with protective plastic sheets.

- The general vicinity of the impacted ceiling area should be contained under negative pressure with enough extra room to allow worker movement should the mold growth be relatively wide before the ceiling is opened.
    - Seal all vents to forced air systems.

- Any workers in the containment should wear respiratory and clothing protection per the general guidance of ANSI/IICRC S520-2008 Section 8 and Chapter 6.
- All air scrubbers should be cleaned from the previous job AND, *most importantly*, checked (preferably using a particle counter to document its collection efficiency) to be sure that the HEPA filter in each unit is seated/sealed properly to ensure that particles are being captured and NOT recirculated!

- The ceiling should be opened in each area indicated moving gradually out from underneath the source of the leak and cleaned under the general guidance of ANSI/IICRC S520-2008 Section 12 and Chapter 14 including:
    - Remove mold-impacted ceiling drywall in the leak-impacted areas indicated, exposing ceiling rafters and removing insulation. Continue at least two feet in any direction beyond any signs of visible mold growth to address not-yet-visible mold at the edge of expanding colonies. If additional hidden mold growth is found, document this condition photographically. If the finding is significant enough to impact this scope of work, contact **NES** and your client for an appropriate "change order."
    - HEPA vacuum ALL exposed surfaces in the affected areas including nearby walls.

    - Wipe down with moldicide and seal the more impacted areas as appropriate.

When done with the above remediation activities in each area, take a final step to remove settled spores knocked into the air by the action of the vacuum brushes by "polishing the air." This step is especially important for areas that are contaminated with settled spores, as this area will be following the above activities, and the goal is to significantly reduce these settled spores. The "air polishing" steps are:

- TURN OFF NEGATIVE AIR so that spores are not drawn in from adjacent, uncleaned areas.
- Set up at least one air scrubber in each contained work area, as opposed to operating in the negative air mode. [NOTE: Continuing the use of negative air at this time can draw in spores from adjacent uncleaned areas, reducing the effectiveness of the prior cleaning effort.]
- Set up 3-4 oscillating fans in each area to minimize stagnant air zones. Direct them to sweep the floor and other horizontal surfaces to minimize settling.
- Periodically, 2-3 times a day, use a leaf blower to stir up the settled spores left over after the remediation activities above so that they can eventually be moved to the air scrubbers on drafts from the fans and be filtered out of the air. **BE CAREFUL NOT TO DAMAGE THE INTEGRITY OF THE ISOLATION BARRIERS WITH THE STRONG DRAFTS SINCE THAT WOULD SPREAD CONTAMINATION, defeating the purpose of this entire effort.** At the same time, re-orient the oscillating fans to sweep new areas and re-direct the exhaust from the air scrubber to blow over different surfaces.
- Operate the oscillating fans and air scrubbers for at least 36-48 hours in each area after the cleanup is completed, periodically revisiting the areas for leaf blower mixing and **ALSO** repositioning the smaller fans and scrubber exhaust.
- Operate the oscillating fans and air scrubbers **an ADDITIONAL 24 HOURS AFTER the last aggressive leaf blowing** to reduce the cloud of stirred-up spores.

Post-remediation sampling - To confirm the success of the remediation effort, post-remediation verification air sampling *could* be carried out *BEFORE removing any containment*. [This post-remediation verification (PRV) sampling also needs to be carried out in a timely fashion, preferably within a few days to a week of the effort, so that ensuing moisture/humidity does not have a chance to mask an acceptable effort by regrowth. IF the space is kept dehumidified, the PRV effort can extend to a week or two. The PRV effort *should be carried out BEFORE any remodeling/renovation* to minimize the likelihood of enclosing residual spores behind new surfaces.] The goal for a successful remediation would be that that the moisture/leak indicator spores, *Aspergillus/Penicillium* like spores, are below 1,000 S/m^3 for the disturbed samples and preferably closer to 500 S/m^3 and that *Stachybotrys* is found at no more than single digit spore levels in a single sample.

To avoid problems with mold in the future, be attentive to any and all water intrusion or condensation issues, taking general advice from The Mold Survival Guide for Your Home and for Your Health by Jeff and Connie May (2004). In particular:

- Respond quickly to correct any leaks that may develop or become evident.

- Turn off the water to the washing machine ANY TIME you leave for several days since rubber hose failure can occur in any season and cause massive water damage! **Better still**, treat the water valve as if it were a "switch" and turn off the water after each washing.
- If there are allergic or sensitized individuals living in the house, use a HEPA filter-equipped vacuum for routine cleaning of flooring and upholstery to capture spores and irritants. In addition use pleated media filters in the air handler that are changed out at a minimum at the beginning of the heating and the cooling seasons.

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The above discussion and recommendations are related to background information provided and the conditions visually observable at the time of **NES**'s site visit on 13 November 2013 and are thus limited to these activities and timeframe and the results of sampling at this time. Future events and changes in the condition and operation of the building may well alter the conditions for biological activity/growth, especially moisture. Such changes will alter the relative significance of these recommendations and the effectiveness of their implementation. Thus the impact of such changes and cannot be considered part of the scope of this report/work.

I trust the above information is sufficient for your current needs. Please call us with any questions or to clarify points.

Very truly yours,

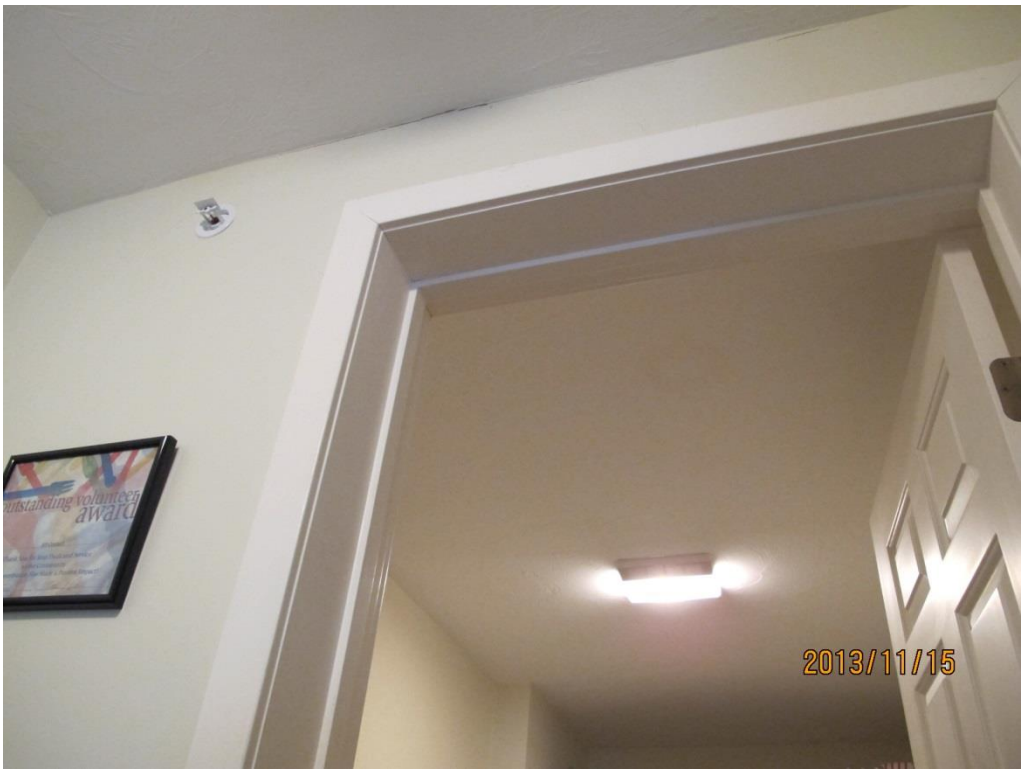
William M. Vaughan, PhD, QEP, CIEC
President, Senior Scientist
QEP=Qualified Environmental Professional (since 1994)
CIEC=Council-certified Indoor Environment Consultant (#0608142)

Attachment A

Photographs Taken During the Inspection and Sampling

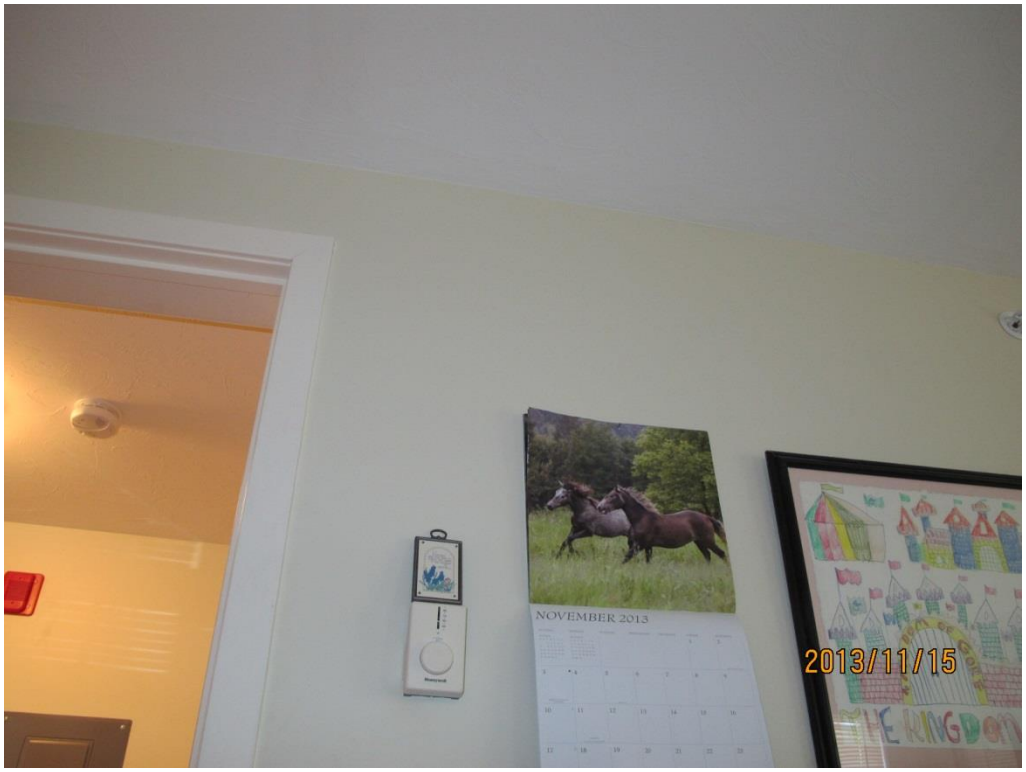
Inspection photos

175 Main Street, #28



Area in hall below leak

Area below leak in bathroom



Beth’s bedroom wall & ceiling

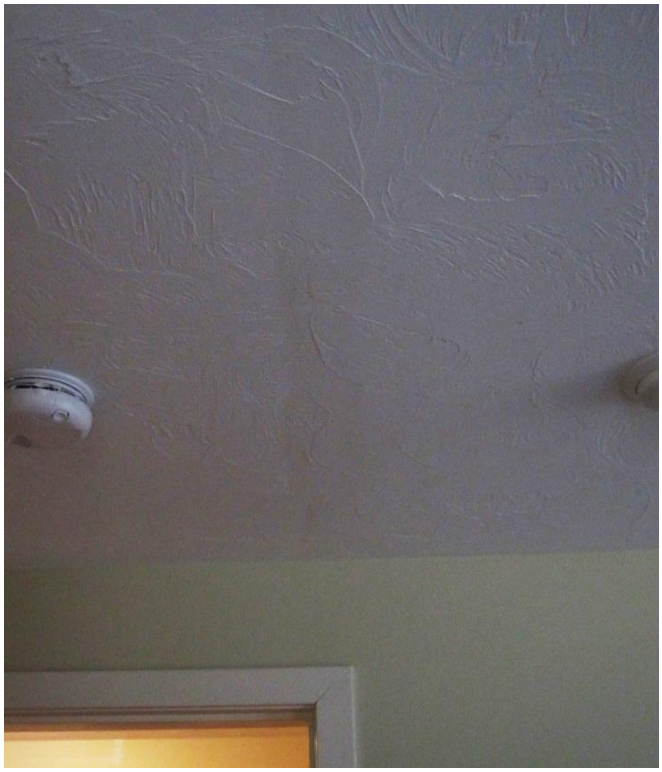
Dry MM reading above bathroom door

Dry MM reading in hall ceiling

Dry MM reading above Beth's bedroom door

Dry MM reading in Beth's bedroom ceiling

Faint staining on Beth's bedroom ceiling
(barely visible at 40% contrast)



Sampling location

ATTACHMENT B

Laboratory results from P&K Microbiology Services, Inc.

*All AIHA accredited laboratories are required to provide raw counts of fungal structures in spore trap reports. These counts are defined by AIHA as "Actual count without extrapolation or calculation". The number in parentheses next to the fungal type represents the exact number (or raw count) of fungal structures observed.

‡ A "Version" greater than 1 indicates amended data.

§ Total has been rounded to two significant figures to reflect analytical precision.

EMLab P&K
3000 Lincoln Drive East, Suite A, Marlton, NJ 08053
(866) 871-1984 Fax (856) 489-4085 www.emlab.com

Client: **NAUSET ENVIRONMENTAL SERVICES**
C/O: William M. Vaughan
Re: **847; Smith Ceiling**

Date of Sampling: 11-13-2013
Date of Receipt: 11-18-2013
Date of Report: 11-26-2013

FUNGAL CULTURE REPORT

Lab ID-Version‡ Location	**Sample Size/ Report Unit**	**Medium**	**Dilution Factor**	**Fungal ID**	**Colony Counts**	**CFU/m^3**	**%**
5151752-1 **847-1** **Bedroom Ceiling Cavity**	Size: 0.1 m3 Unit: 1 m3	**MEA**	10	Cladosporium Penicillium	1 42	100 **4,200** **§ Total: 4,300**	2 **98** 100
Comments:							

The limit of detection is a raw count of 1 at the lowest dilution plated. The analytical sensitivity is equal to 1 raw count/reporting unit x the dilution factor.

‡ A "Version" indicated by -"x" after the Lab ID# with a value greater than 1 indicates a sample with amended data. The revision number is reflected by the value of "x".
§ Total has been rounded to two significant figures to reflect analytical precision.

Attachment C

Ecology and Pathology of Species Reported

NOTE: Characteristics of the major species found at levels above 10% and listed above have been collected from the University of Minnesota, Dr. Fungus and EMLab P&K, LLC. websites.

ascospores

ECOLOGY - A general category of spores that have been produced by means of sexual reproduction. Many ascospores can germinate and later produce asexual spores (conidia). To further complicate matters, some asexual fungi can also become sexual under specific conditions, these are considered ascomycetes.

PATHOLOGY - This generalized group contains potential opportunistic pathogens and toxin producers. They are suspected allergens, though not yet proven.

Aspergillus species

ECOLOGY – Spores from this genus are commonly found in outdoor air, but less frequently than *Cladosporium*, *Penicillium*, Basidomycetes or yeasts. (Their spores are difficult to differentiate from *Penicillium* spores hence they are reported with those spores when only microscopic identification is requested, rather than culturing.)

PATHOLOGY – Of the more than 150 species and varieties of *Aspergillus*, some are known to cause diseases in animals and humans. Several species are commonly isolated in buildings. Many *Asp.* Species can produce mycotoxins depending on the substrate on which they are growing. Antigens of *Asp.* species are available commercially.

basidiospores

ECOLOGY - Sexual spores from a variety of molds that do not thrive in the indoor environment.

PATHOLOGY - Some basidiospores have been shown to cause allergies and asthma.

Cladosporium sp.

ECOLOGY - They are the most commonly identified outdoor fungus (48-60 species). The most common ones include *Cladosporium elatum*, *Cladosporium herbarum*, *Cladosporium sphaerospermum*, and *Cladosporium cladosporioides*. *C. herbarum* is the most frequently found species in outdoor air in temperate climates. Since it is a "dry" spore formed in very fragile chains, it is easily dispersed, hence often found in air samples. The outdoor numbers are reduced in the winter and are often high in the summer. While often found indoors their numbers are less than outdoor numbers, implying that the outdoor environment is the source of these spores. Indoor *Cladosporium* sp. are commonly found on the surface of fiberglass duct liner in the interior of supply ducts, on windows with occasional condensation and on wall surfaces in high humidity conditions or occasional condensation. A wide variety of plants serve as food sources for this fungus. It is found on dead plants, woody plants, food, straw, soil, paint and textiles. They are common in soils, dead organic matter and the air. These fungi can decompose cellulose and are considered "ubiquitous."

PATHOLOGY - The ability to sporulate heavily, ease of dispersal, and buoyant spores makes this fungus the most important fungal airway allergen; causes asthma and hay fever in the Western hemisphere. They are a rare human pathogen. They can cause mycosis and produce greater than 10 antigens (initiators of allergic response) available commercially. They are a common cause of extrinsic asthma (immeadiate-type hypersensitivity: Type I allergen), Type III hypersensitivity pneumonitis: hot tub lung, moldy wall hypersensitivity, etc. Acute symptoms include edema and bronchiospasms, chronic cases may develop pulmonary emphysema.

***Penicillium* sp**.

ECOLOGY - A wide number of organisms have placed in this genus and they are well studied because of their value as producers of antibiotics. Identification to species, among the 200 or so identified to date, is difficult and expensive. They are often found in aerosol and soil samples. They are a ubiquitous saprophyte (meaning they live on dead or decaying organic matter) and "are found everywhere." They are commonly found in temperate regions in soil, food, cellulose and grains as well as on living vegetation. They are also found in paint and compost piles and soils. They are commonly found in water-damaged dry wall, damp latex paint, carpet, wall paper, and on interior fiberglass duct insulation. (Their spores are difficult to differentiate from *Aspergillus* spores hence they are reported with those spores when only microscopic identification is requested, rather than culturing.)

PATHOLOGY - They may cause hypersensitivity pneumonitis and/or allergic alveolitis in susceptible individuals. They are reported to be allergenic (skin). Some species can produce mycotoxins. They are a common cause of extrinsic asthma (immeadiate-type hypersensitivity: type I). Acute symptoms include edema and bronchiospasms, chronic cases may develop pulmonary emphysema. Can cause allergic reactions to sensitized people and are associated with mycotic keratosis in humans.

Molds - www.epa.gov/iaq/molds [provides link to mold resources]

Building Sciences - http://www.buildingscience.com/resources/more-topics/mold/

Centers for Disease Control**:** http://www.cdc.gov/mold/dampness_facts.htm

Minnesota Department of Health: Mold in Homes
http://www.health.state.mn.us/divs/eh/indoorair/mold/index.html