Indoor Air Quality Analysis & Recommendations

Alyce Hatch Center
1406 NW Juniper Street
Bend, Oregon

Presented to:

Mr. Bob Martin
Director of Facilities and Construction
High Desert ESD

Prepared by:

317 NE 144th Street
Vancouver, WA 98685
(360) 576-6331
www.mold-investigations.com

MOLD INVESTIGATIONS, LLC
Microbial Detection Specialists

317 NE 144th Street • Vancouver, WA 98685
(360) 576-6331
www.mold-investigations.com

INDOOR AIR QUALITY REPORT

Report Date: December 28th, 2016

Subject Property: Alyce Hatch Center
1406 NW Juniper Street
Bend, Oregon

Client: Mr. Bob Martin
High Desert ESD

On November 8, 2015, Mold Investigations performed an onsite inspection and testing at the subject property referenced above. The inspection and testing was performed by Thomas Nadermann in order to determine if there was a mold or chemical issue in the play area and, if so, whether the amounts and types found may be indicative of a prior or ongoing moisture issues. In addition the concerns of staff regarding the chemical odor noted in the play room would be addressed. Recommendations for mold removal and remediation, if necessary, will be made based on the results obtained from the testing.

The major area of investigation was the play room. It had been reported that a chemical odor was noted in the play room, possibly as a result of the rubber matting off gassing. No evidence of moisture intrusion was noted.

Evidence of mold contamination was not noted and no further investigation is recommended.

Sampling and Analytical Protocols

An inspection of the area was performed to determine if there was any evidence of prior or current moisture intrusion. Moisture readings were taken of the surfaces utilizing a Delmhorst MoistureCheck meter augmented by a FLIR infrared camera (FLIR-I5-5). Temperature and humidity readings were taken of ambient air using a TSI indoor air quality probe calibrated for the measurement of temperature, humidity, carbon monoxide, and carbon dioxide.

Air samples were collected from the playroom and outside the west entry for comparative reference. The air samples were collected on Air-O-Cell cassettes at a flow rate of 15

liters/minute for five minutes for the spore tests. Air samples were also collected using sorbent tubes for VOC and Formaldehyde testing. Initial formaldehyde results were inconclusive and were repeated on November 23rd.

Sampling and testing protocols are based on guidelines from the *Field Guide for the Determination of Biological Contaminants in Environmental Samples*, published by the American Industrial Hygiene Association, and from *Bioaerosols: Assessment and Control,* published by the American Conference of Governmental Industrial Hygienists.

Analytical work was performed by EMLab P&K of Bothell, Washington and Prism Analytical Technologies, Mt. Pleasant, Michigan. The results of the sampling can be seen in the accompanying laboratory reports.

Results and Discussion

Air Sampling Results:

The following table presents the results of the non-viable air sampling.

Spore Trap Results: Non-Viable Methodology

Fungal ID	1 Outside Reference		2 Playroom	
	Raw Count	Spores/m^3	Raw Count	Spores/m^3
Ascospores	25	1300	1	53
Basidiospores	66	3500	3	160
Cladosporium	7	370	ND	ND
Other Brown	ND	ND	1	13
Penicillium/ Aspergillus types	4	210	2	110
Smuts, Periconia, Myxomycetes	3	40	ND	ND
Total Spores	***105***	***5500***	***7***	***330***

ND = Non Detect

Air samples did not indicate an elevated mold spore count in the indoors compared to outdoors; 330 spores/m^3 and 5,00 spores/m^3, respectively with similar species (*basidiospores)* dominating the samples. The mold concentrations found indoors should generally be lower than outdoor levels with similar species dominating the samples.

Based on the samples collected, there does not appear to be a mold issue in the play room at this time.

VOC Results:

Total VOCs (TVOCs) and total mold VOCs (TMVOCs) were found as follows:

Sample Location	TVOCs (ng/L)	TMVOCs (ng/L)
Play Room	240	3

Results are considered in the normal range.

No federal or state agency has specified a limit for TVOCs in indoor air; however, the U.S. Green Building Council (USGBC) has recommended 500 ng/L as the limit. TVOC levels below 500 ng/L indicate that the indoor air quality is acceptable. TVOC levels between 500 and 1,500 indicate that the TVOC is marginal and some effect on the occupants is possible. Levels above 1,500 ng/L indicate that the indoor air quality should be improved. Based on what the individual compounds are that make up the TVOC, it is possible to suggest actions which will lower the level into an acceptable range.

Contamination Index Category	Play Room Est VOC Level (ng/L)	Descriptions/Suggestions for VOC Reduction
Coatings (Paints, Varnishes, etc.)	93 Normal	Includes interior and exterior paints (including low- or no-VOC paints),varnishes, lacquers, some sealants, and other products that can be classified as a coating over a surface. Typically, VOCs from these products are in the 10 to 14 carbon size range and can linger for several months after application, sometimes longer. Ventilate as much as possible during and after application of any of these products. Dispose of opened but unused products and related supplies if possible or store in areas that will minimize off gassing. Additional sources include fuel oil or diesel fuel..
Light Solvents	11 Normal	Stoddard solvent; mineral spirits; some coatings (paints, varnish, enamels, etc.); wax remover; adhesives; automotive products; light oils. Typically, VOCs from these products are in the 6 to 9 carbon size range.
Personal Care and Cleaning Products	15 Normal	Personal care products such as soap, deodorant, lotions, perfumes, hair coloring supplies, nail care supplies, oral hygiene products, etc. Cleaning agents such as surface, window, and flooring products, also restroom and antibacterial products. These products contain many VOCs that will dissipate if use is discontinued or reduced.
Odorants and Fragrances	16 Normal	Air fresheners, scented cleaning products, and scented personal care products.

Formaldehyde Results

The National Institute for Occupational Safety and Health has set a recommended formaldehyde exposure limit of 20 ng/L. The Occupational Health and Safety Administration has set a workplace permissible exposure limit of 936 ng/L.

Sample Location	Formaldehyde Concentration (ng/L)
Playroom 1	56

The formaldehyde level in the playroom is considered slightly “elevated”. Improvements can be achieved by locating and removing sources or increasing ventialtion. The main sources of

formaldehyde are composite or engineered wood products that contain urea-formaldehyde resins (e.g. particle board, hardwood plywood paneling, medium density fiberboard). Products that contain phenol-formaldehyde resin also emit formaldehyde but at lower concentrations (e.g. softwood plywood, flake or oriented strand board). Formaldehyde is also present in other building products such as pre-finished engineered flooring, insulation, glues and adhesives, paints and coatings, textiles, disinfectant cleaning products, preservatives, cosmetics, pet care products, bactericides, and fungicides. Formaldehyde is also a byproduct of many combustion processes, such as tobacco smoke and fuel-burning appliances (gas stoves, kerosene space heaters, and fireplaces).

The levels noted are still below the Federal Formaldehyde Standard set by President Obama in 2010 for manufacturers of 0.09 ppm, or 90 ppb.

Indoor Air Quality Measurements:

The following table outlines the meter readings noted from the IAQ meter and particle counter taken onsite. Readings inside the play room were normal for CO_2, primarily as a function of the low occupancy in the air space. Other readings were considered normal including the particle count function being below 300 counts for 0.5 micron sized particles and higher.

Indoor Air Quality Monitoring Data Table

	CO	CO_2	Particle Counts	Temp. (°F)	Rel. Humidity
Inside	0	821	448 / 31	71.4°	34.8%
Outside	0	638	---	72.8°	30.1%

Visual Inspection Results:

The interior inspection of the play area did not reveal evidence of past or present moisture intrusion.

Moisture measurements were taken of the surfaces. The readings did not indicate excessive moisture.

Abnormal mold growth or evidence of water intrusion was not observed within play room area. No evidence of current moisture intrusions or mold growth was observed in any of the inspected areas.

No specific odor was noted during the inspection other than a faint rubber like odor.

Recommendations

Based on the visual inspection and sample results, Mold Investigations does not recommend further investigations at this time. The play room appears well maintained and is very clean. No volatile organic chemicals were noted at significant concentrations.

However, given the Formaldehyde levels are slightly elevated, additional ventilation is recommended in the play room area. As the flooring has been in place for a while, the final curing of the rubber is assumed to be complete and these odors should dissipate. Spilling of hot liquids onto the surface may also prompt an increase in off gassing.

By placing an in room air filter system into the play area with a carbon filter should provide a short term solution. Evaluating the HVAC supply and return vents to the room and placing an increase of fresh air make up to the play room would provide a more long term solution.

Given the size of the flooring and the amount of covered area, periodic reviews of that area of the building are recommended to prevent further issues from developing. Should conditions change or additional problems encountered, further investigations may be warranted.

Conclusion

The presence of high concentrations of mold on surfaces in a building is often indicative of prior or ongoing moisture and/or ventilation problems and must be removed from the indoor environment. Also, the presence of high humidity and/or moisture levels is problematic and can contribute to the outgrowth of mold. Since the levels of mold found in this play room were within normal ranges compared to outdoors, and since the relative humidity and moisture levels were well within normal ranges, there does not appear to be a concern at this time. As long as the moisture and humidity levels in the play room remain within acceptable levels, the likelihood of a mold problem occurring in this area will remain small.

Chemical odors are often difficult to assess and quantify. No VOC's were noted during the sampling event. Formaldehyde levels were slightly elevated and are assumed to be a byproduct of the rubber impact floor matting installed across the play room. Given the poor ventilation of the play room area and its infrequent use, the use of appropriate filtration and improved ventilation should resolve this issue.

Sincerely,

Thomas Nadermann
Principal

Photo Log

Play room area

Sampling location in top left corner

Composite impact flooring over carpet

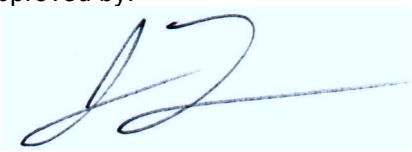
EMLab P&K
A TestAmerica Company

Report for:

Mr. Thomas Nadermann
Mold Investigations, LLC-WA
317 NE 144th Street
Vancouver, WA 98685

Regarding: Project: High Desert ESI; Alyce Hatch Center
EML ID: 1631441

Approved by:



Technical Manager
Justin Ford

Dates of Analysis:
Spore trap analysis: 11-10-2016

Service SOPs: Spore trap analysis (EM-MY-S-1038)
AIHA-LAP, LLC accredited service, Lab ID #178599

All samples were received in acceptable condition unless noted in the Report Comments portion in the body of the report. Due to the nature of the analyses performed, field blank correction of results is not applied. The results relate only to the items tested.

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EMLab P&K
19515 North Creek Pkwy N, #100, Bothell, WA 98011
(866) 888-6653 Fax (623) 780-7695 www.emlab.com

Client: Mold Investigations, LLC-WA
C/O: Mr. Thomas Nadermann
Re: High Desert ESI; Alyce Hatch Center

Date of Sampling: 11-08-2016
Date of Receipt: 11-09-2016
Date of Report: 11-10-2016

SPORE TRAP REPORT: NON-VIABLE METHODOLOGY

Location:	1: Outside Ref				2: Play Room			
Comments (see below)	None				None			
Lab ID-Version‡:	7584387-1				7584388-1			
Analysis Date:	11/10/2016				11/10/2016			
Sample volume (liters)	75				75			
Background debris (1-4+)††	2+				2+			
	Count	Count/m3	DL/m3*	%	Count	Count/m3	DL/m3*	%
Hyphal fragments	2	27	13	n/a				
Pollen								
§ TOTAL FUNGAL SPORES	105	5,500	n/a	100	7	330	n/a	100
Ascospores	25	1,300	53	24	1	53	53	16
Basidiospores	66	3,500	53	64	3	160	53	48
Chaetomium								
Cladosporium	7	370	53	7				
Other brown					1	13	13	4
Penicillium/Aspergillus types	4	210	53	4	2	110	53	32
Smuts, Periconia, Myxomycetes	3	40	13	1				
Stachybotrys								
Stemphylium								
Torula								
Ulocladium								
Zygomycetes								

Comments:

Spore types listed without a count or data entry were not detected during the course of the analysis for the respective sample, indicating a raw count of <1 spore.

The analytical sensitivity is the spores/m^3 divided by the raw count, expressed in spores/m^3. The limit of detection is the analytical sensitivity (in spores/m^3) multiplied by the sample volume (in liters) divided by 1000 liters.

*The DL/m3 has been rounded to a whole number.

††Background debris indicates the amount of non-biological particulate matter present on the trace (dust in the air) and the resulting visibility for the analyst. It is rated from 1+ (low) to 4+ (high). Counts from areas with 4+ background debris should be regarded as minimal counts and may be higher than reported. It is important to account for samples volumes when evaluating dust levels.

‡ 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 Fungal Spores has been rounded to two significant figures to reflect analytical precision.

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Re: High Desert ESI; Alyce Hatch Center

Date of Sampling: 11-08-2016
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MoldRANGE™: Extended Outdoor Comparison

Outdoor Location: 1, Outside Ref

Fungi Identified	Outdoor data	Typical Outdoor Data for: November in Washington† (n‡=987)						Typical Outdoor Data for: The entire year in Washington† (n‡=12667)					
	spores/m3	very low	low	med	high	very high	freq %	very low	low	med	high	very high	freq %
Generally able to grow indoors*													
Alternaria	-	7	13	27	53	93	14	7	13	20	53	80	17
Bipolaris/Drechslera group	-	7	7	13	13	27	4	7	7	13	27	53	3
Chaetomium	-	7	7	13	37	91	4	7	7	13	27	67	6
Cladosporium	370	53	110	270	840	1,700	85	53	110	320	1,100	2,200	83
Curvularia	-	9	12	13	19	34	2	7	7	13	27	80	2
Nigrospora	-	-	-	-	-	-	1	7	7	13	13	27	1
Other brown	-	7	11	13	40	58	24	7	13	13	40	53	25
Penicillium/Aspergillus types	210	53	110	350	980	1,700	92	53	110	270	690	1,200	90
Stachybotrys	-	7	12	13	120	320	3	7	7	13	80	350	2
Torula	-	7	13	20	59	150	3	7	7	13	40	53	5
Seldom found growing indoors**													
Ascospores	1,300	58	160	670	2,000	3,100	91	53	110	440	1,500	2,700	90
Basidiospores	3,500	210	680	3,300	11,000	20,000	96	120	320	1,400	5,000	9,800	96
Rusts	-	7	11	13	39	53	11	7	12	13	53	80	16
Smuts, Periconia, Myxomycetes	40	13	13	27	93	230	46	7	13	33	150	400	46
§ TOTAL SPORES/m3	5,500												

†The 'Typical Outdoor Data' represents the typical outdoor spore levels for the location and time frame indicated. The last column represents the frequency of occurrence. The very low, low, med, high, and very high values represent the 10, 20, 50, 80, and 90 percentile values of the spore type when it is detected. For example, if the frequency of occurrence is 63% and the low value is 53, it would mean that the given spore type is detected 63% of the time and, when detected, 20% of the time it is present in levels above the detection limit and below 53 spores/m3. These values are updated periodically, and if enough data is not available to make a statistically meaningful assessment, it is indicated with a dash.

§ Total Spores/m3 has been rounded to two significant figures to reflect analytical precision.

* The spores in this category are generally capable of growing on wet building materials in addition to growing outdoors. Building related growth is dependent upon the fungal type, moisture level, type of material, and other factors. *Cladosporium* is one of the predominant spore types worldwide and is frequently present in high numbers. *Penicillium/Aspergillus* species colonize both outdoor and indoor wet surfaces rapidly and are very easily dispersed. Other genera are usually present in lesser numbers.

** These fungi are generally not found growing on wet building materials. For example, the rusts and smuts are obligate plant pathogens. However, in each group there are notable exceptions. For example, agents of wood decay are members of the basidiomycetes and high counts of a single morphological type of basidiospore on an inside sample should be considered significant.

‡n = number of samples used to calculate data.

Interpretation of the data contained in this report is left to the client or the persons who conducted the field work. This report is provided for informational and comparative purposes only and should not be relied upon for any other purpose. "Typical outdoor data" are based on the results of the analysis of samples delivered to and analyzed by EMLab P&K and assumptions regarding the origins of those samples. Sampling techniques, contaminants infecting samples, unrepresentative samples and other similar or dissimilar factors may affect these results. In addition, EMLab P&K may not have received and tested a representative number of samples for every region or time period. EMLab P&K hereby disclaims any liability for any and all direct, indirect, punitive, incidental, special or consequential damages arising out of the use or interpretation of the data contained in, or any actions taken or omitted in reliance upon, this report.

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C/O: Mr. Thomas Nadermann
Re: High Desert ESI; Alyce Hatch Center

Date of Sampling: 11-08-2016
Date of Receipt: 11-09-2016
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MoldSTAT™: Supplementary Statistical Spore Trap Report

Outdoor Summary: 1: Outside Ref

Species detected	Outdoor sample spores/m3 (<100 / 1K / 10K / >100K)	Typical outdoor ranges (North America)	Freq. %
Ascospores	1,300	13 - 210 - 6,300	76
Basidiospores	3,500	13 - 430 - 24,000	91
Cladosporium	370	27 - 480 - 9,900	90
Penicillium/Aspergillus types	210	13 - 170 - 2,600	67
Smuts, Periconia, Myxomycetes	40	7 - 53 - 930	64
Total	5,500		

The "Typical outdoor ranges" and "Freq. %" columns show the typical low, medium, and high spore counts per cubic meter and the frequency of occurrence for the given spore type. The low, medium, and high values represent the 2.5, 50, and 97.5 percentile values when the spore type is detected. For example, if the low value is 53 and the frequency of occurence is 63%, it would mean that we typically detect the given spore type on 63 percent of all outdoor samples and, when detected, 2.5% of the time it is present in levels below 53 spores/m3.

Indoor Samples

Location: 2: Play Room

% of outdoor total spores/m3	Friedman chi-square* (indoor variation)	Agreement ratio** (indoor/outdoor)	Spearman rank correlation*** (indoor/outdoor)	MoldSCORE**** (indoor/outdoor)
Result: 6%	dF: N/A Result: N/A Critical value: N/A Inside Similar: N/A	Result: 0.6667	dF: 6 Result: 0.5571 Critical value: 0.7714 Outside Similar: No	Score: 115 Result: Low

Species Detected	Spores/m3 (<100 / 1K / 10K / >100K)
Ascospores	53
Basidiospores	160
Other brown	13
Penicillium/Aspergillus types	110
Total	330

* The Friedman chi-square statistic is a non-parametric test that examines variation in a set of data (in this case, all indoor spore counts). The null hypothesis (H0) being tested is that there is no meaningful difference in the data for all indoor locations. The alternative hypothesis (used if the test disproves the null hypothesis) is that there is a difference between the indoor locations. The null hypothesis is rejected when the result of the test is greater than the critical value. The critical value that is displayed is based on the degrees of freedom (dF) of the test and a significance level of 0.05.

** An agreement ratio is a simple method for assessing the similarity of two samples (in this case the indoor sample and the outdoor summary) based on the spore types present. A score of one indicates that the types detected in one location are the same as that in the other. A score of zero indicates that none of the types detected indoors are present outdoors. Typically, an agreement of 0.8 or higher is considered high.

*** The Spearman rank correlation is a non-parametric test that examines correlation between two sets of data (in this case the indoor location and the outdoor summary). The null hypothesis (H0) being tested is that the indoor and outdoor samples are unrelated. The alternative hypothesis (used if the test disproves the null hypothesis) is that the samples are similar. The null hypothesis is rejected when the result of the test is greater than the critical value. The critical value that is displayed is based on the degrees of freedom (dF) of the test and a significance level of 0.05.

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MoldSTAT™: Supplementary Statistical Spore Trap Report

**** MoldSCORE™ is a specialized method for examining air sampling data. It is a score between 100 and 300, with 100 indicating a greater likelihood that the airborne indoor spores originated from the outside, and 300 indicating a greater likelihood that they originated from an inside source. The Result displayed is based on the numeric score given and will be either Low, Medium, or High, indicating a low, medium, or high likelihood that the spores detected originated from an indoor source. EMLab P&Kreserves the right to, and may at anytime, modify or change the MoldScore algorithm without notice.

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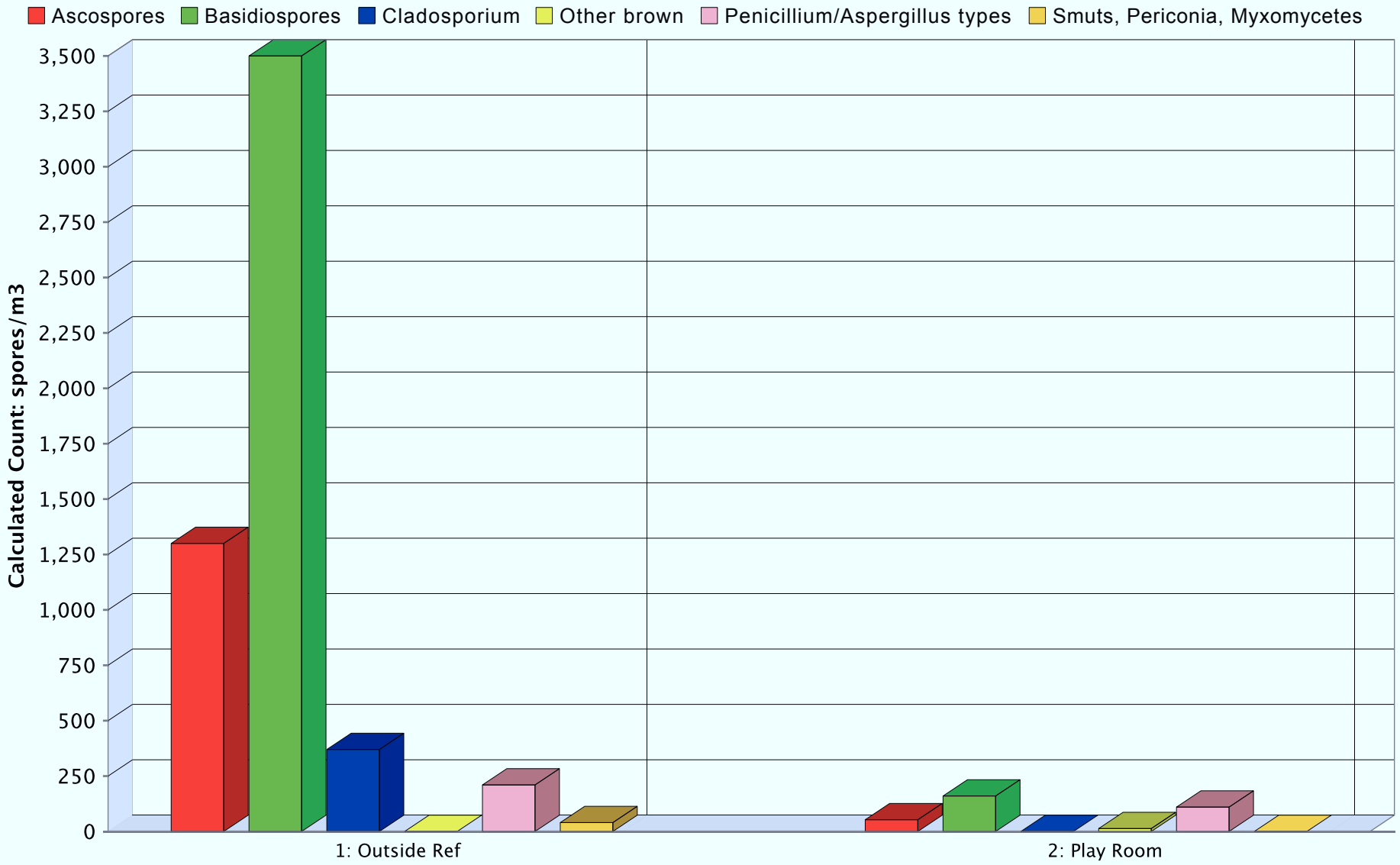
SPORE TRAP REPORT: NON-VIABLE METHODOLOGY



Comments:

Note: Graphical output may understate the importance of certain "marker" genera.

PRISM Analytical Technologies

IAQ Commercial Survey™
Inspect™

Client Sample ID: 20 L Sample Play Room
Laboratory ID: 56973-1

Client: Sterling Technologies
317 NE 144th St
Vancouver, WA 98685

Report Number: 56973

Sampled By: Thomas Nadermann
Project: High Desert
Location: Bend, OR
-

Thank you for using IAQ Commercial Survey!
If you have questions about your report, please contact your service provider who performed this test.

Client Sample ID: 20 L Sample Play Room
Sample Volume (L): 20.0
Date Sampled: 11/08/2016
Sample Type: Pump SS424
Sample Condition: Acceptable

Receive Date: 11/10/2016
Approve Date: 11/10/2016
Scan Date: 11/10/2016
Report Date: 11/14/2016

IAQ Commercial Survey™ is one of the most advanced, trusted air testing products on the market today for identifying chemical sources and active mold growth. Many indoor air quality (IAQ) issues identified by IAQ Commercial Survey can be easily remediated or eliminated. This test is an invaluable tool for improving air quality because it provides important information on potential contamination issues that cannot be detected by a visual inspection alone. Acting upon the information in this report will enable you to dramatically improve the air quality, creating a healthier environment.

Your Indoor Air Quality Report Summary

Your Indoor Air Quality Report has several sections describing different aspects of your air quality. A summary of this data is provided below, additional information and descriptions are included in the full report.

Total Volatile Organic Compounds (TVOC) Level

TVOC is a general indicator of the IAQ (see page 2).

Total VOCs **240 ng/L**

Total Mold Volatile Organic Compounds (TMVOC) Level

TMVOC is an assessment of the actively growing mold (see page 3).

Total MVOCs **3 ng/L**

Contamination Index (CI) Level

The CI shows the types of air-contaminating products and materials that are present in the sampled area (see pages 7 and 8). These levels are estimates based on common home products and activities.

Building Sources

See page 7 for more detail.

	Coatings (Paints, Varnishes, etc.)
	PVC Cement
	Building Materials-Toluene Based
	Gasoline
	Fuel Oil, Diesel Fuel, Kerosene
	Light Hydrocarbons
	Light Solvents

Occupant Sources

See page 8 for more detail.

	HFCs and CFCs (FreonsTM)
	Personal Care and Cleaning Products
	Odorants and Fragrances
	Dry Cleaning Solvents

Note: Severity levels begin at Normal or Minimal and progress through Moderate, Elevated, High and/or Severe. The color progression from green to red indicates results that are increasingly atypical and suggest potentially higher risk.

Normal	Moderate	Elevated	High	Severe

Prism Analytical Technologies, Inc., the creator of IAQ Commercial Survey, has been performing air quality assessments to industry and environmental consultants since 1995. Prism Analytical Technologies, Inc. (ID 166272) is accredited by the AIHA Laboratory Accreditation Programs (AIHA-LAP), LLC in the Industrial Hygiene accreditation program for GC/MS Field of Testing as documented by the Scope of Accreditation Certificate and associated Scope. This analysis references methods EPA TO-17 and ISO 16000-6, which fall within the Scope of Accreditation.

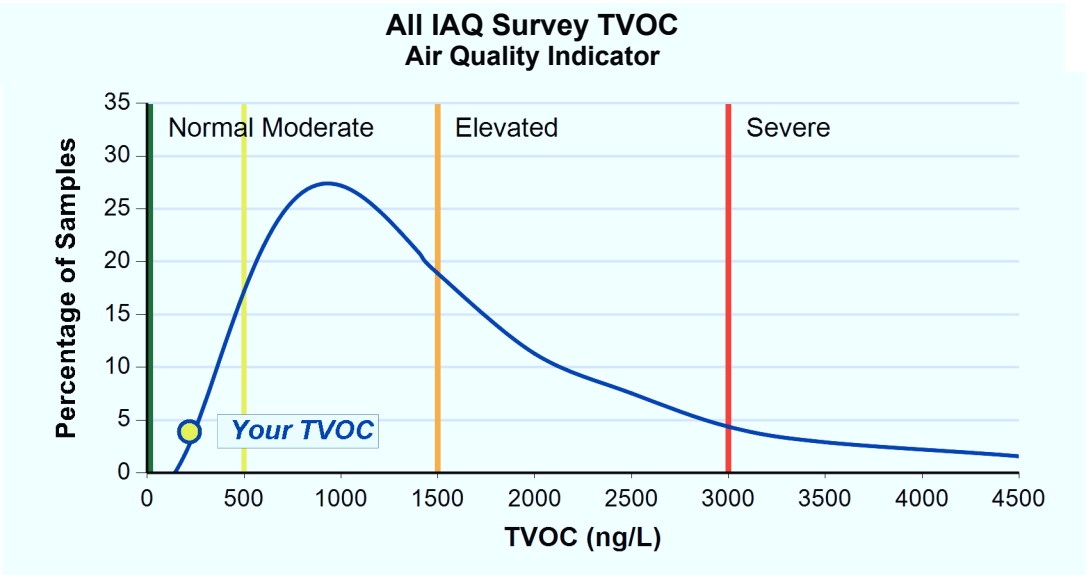
Total Volatile Organic Compound (TVOC) Summary

Your TVOC Level is: 240 ng/L

IAQ is acceptable for most individuals; chemically sensitive persons may require lower levels.

Your Indoor Air Quality Level (Highlighted)

Normal	Moderate	Elevated	Severe
< 500 ng/L	500 - 1500 ng/L	1500 - 3000 ng/L	> 3000 ng/L



The average TVOC is 1900 ng/L

This chart represents the TVOC distribution of over 8,000 samples. Over 80% of these samples indicate improvements in IAQ are necessary to achieve the goal of TVOC less than 500 ng/L.

The chart above shows the TVOC levels for all locations tested using IAQ Survey. Results for this air sample are displayed on the chart as a yellow circle. The blue curved line represents the relationship between the percentage of locations (indicated on the vertical y-axis) and the TVOC level (indicated on the horizontal x-axis). The green, yellow, orange, and red vertical bars represent divisions between Normal, Moderate, Elevated, and Severe TVOC levels. As the TVOC value increases, individuals may experience aggravated health problems, and therefore, the need to address VOC issues becomes more critical. However, reductions in VOCs can be made at any level.

The U.S. federal government has not specified a TVOC limit for indoor air. However, the U.S. Green Building Council (USGBC) has recommended 500 ng/L as the upper TVOC limit. As the TVOC increases, the probability of adverse effects increases. The levels are based on observed health effects and have been determined from a combination of published journal articles (1, 2, 3) and the statistical distribution of TVOC concentrations from the IAQ Survey methodology.

The presence of chemicals in your sampled location can cause a wide range of problems, ranging from an unpleasant odor to physical symptoms (burning and irritation in the eyes, nose, and throat; headaches; nausea; nervous system effects; severe illness; etc.). In some cases, these conditions may make the location uninhabitable. Anyone with respiratory issues like asthma and allergies, as well as children, the elderly, and pregnant women are more susceptible to poor indoor air quality than healthy individuals. However, at higher TVOC levels even healthy individuals are likely to experience ill effects. The following websites can offer more information:

US EPA Indoor Air Quality (IAQ)
American Lung Association Healthy Air at Work
World Health Organization (WHO) Guidelines for Indoor Air Quality
Lawrence Berkeley National Laboratory Indoor Volatile Organic Compounds (VOCs) and Health

The Contamination Index (CI) in the next pages of this report will help guide you through determining what types of products or materials in the sampled location could be problematic for your IAQ and will provide some recommendations to help reduce or eliminate them.

1 L. Molhave, Volatile Organic Compounds, Indoor Air Quality and Health, Vol. 5, International Indoor Air Quality Conference, Toronto, Canada, 1990, p. 22 ff.
2 European Collaborative Action: Indoor Air Quality and its Impact on Man (ECA-IAQ), Report No 19 Total Volatile Organic Compounds (TVOC) in Indoor Air Quality Investigations, 1997. (from L. Molhave et al., Total Volatile Organic Compound (TVOC) in Indoor Air Quality Investigation, Indoor Air 1997; 225-240.)
3 T. Salthammer, Critical evaluation of approaches in setting indoor air quality guidelines and reference values, Chemosphere 82, 2011, 1507-1517.

PRISM Analytical Technologies

IAQ Commercial Survey™
Inspect™

Client Sample ID: 20 L Sample Play Room
Laboratory ID: 56973-1

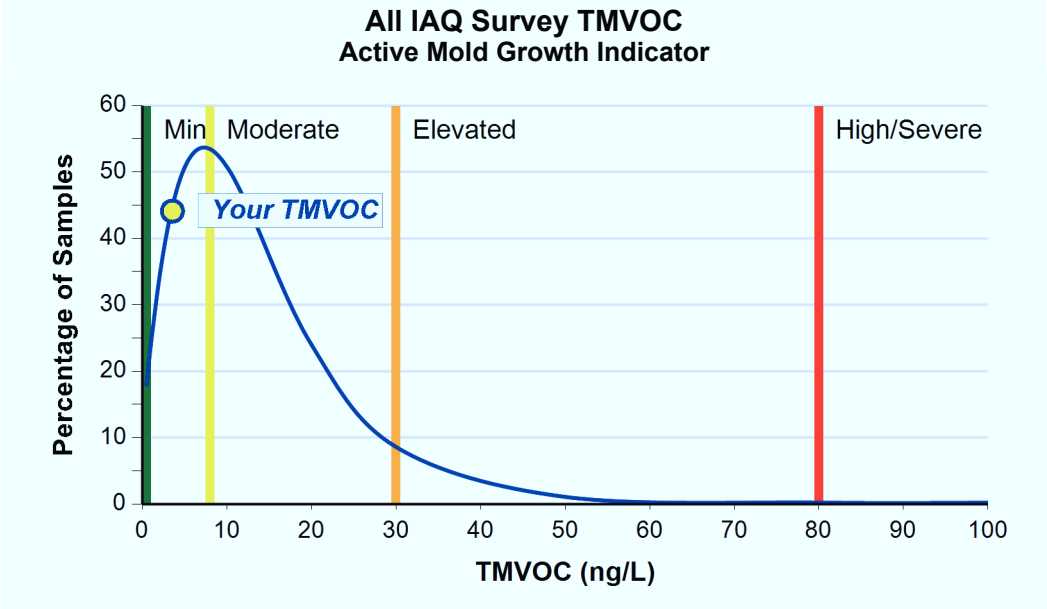
Total Mold Volatile Organic Compound (TMVOC) Summary

Your TMVOC Level is: 3 ng/L

Actively growing molds may be present, but are at or below levels found in most homes and working environments.

Your Active Mold Level (Highlighted)

Minimal	Active-Moderate	Active-Elevated	Active-High	Active-Severe
< 8 ng/L	8 - 30 ng/L	30-80 ng/L	80 - 150 ng/L	150 + ng/L



The average TMVOC is 10 ng/L

This chart represents the TMVOC distribution of over 8,000 samples. Approximately half the samples indicate that some active mold growth is occurring at the time of sample collection.

The chart above shows the TMVOC level for all locations tested using IAQ Survey. Results for this air sample are displayed on the chart as a yellow circle. The blue curved line represents the relationship between the percentage of locations (indicated on the vertical y-axis) and the TMVOC level (indicated on the horizontal x-axis). For example, a TMVOC of 20 ng/L is reported in ~20% of the samples. The green, yellow, orange, and red vertical bars represent divisions between Minimal, Moderate, Elevated, and High/Severe TMVOC levels.

Molds are fungi that grow in the form of multicellular filaments called hyphae that spread to form a network or colony called mycelium. There are thousands of known species of molds, although a much smaller number of mold species are commonly found in indoor environments.

Molds can affect humans and animals in their vicinity in several ways. The most commonly known aspect of molds is the spores they produce as their primary means of reproduction. Spores are released from the mature mold body and spread by air currents and on people, animals, or materials that travel from place to place. These spores can remain viable for a long time until they find a suitable environment and grow to form new colonies. In addition to spores, mycotoxins can also be released under certain situations. Mycotoxins are chemicals that are produced during certain parts of the mold life cycle and can evoke a toxic response (e.g., severe allergic reactions and respiratory irritation and exacerbation of asthma symptoms or other respiratory ailments) in humans and animals. Mycotoxins have low volatility, meaning they have relatively low concentrations in air, so contact or ingestion rather than inhalation is often the main route of exposure for these chemicals.

Finally, mold VOCs (MVOCs) are produced during the metabolic or digestive processes of molds and therefore can be used as an indicator of actively growing mold. When mold is in an inactive or dormant state it does not produce many MVOCs and so cannot be used as an indicator of inactive mold. There are a number of factors that can affect the production and movement of MVOCs, including but not limited to the genus/species, ventilation rates, temperature, humidity, growth surfaces, and competition from other molds. These factors make determination of the genus/species of mold very difficult so the presence of MVOCs indicates active mold growth but not the genus/species of the mold.

Total Mold Volatile Organic Compound (TMVOC) Summary

Mold can grow anywhere that satisfies four primary conditions.

1. Presence of mold spores – spores are everywhere and it is very difficult if not impossible to remove them completely.
2. Appropriate growth surface or nutrient source – molds are adaptable and can grow on almost any surface; many molds especially like cellulose-based materials (e.g., wood, drywall, insulation, cardboard, paper, carpet, etc.).
3. Appropriate temperature – although many molds grow best in warmer temperatures, given enough time mold can grow at almost any temperature condition.
4. Water – this is the most significant and most important criteria since the other conditions are too commonly available to be controlled. The consensus of most organizations with a perspective on air quality (e.g., WHO, EPA, AIHA, ASHRAE, etc.)[a] is that controlling moisture and dampness is the only way to consistently control or limit mold growth.

Mold Sources

Since there are so many possible locations that mold can grow, it can be difficult to locate without visual indicators. However, there are some potential locations where molds are often found, as listed here.

- Air conditioning units or drain lines
- Near plumbing leaks
- Near roof or wall leaks
- Basement water intrusion from surrounding soil
- Any consistently humid area
- Near condensation around windows or any other condensation locations like exterior walls (typically where there is a temperature gradient that allows water to condense)
- Freezer/refrigerator door seals, drain lines, or drip pans; especially in summer
- Indoor plants
- Empty beverage containers and glasses, especially if left for trash or recycling without being rinsed out
- Wastebaskets and trash cans containing discarded food or wet items
- Stand pipes and traps
- Books, magazines, and newspapers if they have gotten wet or sit for a long time
- Outside mold, especially if the air intake is near the ground and landscaping near the building uses wood chips or mulch

Typically, if there is no plumbing leak, condensation, or water intrusion into the building, there will not be a mold problem. If active mold growth is indicated, the first step in fixing the problem is to find and repair the water intrusion or moisture build up.

Some new or extensively renovated buildings can have high MVOC results. Additional dampness is often introduced into a new building during the construction process (e.g., newly installed cement) and can lead to optimal mold growth conditions. Also, some building materials may have mold growth on them when they are installed due to exposure to water before installation. It is strongly recommended that new buildings or those with extensive renovation undergo a drying process to eliminate or reduce the potential for mold growth.

Total Mold Volatile Organic Compound (TMVOC) Summary

MVOC Interpretation

As described above, the TMVOC value is an assessment of the quantity of actively growing mold in the sampled location. Like TVOC, no government unit or organization has specified limits for TMVOC. The levels below describe the effects individuals exposed to these TMVOC values may experience. These levels are qualitative estimates of possible effects experienced by healthy individuals. Sensitive individuals or those with chronic or respiratory issues may experience effects at much lower levels. Mold may be visible on a surface but in an inactive state resulting in little or no production of MVOCs. Regardless of the TMVOC result if mold is visible it should be removed since molds may still produce spores or mycotoxins in an inactive state and new exposure to water or moisture can initiate new mold growth. Since MVOCs are VOCs, they can be affected by the same environmental conditions that affect other VOCs. Primarily lower temperature and higher air flow or ventilation will reduce MVOC concentrations. Any water or moisture issues should be addressed quickly to limit the potential for mold growth.

These levels were determined empirically through interaction with air quality professionals regarding the reported health effects experienced by individuals exposed to actively growing mold.

TMVOC (ng/L)	Level	Description
< 8	Minimal or Ambient	Actively growing molds may be present, but are at or below levels found in most buildings (i.e., these levels could be considered ambient or background).
8 - 30	Active - Moderate	Actively growing molds are present; individuals sensitive to molds will likely be affected. Investigate possible water or moisture sources. See Mold Sources.
30 - 80	Active - Elevated	Significant levels of actively growing molds are present; reactions or symptoms are probable. See Mold Sources
80-150	Active - High	High levels of actively growing molds are present; high probability that all occupants will be affected; take immediate action to locate and remove mold. See Mold Sources.
> 150	Active - Severe	Excessive levels of actively growing molds are present; all occupants will be affected; take immediate action to locate and remove mold. See Mold Sources.

Additional Information about Mold

[aa] World Health Organization (WHO):
WHO Guidelines for Indoor Air Quality – Dampness and Mold

US Environmental Protection Agency (EPA):
Molds and Moisture

American Industrial Hygiene Association (AIHA)
Position Statement on Mold and Dampness

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
Limiting Indoor Mold and Dampness in Buildings
(Position Documents; click on Limiting Indoor Mold and Dampness in Buildings)

Contamination Index™

The Contamination Index™ (CI) shows the types of air-contaminating products and materials that are present in the sampled area. Each CI category shows the approximate contribution of that category to the TVOC level, indicates how your location compares to thousands of other locations, and provides some suggestions about which products and materials might be the source for the VOCs. The CI is divided into two main source groups: Building Sources and Occupant Sources.

1. Building Sources are those that are typically part of the structure of the building and may be more difficult to reduce in the short term. Recent construction or renovation often increases the CI categories in this group to the Elevated, High, or Severe levels. VOCs from these activities often decrease substantially in the month following use or application of these products, especially if the area is flushed with air to dissipate the VOCs off gassed from the new products or materials.

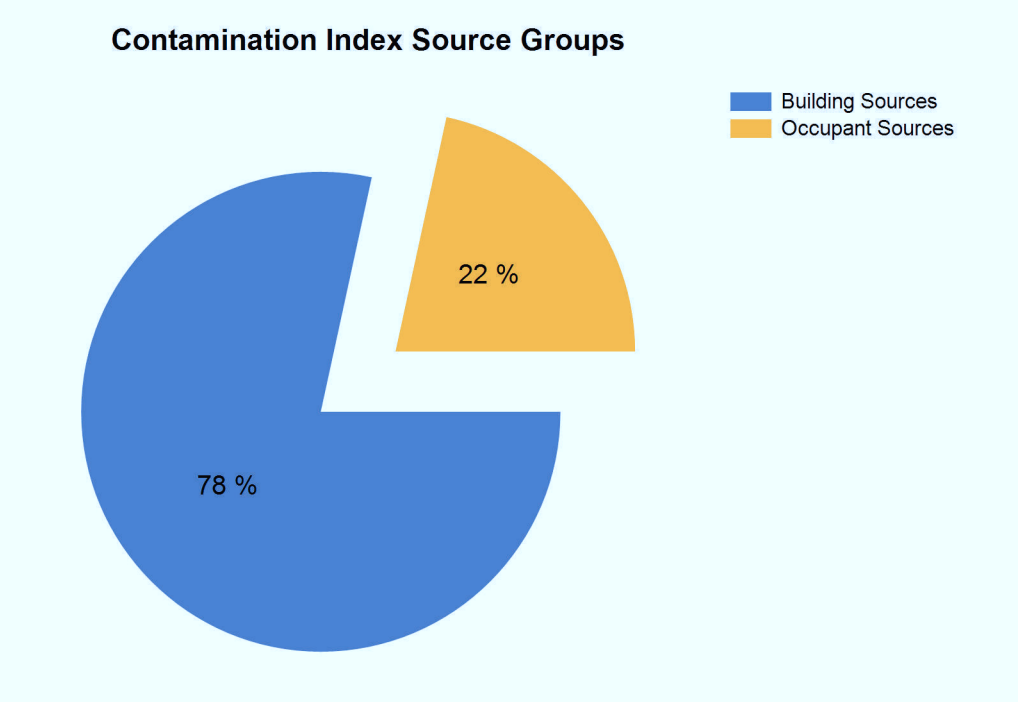
2. Occupant Sources are those that the occupants of the building bring into the building and can usually be more readily identified and remediated. Recent construction or renovation can often contribute to other source categories in addition to Building Sources.

It is possible for a category listed in one source group to belong to another source group. For example, the 'Coatings' category is in the Building Sources group because the largest contribution is typically the paint on the walls, but cans of paint stored in a basement or storage area could be considered part of the Occupant Sources group. Always consider all possible sources for a particular CI category.

The CI categories comprise the most common sources but other products or activities may be present that are not included in the CI. The values assigned to each category are approximations based on typical office and commercial spaces. Locations with additional or atypical sources may require additional investigation to determine the source of certain chemicals that are not accurately represented by the CI.

Since there are potentially many sources of VOCs, buildings can often be re-contaminated even after sources have been removed because new products are constantly being brought into the building. Occupants should take note of this fact, and view IAQ as a continuous improvement process.

The chart below depicts the distribution of the Contamination Index source groups. These source groups are estimates and may not indicate all of the VOCs in your air sample.



Contamination Index™ Building Sources

Use the Contamination Index (CI) below to help you find products and materials in the sampled area that may be affecting your indoor air quality. Removing or reducing these products will improve your air quality. The concentrations reported here are approximate and may not add up to the TVOC value on page 2 of this report. These categories are typically part of the structure of the building and may be more difficult to reduce in the short term. Recent construction or renovation will often cause these categories to be elevated. Increased ventilation will help to reduce VOCs from construction or renovation sources. Levels indicated as Elevated, High, or Severe should be addressed immediately, and those listed as Moderate are areas that can be improved over time.

Building Sources

Contamination Index Category	Estimated VOC Level (ng/L)	Severity	Source Prediction & Suggestions for VOC Reduction
Coatings (Paints, Varnishes, etc.)	93	**Normal**	Includes interior and exterior paints (including low- or no-VOC paints), varnishes, lacquers, some sealants, and other products that can be classified as a coating over a surface. Typically, VOCs from these products are in the 10 to 14 carbon size range and can linger for several months after application, sometimes longer. Ventilate as much as possible during and after application of any of these products. Dispose of opened but unused products and related supplies if possible or store in areas that will minimize off gassing. Additional sources include fuel oil or diesel fuel.
PVC Cement	0	**Normal**	PVC cement is used to join pieces of PVC pipe together, usually for plumbing.
Building Materials-Toluene Based	0	**Normal**	Adhesives and glues used in construction and maintenance, arts and crafts; adhesive removers; contact cement; sealants; coatings (paint, polyurethane , lacquer, thinner); automotive products, including parts cleaners. Additional sources include gasoline and other fuels.
Gasoline	9	**Normal**	VOCs from gasoline are typically a result of off-gassing from gas containers, small spills, and gas-powered equipment used in facilities maintenance in nearby garage or storage areas. Most vehicles in good operating condition do not emit gasoline vapors due to the tightly sealed gas tank. This category does not include exhaust emissions. Gasoline VOCs can linger on clothing after refueling at a gas station. Gasoline includes chemical compounds that are also included in the Light Solvents category.
Fuel Oil, Diesel Fuel, Kerosene	0	**Normal**	Typically found in garages and facilities maintenance areas. These fuels are not very volatile so they will not readily get into the air, but they can linger for a long time and produce a strong, unpleasant odor. This category does not include exhaust emissions. Additional sources include coatings such as paints, varnishes, sealants, waxes, etc.
Light Hydrocarbons	3	**Normal**	Building materials; aerosol cans; liquefied petroleum gas (LPG); refrigerant; natural gas; propellant; blowing agent. Includes chemical compounds such as propane, butane, and isobutane.
Light Solvents	11	**Normal**	Stoddard solvent; mineral spirits; some coatings (paints, varnish, enamels, etc.); wax remover; adhesives; automotive products; light oils. Typically, VOCs from these products are in the 6 to 9 carbon size range.

Contamination Index™ Occupant Sources

Use the Contamination Index (CI) below to help you find products and materials in the sampled area that may be affecting your indoor air quality. Removing or reducing these products will improve your air quality. The concentrations reported here are approximate and may not add up to the TVOC value on page 2 of this report. These categories are typically brought into the building by the occupants and can often be readily identified and removed or contained. Levels indicated as Elevated, High, or Severe should be addressed immediately, and those listed as Moderate are areas that can be improved over time.

Occupant Sources

Contamination Index Category	Estimated VOC Level (ng/L)	Severity	Source Prediction & Suggestions for VOC Reduction
HFCs and CFCs (FreonsTM)	1	**Normal**	Most often used as refrigerants for air conditioners and refrigerator/freezers and propellants for blown-in insulation, cushions, aerosol cans, etc. Many of these chemical compounds are being phased out because of the Montreal Protocol.
Personal Care and Cleaning Products	15	**Normal**	Personal care products such as soap, deodorant, lotions, perfumes, hair coloring supplies, nail care supplies, oral hygiene products, etc. Cleaning agents such as surface, window, and flooring products, also restroom and antibacterial products. These products contain many VOCs that will dissipate if use is discontinued or reduced.
Odorants and Fragrances	16	**Normal**	Air fresheners, scented cleaning products, and scented personal care products.
Dry Cleaning Solvents	0	**Normal**	Typical dry-cleaning methods employ the use of carcinogenic chemicals. Dry-cleaning should be allowed to vent outside, without plastics bags, before being placed inside.

Significant VOCs

Based upon your specific air analysis, the chemical compounds listed below are significant contributors to the TVOC level reported on page 2 of your IAQ Commercial Survey Report or are indicative of specific types of products or problems. Compounds from a variety of chemical classes are represented here, although only the most common or most notable are specifically listed. These chemical compounds may come from a variety of sources as shown in the Contamination Index section of this report. Many of these chemical compounds are commonly found in office and commercial locations. However, locating and removing the source of the chemical compound is the most effective way to reduce the contribution of that chemical compound to the TVOC, which ultimately leads to improved IAQ. If removing the source is not possible, try to contain it in some way (e.g., placing the source in an air-tight container when not in use). In addition, the ventilation system in some locations may not be optimized so evaluate the ventilation system and make adjustments to increase the amount of fresh air. Filter or purify re-circulated inside air to help reduce the TVOC. Since VOCs may continue to off-gas even when the sources are stored, ventilation and air-purification methods will need to be employed continuously in order to keep the VOC levels low. The Chemical Abstracts Service (CAS) registry number after the chemical compound name in the table below is a unique identifier for that chemical compound and is often the best means to search for additional information. The two VOC levels in the table below (ng/L and ppb) are different ways of describing the same concentration, in some cases exposure limits or other information may be described using one or both of these concentration units.

Compound	CAS	Estimated VOC Level (ng/L)	Estimated VOC Level (ppb)	Description

The notes below indicate any additional significant compounds present in this air sample or other noteworthy information.

No significant VOCs were detected in this air sample.

EPA Hazardous Air Pollutants (HAPs)

Hazardous air pollutants, also known as toxic air pollutants or air toxics, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Listed below are those HAPs that are included with the IAQ Commercial Survey VOC test. This list does not include all HAPs. The '<' (less than) symbol in the 'Estimated VOC Level' columns indicates the compound is below the reporting limit for this air sample and therefore can be considered absent from the air sample. For more information about HAPs visit the EPA Air Toxics website. The exposure limits listed below can also be found in the NIOSH Guide to Chemical Hazards. The HAPs in the table below may also be listed as Significant VOCs if the concentration of that chemical compound is greater than the threshold level for a Significant VOC.

Compound	CAS	Estimated VOC Level (ng/L)	Estimated VOC Level (ppb)	NIOSH Exposure Limit	Description
Carbonyl sulfide	463-58-1	< 1	< 0.4	None Listed	Fumigant; contaminated drywall; fuel combustion byproduct; some foods; naturally occurring at low levels
Carbon Disulfide	75-15-0	< 1	< 0.3	3,000 ng/L (1,000 ppb)	Solvent; fumigant; contaminated drywall; combustion byproduct
Methylene Chloride	75-09-2	< 1	< 0.3	Carcinogen	Automotive products; degreasing solvent; paint stripper; adhesive remover; aerosol propellant; insecticide
Hexane (C 6)	110-54-3	< 1	< 0.3	180,000 ng/L (50,000 ppb)	Solvent; adhesive; grease; lubricant; paints and coatings; petroleum fuel component
1,1,1-Trichloroethane	71-55-6	< 1	< 0.2	C; 1,900,000 ng/L (350,000 ppb)	Adhesives, lubricants, cleaners, solvents
Benzene	71-43-2	< 1	< 0.3	320 ng/L (100 ppb)	Gasoline. Less common sources include some discontinued solvents; printing and lithography; paints and coatings; rubber; dry cleaning; adhesives; detergents
1,2-Dichloroethane	107-06-2	< 1	< 0.2	Carcinogen; 4,000 ng/L (1,000 ppb)	PVC production; solvent for rubber, insecticides, oils, waxes, gums, resins; rug and upholstery cleaners
Trichloroethene	79-01-6	< 1	< 0.2	Carcinogen	Dry cleaning; degreasers and cleaners for home/automotive; varnish removers; anesthetic
Methyl methacrylate	80-62-6	< 1	< 0.3	410,000 ng/L (100,000 ppb)	Acrylic Polymers for paints and coatings, adhesives, fillers; solvent; pharmaceuticals; personal care
Toluene	108-88-3	< 1	< 0.3	375,000 ng/L (100,000 ppb)	Gasoline; adhesives (building and arts/crafts); contact cement; solvent; heavy duty cleaner
Tetrachloroethene	127-18-4	< 1	< 0.1	Carcinogen	Dry cleaning; adhesives, automotive cleaners, polishes
Ethylbenzene	100-41-4	< 1	< 0.2	435,000 ng/L (100,000 ppb)	Gasoline; paints and coatings; solvent; pesticide
m,p-Xylene	108-38-3; 106-42-3	< 1	< 0.2	435,000 ng/L (100,000 ppb)	Gasoline; paints and coatings; adhesives and cements; solvent; print cartridges
o-Xylene	95-47-6	< 1	< 0.2	435,000 ng/L (100,000 ppb)	Gasoline; paints and coatings; adhesives and cements; solvent; print cartridges
Styrene	100-42-5	< 1	< 0.2	215,000 ng/L (50,000 ppb)	Polystyrene foam; synthetic rubber; flavoring agent
1,4-Dichlorobenzene	106-46-7	< 1	< 0.2	Carcinogen	Moth balls/crystals; room deodorant
Naphthalene	91-20-3	< 1	< 0.2	50,000 ng/L (10,000 ppb)	Gasoline; diesel; Moth balls/crystals; insecticide

These results are authorized by the Laboratory Director or approved representative.

This analysis was performed by Prism Analytical Technologies, Inc. (Prism). The results contained in this report are dependent upon a number of factors over which Prism has no control, which may include, but are not limited to, the sampling technique utilized, the size or source of sample, the ability of the sampler to collect a proper or suitable sample, the compounds which make up the TVOC, and/or the type of mold(s) present. Therefore, the opinions contained in this report may be invalid and cannot be considered or construed as definitive and neither Prism, nor its agents, officers, directors, employees, or successors shall be liable for any claims, actions, causes of action, costs, loss of service, medical or other expenses or any compensation whatsoever which may now or hereafter occur or accrue based upon the information or opinions contained herein.

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PRISM Analytical Technologies

IAQ Commercial Survey™
Formaldehyde

Air Analysis For: High Desert ESD
Location Tested: Bend, OR
-

Sampling Professional: Thomas Nadermann
Sterling Technologies
317 NE 144th St
Vancouver, WA 98685

Client Sample ID: Playroom 1
Sample Volume (L): 4.0
Date Sampled: 11/23/2016
Sample Type: TDT RR624
Sample Condition: Acceptable

Report Number: 57380
Laboratory ID: 57380-2

Thank you for using IAQ Commercial Survey!
If you have questions about your report, please contact your service provider who performed this test.

Order Date: 11/28/2016
Scan Date: 11/28/2016
Report Date: 11/30/2016

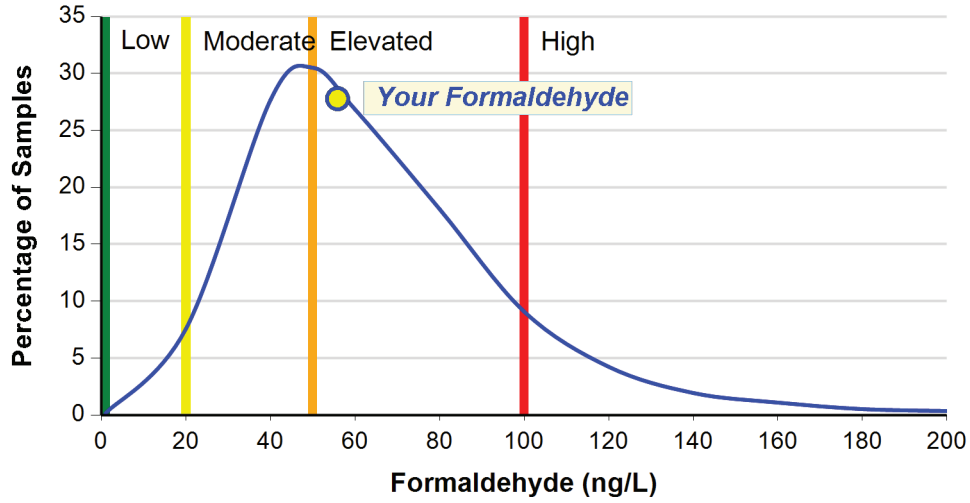
Formaldehyde Concentration: 56 ng/L (45 ppb)

Your Formaldehyde Level (Highlighted)

Low	Moderate	Elevated	High
< 20 ng/L < 16 ppb	20-50 ng/L 16-40 ppb	50-100 ng/L 40-80 ppb	> 100 ng/L > 80 ppb

Recommendation: Consider locating and removing formaldehyde sources. See formaldehyde sources section for more information.

All IAQ Survey Formaldehyde Results



This chart represents the Formaldehyde distribution of over 7,000 samples.

Approximately half the samples have concentrations in the 30-70 ng/L range.

The chart above shows the formaldehyde concentrations for all locations tested using IAQ Survey. Results for this air sample are displayed on the chart as a yellow circle. The blue curved line represents the relationship between the percentage of locations (indicated on the vertical y-axis) and the formaldehyde concentration (indicated on the horizontal x-axis). The green, yellow, orange, and red vertical bars represent divisions between Low, Moderate, Elevated, and High formaldehyde concentrations.

Formaldehyde concentrations can vary depending on environmental conditions such as temperature, humidity, and ventilation rate. As temperature and humidity increase, the formaldehyde concentration will increase and as the ventilation rate increases, the formaldehyde concentration will decrease.

Formaldehyde Exposure Guidelines

The US Occupational Safety and Health Administration (OSHA) has set a workplace **permissible exposure limit** (PEL) of 940 ng/L (750 parts per billion). The National Institute for Occupational Safety and Health (NIOSH) has set a **recommended exposure limit** (REL) of 20 ng/L (16 ppb) with a 120 ng/L (100 ppb) 15 minute ceiling limit.

Although these formaldehyde concentration limits are applicable to all types of workplace environments, most office or retail locations without additional occupational exposure (e.g., industrial or manufacturing processes generating formaldehyde) typically have formaldehyde concentrations less than 100 ng/L (80 ppb). Most indoor environments measured by Prism's air test have concentrations in the range of 30 to 70 ng/L.

The table below provides some of the limits applicable to workplace environments. In general, formaldehyde concentrations should be kept as low as reasonably achievable.

Organization	Concentration		Type
	ng/L	ppb	
OSHA	630	500	Action Level (8 hour)
	940	750	PEL (8 hour)
	2,500	2,000	STEL (15 min)
NIOSH	20	16	REL (8 hour)
	120	100	Ceiling (15 min)
ACGIH	370	300	TLV (8 hour)
LEED	32	27	Green Building (4 hour)
WHO	100	80	Short-Term (0.5 hour)

OSHA: Occupational Health and Safety Administration
NIOSH: National Institute for Occupational Safety and Health
ACGIH: American Conference of Governmental Industrial Hygienists
LEED: Leadership in Energy & Environmental Design (Green Building Council)
WHO: World Health Organization

PEL: Permissible Exposure Limit
REL: Recommended Exposure Limit
TLV: Threshold Limit Value
TWA: Time Weighted Average
STEL: Short Term Exposure Limit

Note: Concentration can be expressed in several ways and various organizations may use different units.
1 ng/L = 1 $\mu g/m^3$ = 0.001 mg/m^3
1 ppb = 0.001 ppm
To convert between the two sets of units listed above the molecular weight of formaldehyde must be used, which produces the conversion factors below:
ppb concentration = ng/L concentration * 0.8 or ng/L concentration= ppb concentration * 1.25

Major Health Effects of Formaldehyde Exposure

Health effects vary depending on the individual. Common symptoms of acute exposure include irritation of the throat, nose, eyes, and skin; this irritation can potentially exacerbate asthma symptoms and other respiratory illnesses. Long term, or chronic, exposure may also cause chronic runny nose, chronic bronchitis, and obstructive lung disease. In 2004, the International Agency for Research on Cancer (IARC) reclassified formaldehyde from "probably carcinogenic to humans" to "carcinogenic to humans" related to nasopharyngeal cancer. Since many factors are involved in the development of cancer, no definitive "safe level" of exposure has been established. The best way to reduce the risk of cancer is to limit exposure.

Formaldehyde Sources

There are many possible sources for formaldehyde in the indoor environment, although building products typically make up a large proportion of the concentration. Any recent renovation or new material brought into the building is likely to increase the formaldehyde levels. The concentration will decrease over time as the materials off gas, so increasing the ventilation as much as possible is typically the best way to quickly decrease formaldehyde after recent renovation or installation of new materials.

- Products that contain urea-formaldehyde (UF) resins
  - particleboard, hardwood plywood paneling, medium density fiberboard
- Products that contain phenol-formaldehyde (PF) resins (lower concentrations of formaldehyde than UF resins)
  - softwood plywood, flake or oriented strand board
- Pre-finished engineered flooring
- Insulation
- Glues and adhesives
- Paints and coatings
- Textiles
- Disinfectant cleaning products and soaps
- Preservatives
- Personal care products, especially certain hair products
- Cosmetics
- Pet care products
- Bactericides and fungicides
- Combustion byproduct (burning)
  - Tobacco smoke and fuel-burning appliances (gas stoves, kerosene space heaters and fireplaces)

Formaldehyde is also produced naturally in living systems, e.g., trees and other plant life, and during decay and combustion processes. Formaldehyde is also involved in atmospheric processes. Outdoor concentrations of formaldehyde from both natural and man-made sources can range from less than 1 ng/L in remote areas to 10-20 ng/L in urban environments.

Additional Resources

US OSHA Toxic and Hazardous Substances-Formaldehyde
US OSHA Fact Sheet-Formaldehyde
US NIOSH Formaldehyde
World Health Organization (WHO) Air Quality Guidelines for Europe, 2nd Edition (2000): pg 87-91
Europe: Report No. 7-Indoor Air Pollution by Formaldehyde in European Countries (1990)
US Consumer Product Safety Commission (CPSC) Update on Formaldehyde (2013)
US Environmental Protection Agency: Formaldehyde
US Agency for Toxic Substances and Disease Registry (ATSDR): Formaldehyde ToxFAQs™
US National Institutes of Health (NIH): ToxTown: Formaldehyde
Chemical Reviews (Journal): Formaldehyde in the Indoor Environment
Household Products Database: Formaldehyde

These results are authorized by the Laboratory Director or approved representative.

This analysis was performed by Prism Analytical Technologies, Inc. (Prism) using the Hantzsch, or acetylacetone (acac), method. This test method has been correlated with or is compliant with the California Air Resources Board (CARB) § 93120, European DIN Standard EN-717, and ASTM methods D-5582 and E-1333. It has also been compared with DNPH testing used in NIOSH 2016 and found to be in good agreement. The AIHA Laboratory Accreditation Program (AIHA-LAP), LLC is currently reviewing this method for accreditation as a Unique Scope; approval is pending.
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