VANDRIEL OHS CONSULTING
BUILDING A HEALTHY WORKPLACE

"PRELIMINARY REPORT ON MOULD CULTURE SAMPLES AT PARKVIEW ELEMENTARY"

PREPARED FOR	School District 83
PREPARED BY	Ivan Cheung M.Sc.
REVIEWED BY	Robin Van Driel M.Sc., CIH, ROH, CRSP
SITE LOCATION	605 Parksville Street, Sicamous, BC
REPORT DATE	October 7, 2019

1. INTRODUCTION

VanDriel OHS Consulting ("VOHS") was retained by School District 83 to perform indoor air monitoring at Parkview Elementary (605 Parksville Street, Sicamous, BC). Due to a recent odour complaint by students and staff, the staff and students in the west wing of the school were relocated to the east side of the school. The odour was described by those first on the scene as musty, similar to a wet basement smell, and the smell of rotten food. Reported symptoms believed to have been caused by this odour included headaches and upper respiratory tract irritation. It was reported that the odour complaint was made after a day of heavy rainfall, which was not typical for Sicamous. The rainfall was reported to have flooded the school parking lot and may have added a substantial amount of water into the crawlspace.

This report covers the culturable samples of mould collected at the school on September 19, 2019.

2. INVESTIGATION METHOD

On September 19, 2019, culturable samples of mould were collected to aid in assessing the indoor air quality of the school, with a focus on the west wing of the building.

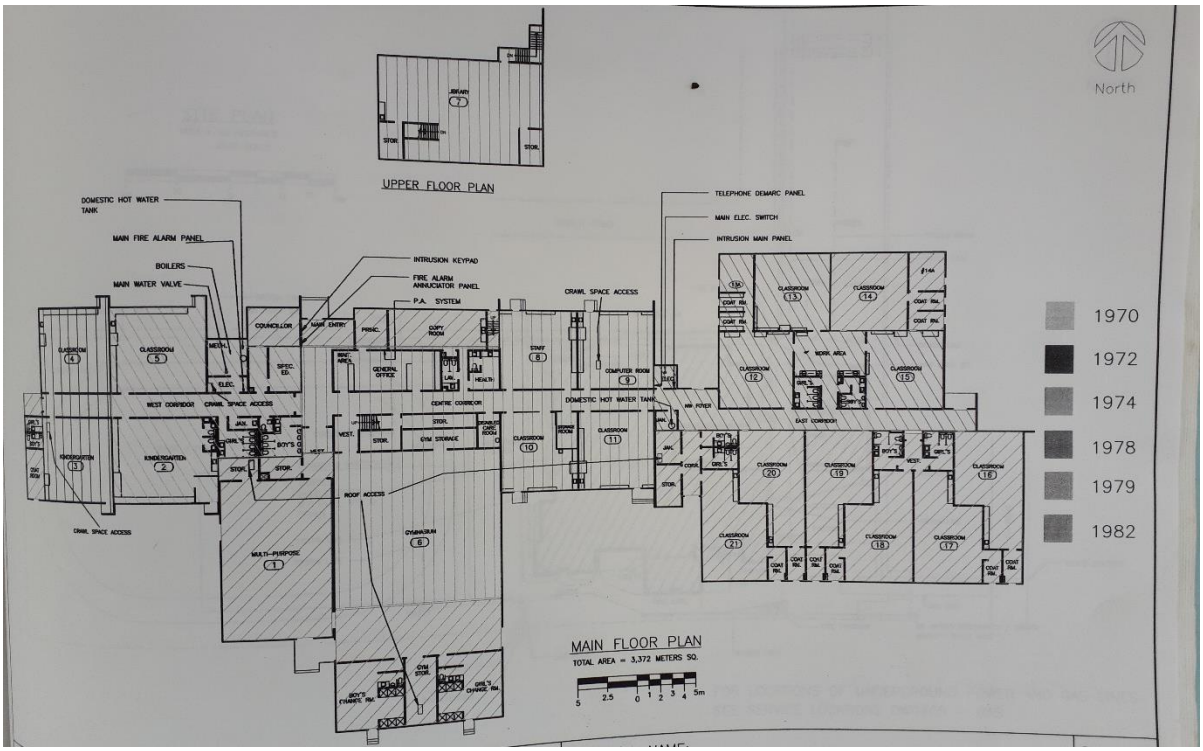

Figure 1: Floor plan of Parkview Elementary. Not to scale.

Six samples were collected throughout the building to determine the amount of culturable mould in the air. These samples were collected from the following locations:

1. adjacent to the air handling units of the west wing on the roof,
2. the west corridor,
3. the crawlspace,
4. the office area,

5. the occupied east corridor, and
6. outside by the west wing doors.

Air was drawn through an Andersen n-stage sampler and collected onto a malt extract agar (MEA) plate at 28.3 L/min for 7 to 15 minutes depending on the location. At this flow rate, particles above 0.65 µm diameter will go through one of the 400 evenly spaced holes and make contact with the agar plate, and spores that make it onto the agar will grow on the MEA. The flow rate was measured before sample collection using a primary flow calibrator, Defender 510 (Mesa Laboratory Inc., Butler, NJ). Appendix A has the calibration certificate for the flow calibrator.

The samples were incubated at room temperature for 2 weeks such that colony forming units of mould (CFU) are visible under a microscope and identifiable based on their morphology. An additional correction must be done to account for the loss in the number of viable CFU should there be more than one CFU that landed through the same hole based on Monte Carlo simulations for up to 400 CFU on the agar (Macher, 1989).

3. Analysis of Culturable Samples

The indoor culturable samples are compared with the outdoor culturable samples by counts and genus to evaluate whether there is a source of mould that is not typical of the outdoor environment and is growing indoors. As all samples contain at least 1 CFU of *Cladosporium* sp. and *Penicillium* sp., a chi-squared test was done to show the difference between the outdoor samples and the indoor samples. A chi-squared test involves comparing two groups of discrete values (such as counts of CFU) to determine whether the two groups differ based on what is observed (or measured) and what is expected (i.e. the proportion of values between the two groups). As per statistical convention, a p-value (the probability that the results observed is random given that the trend being observed is truly random) below 5% (or $\alpha = 0.05$) means that there is a significant difference between the proportion of the two groups of samples. As there are only two groups for comparison of the proportion of fungi, the comparison can only change with one degree of freedom (df), that is, the result of one fungal genus leaves only one possible result for the other.

4. Results and Interpretation

Appendix B contains the laboratory results. Appendix C contains the laboratory chain of custody form.

Results from the samples collected in the office area, east wing corridor and west wing corridor showed lower fungal concentration than the outdoor samples (Table 1). This suggest that the ventilation system on the roof is functioning adequately to remove dust particles from the outdoors. The samples collected from the crawlspace showed greater fungal concentration, about three times, than the outdoor samples. This suggests that the crawlspace is a likely source of fungal growth at the school.

The samples from the office area, east wing corridor and the west wing corridor had a similar ratio of *Cladosporium* sp. and *Penicillium* sp. as the outside samples (Table 2). However, the crawlspace had a different ratio of the two fungi genus than the outside samples. This suggests that the fungal community inside the crawlspace differs from that of the outside. The crawlspace also only grew one species of *Cladosporium* sp. unlike the other indoor spaces. This suggests that the dominant community in the crawlspace differ from those outside.

Table 1: Counts of Colony Forming Unit (CFU) and Relative Amount of Culturable Mould (%) at Parkview Elementary.

	Rooftop by Air Handling Unit	Outside West Entrance	Corridor in West Wing	Crawlspace in West Wing	Office Area	Corridor in East Wing
Actual Total Count (CFU)	39	17	6	59	9	14
Corrected Total Count (CFU)	43.4	17.8	6.1	69.9	9.2	14.6
Concentration (CFU/m^3)	114	126	18	341	22	53.9
Alternaria sp. (%)	2.6%	0	0	0	11.1%	14.3%
Cladosporium sp. (%)	51.3%	47.1%	66.7%	23.7%*	33.3%	35.7%
Penicillium sp. (%)	38.5%	41.2%	33.3%	71.2%	55.6%	14.3%
Rhodotorula sp. (%)	0	0	0	1.7%	0	0
Trichoderma sp. (%)	0	0	0	0	0	14.3%
Sterile colony (%)	7.7%	11.8%	0	3.4%	0	21.4%

Rounding may lead to a total percent of CFUs above or below 100%. *All *Cladosporium* sp. are *Cladosporium herbarum*.

Table 2: Chi-squared test of Penicillium sp. and Cladosporium sp. CFU from samples collected at Parkview Elementary.

Comparison groups	Chi-squared (χ^2)	p-value (df = 1)
Crawlspace to Outside West Entrance	4.44	**0.035**
Crawlspace to Roof	9.5	**0.002**
East corridor to Outside West Entrance	0.64	0.42
East corridor to Roof	0.49	0.48
West corridor to Outside West Entrance	0.31	0.58
West corridor to Roof	0.19	0.66
Office to Outside West Entrance	0.52	0.47
Office to Roof	1	0.31

Bolded red values show significant differences between the two samples.
df = degrees of freedom

It was reported that there was a heavy rainfall the day before the odour was detected in the school. Since the crawlspace has a different fungal community than the outdoor environment, it may generate an odour that would differ from the outdoor environment when the crawlspace becomes wet. As *Penicillium* sp. is what is most associate with bread mould, it is possible that the odour of rotten food detected by those who arrived first at the school came from the *Penicillium* growth in the crawlspace when the crawlspace became wet or damp.

5. Recommendations

The crawlspace must be kept dry to prevent further odour complaints due to the crawlspace becoming wet. Currently, there is a system of heaters and fans that dry out the crawlspace, which may not be sufficient when there is a heavy rainfall. A long-term recommendation is to finish the crawlspace floor surface with concrete removing the potential for soil/sand from harvesting mould growth.

6. Reference

Macher, J. M. (1989). Positive-hole correction of multiple-jet impactors for collecting viable microorganisms. *American Industrial Hygiene Association Journal, 50*(11), 561-568.

Report Completed By

Ivan Cheung, M.Sc.
Occupational Hygiene Specialist

Report Reviewed By

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OHS Consultant
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Appendix A: Certificate of Calibration

MesaLabs

NVLAP Lab Code 200661-0
Calibration

As Shipped Calibration Data

Certificate No	296704	**Lab. Pressure**	738 mmHg
Technician	Sonia Otero	**Lab. Temperature**	22.6 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Shipped
25001 ccm	25066 ccm	-0.26%	1.00%	In Tolerance
5018.1 ccm	5015.6 ccm	0.05%	1.00%	In Tolerance
1512.4 ccm	1508.05 ccm	0.29%	1.00%	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML 500-44	113761	21-Feb-2019	21-Feb-2020

Calibration Notes

The expanded uncertainty of flow has a coverage factor of k = 2 for a confidence interval of approximately 95%.

Flow testing is in accordance with our test number PR17-13 with an expanded uncertainty of 0.27% using high-purity nitrogen or filtered laboratory air.

Traceability to the International System of Units (SI) is verified by accreditation to ISO/IEC 17025 by NVLAP under NVLAP Code 200661-0.

Technician Notes:

Mohammed Aziz
Director of Engineering
Mesa Laboratories, Inc., Butler, NJ

Mesa Laboratories Inc. 10 Park Place Butler, NJ 07405 USA
-8400 FAX (973) 492-8270 www.mesalabs.com Symbol "MLAB" on the NAS

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CAL02-49 Rev C05

APPENDIX B: LABORATORY RESULT

EMSL Canada Inc.
2756 Slough Street, Mississauga, ON L4T 1G3
Phone/Fax: (289) 997-4602 / (289) 997-4607
http://www.EMSL.com torontolab@emsl.com

EMSL Canada Or 551911485
CustomerID: 55VAND29
CustomerPO: IAQ 1
ProjectID:

Attn: **Robin Van Driel**
VanDriel OHS Consulting
PO Box 19098 Fourth Ave PO
Vancouver, BC V6K 4R8

Phone: (778) 879-8009
Fax:
Received: 09/24/19 11:13 AM
Analysis Date: 10/1/2019
Collected: 9/19/2019

Project: **IAQ 1**

Test Report: Viable Fungi Identification and Enumeration (Genus Level ID from Plate and Strip Impactors (EMSL Method MICRO-SOP-202))

Sample Description	Location	Volume (L)	Media	Incubation Temp (C)	Sensitivity (CFU/m³)	Fungal Identification	Colony Count	CFU/m³
M01	Roof by HVAC	382	MEA	25	3	*Alternaria sp.*	1	3
551911485-0001						*Cladosporium sp.*	20	60
						Penicillium sp.	15	45
						Sterile(white)	3	9
						Total	**39**	**117**
M02	West Corridor	333	MEA	25	3	*Cladosporium sp.*	4	12
551911485-0002						*Penicillium sp.*	2	6
						Total	**6**	**18**
M03	West Crawlspace	205	MEA	25	5	*Cladosporium herbarum*	14	70
551911485-0003						*Penicillium sp.*	42	210
						Rhodotorula sp.	1	5
						Sterile(white)	2	10
						Total	**59**	**295**
M04	Blank		MEA	25		**None Detected**		
551911485-0004								
Blank								
M05	Outside (West)	141	MEA	25	7	*Cladosporium sp.*	8	56
551911485-0005						*Penicillium sp.*	7	49
Background						*Sterile(white)*	2	14
						Total	**17**	**119**
M06	Office Area	409	MEA	25	2	*Alternaria sp.*	1	2
551911485-0006						*Cladosporium sp.*	3	6
						Penicillium sp.	5	10
						Total	**9**	**18**

Analyst(s)

Sneha Panchal (7)

Sneha Panchal, M.Sc.,RMCCM Laboratory Manager
or other approved signatory

Positive hole correction factors have not been applied to the reported data. The detection limit is equal to 1 colony forming unit (CFU) per agar plate. EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. When the information supplied by the customer can affect the validity of the result, it will be noted on the report.

Samples analyzed by EMSL Canada Inc. Mississauga, ON

Initial report from 10/04/2019 12:14:04

Test Report ViableFungi-7.26.0 Printed: 10/4/2019 12:14:04 PM 1

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

EMSL Canada Inc.
2756 Slough Street, Mississauga, ON L4T 1G3
Phone/Fax: (289) 997-4602 / (289) 997-4607
http://www.EMSL.com torontolab@emsl.com

EMSL Canada Or	551911485
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CustomerPO:	IAQ 1
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Collected:	9/19/2019

Project: **IAQ 1**

Test Report: Viable Fungi Identification and Enumeration
(Genus Level ID from Plate and Strip Impactors (EMSL Method MICRO-SOP-202))

Sample Description	Location	Volume (L)	Media	Incubation Temp (C)	Sensitivity (CFU/m³)	Fungal Identification	Colony Count	CFU/m³
M07	East Corridor	271	MEA	25	4	*Alternaria sp.*	2	8
551911485-0007						*Cladosporium sp.*	5	20
						Penicillium sp.	2	8
						Sterile(dark)	1	4
						Sterile(white)	2	8
						Trichoderma sp.	2	8
						Total	**14**	**56**

Analyst(s)

Sneha Panchal (7)

Sneha Panchal, M.Sc.,RMCCM Laboratory Manager
or other approved signatory

Positive hole correction factors have not been applied to the reported data. The detection limit is equal to 1 colony forming unit (CFU) per agar plate. EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. When the information supplied by the customer can affect the validity of the result, it will be noted on the report.
Samples analyzed by EMSL Canada Inc. Mississauga, ON

Initial report from 10/04/2019 12:14:04

Test Report ViableFungi-7.26.0 Printed: 10/4/2019 12:14:04 PM

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APPENDIX C: CHAIN OF CUSTODY FORM

OrderID: 691902384

EMSL ANALYTICAL, INC.
LABORATORY · PRODUCTS · TRAINING

Microbiology Chain of Custody

EMSL Order Number (*Lab Use Only*): 691902384

PHONE:
FAX:

Company Name: VanDriel OHS Consulting	**EMSL-Bill to:** ☒ Same ☐ Different If Bill to is Different note instructions in Comments** *Third Party Billing requires written authorization from third party*
Street:	
City: **State/Province:**	**Zip/Postal Code:** **Country:**
Report To (Name): Robin Van Driel, Ivan Cheung	**Telephone #:**
Email Address: robin@vohsgroup.com, ivan@vohsgroup.com	**Fax #:** **Purchase Order:**
Project Name/Number: IAQ 1	**Please Provide Results:** ☐ Fax ☒ Email

U.S. State Samples Taken: **Zip Code Sample Taken:** **Connecticut Samples:** ☐ Commercial ☐ Residential

**Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide. TATs are subject to methodology requirements*

Sterile, Sodium Thiosulfate Preserved Bottle Used: ☐ **Biocide Used in Source (specify):** ☐

Public Water Supply Samples: ☐ **Note: All results may automatically be reported to DOH if required by state.**

Turnaround Time (TAT) Options * - Please Check

☐ 3 Hour ☒ 6 Hour ☐ 24 Hour ☐ 48 Hour ☐ 72 Hour ☐ 96 Hour ☐ 1 Week ~~☒ 2 Week~~

Microbiology Test Codes

M001 Air-O-Cell
M030 Micro 5
M174 MoldSnap
M032 Allergenco-D
M041 Fungal Direct Examination
M168 Pollen ID & Enumeration
M280 Dust Characterization Level-1
M281 Dust Characterization Level-2
M005 Viable Fungi- Air Samples (Genus ID & Count)
M006 Viable Fungi- Air Samples (Includes *Penicillium, Aspergillus, Cladosporium, Stachybotrys* Species ID & Count)
M007 Culturable fungi - Surface Samples (Genus ID & Count)
M008 Culturable fungi - Surface Samples (Includes *Penicillium, Aspergillus, Cladosponum, Stachybotrys* Species ID & Count)
M009 Bacteria Culture Gram Stain & Count
M010 Bacteria Count & ID - 3 Most Prominent
M011 Bacteria Count & ID - 5 Most Prominent
M012 Pseudomonas aeruginosa (P/A***)
M024 Pseudomonas aeruginosa (MFT*)
M015 Heterotrophic Plate Count
M017 Total Coliform & E. coli (Colilert P/A***)
M018 Total Coliform & E. coli (MFT*)
M114 Total Coliform & E. coli Enumeration (Colilert MPN**)
M019 Fecal Coliform (MFT*)
M020 Fecal Streptococcus (MFT*)
M029 Enterococci (MFT*)
M129 Enterococci (Enterolert P/A***)
M180 Real Time qPCR-ERMI 36 Panel
M025 Sewage Screen –Water (MFT*)
M115 Sewage Screen - Water (P/A***)
M116 Sewage Screen - Water (MPN**)
M117 Sewage Screen - Swab (P/A***)
M013 Sewage Screen - Swab (MFT*)
M133 Methicillin-resistant Staph. aureus (MRSA)
M031 Rapid-growing non-TB Mycobacteria Detection & Enumeration
M014 Endotoxin Analysis
M044 Group Allergen (Cat, Dog, Cockroach, Dust Mite)
Other See Analytical Price Guide
Legionella Analysis Please use EMSL Legionella COC

*MFT= Membrane Filtration Technique
**MPN= Most Probable Number
***P/A= Presence/Absence

Name of Sampler: Ivan Cheung **Signature of Sampler:**

Sample #	Sample Location/Description	Sample Type	Potable/ NonPotable (only for waters)	Test Code	Volume/ Area	Date/Time Collected	Temperature (°C) (Lab Use Only)
Example A1	Kitchen Sink/Tap	Water	☒ P ☐ NP	M017	100 mL	9/1/13 4:00 PM	
~~M01~~	~~Roof by HVAC~~	Air	☐ P ☐ NP	M005	~~382 L~~	~~19/09/19~~	
~~M02~~	~~West Corridor~~	Air	☐ P ☐ NP	M005	333 L	19/09/19	
~~M03~~	~~West Crawlspace~~	Air	☐ P ☐ NP	M005	205 L	19/09/19	
~~M04~~	~~Blank~~	Air	☐ P ☐ NP	M005	N/A	19/09/19	
~~M05~~	~~Outside (West)~~	Air	☐ P ☐ NP	M005	141 L	19/09/19	
~~M06~~	Office Area	Air	☐ P ☐ NP	M005	~~409 L~~	19/09/19	

Client Sample # (s): - **Total # of Samples:** 12 **Samples Received Chilled?** (Yes) / No

Relinquished (Client): Ivan Cheung **Date:** 2019/09/20 **Time:** 9:00 am

Received (Lab): **Date:** **Time:**

Comments/Special Instructions:

*6 hours for tape lifts and bulk sample. 2 weeks for agar plate samples.

SEP20 19 11:11AM

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Page 1 Of 2

The crossed out parts are the mould samples.

OrderID: 691902384

EMSL ANALYTICAL, INC.
LABORATORY | PRODUCTS | TRAINING

Microbiology Chain of Custody

EMSL Order Number (*Lab Use Only*):

PHONE:
FAX:

Additional Pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Location/Description	Sample Type	Potable/ NonPotable	Test Code	Volume/ Area	Date/Time Collected	Temperature (°C) (Lab Use Only)
~~M07~~	~~East Corridor~~	~~Air~~	☐P ☐NP	~~M005~~	~~271 L~~	~~19/09/19~~	
B01	AHU above office	Tape	☐P ☐NP	M041	~5 sq in	19/09/19	
B02	West crawlspace-underneath corridor	Tape	☐P ☐NP	M041	~5 sq in	19/09/19	
B03	Ceiling space (west corridor)	Tape	☐P ☐NP	M041	~5 sq in	19/09/19	
C01	Lower Bldg Env-West	Bulk	☐P ☐NP	M041	~7 cu in	19/09/19	
C02	Upper Bldg Env-West	Bulk	☐P ☐NP	M041	~7 cu in	19/09/19	
			☐P ☐NP				
			☐P ☐NP				
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			☐P ☐NP				

Comments/Special Instructions:

Page 2 of 2 pages

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Page 2 Of 2

The crossed out parts are the mould samples.