January 30, 2017

Strait Regional School Board
16 Cemetery Road
Port Hastings, NS B9A 1K6

E-mail: karen.macdonald@srsb.ca

Attention: Karen MacDonald

Re: Concrete Slab Investigation – Moisture Vapour Emissions Rate Testing Report
Dr. John Hugh Gillis High School, 105 Braemore Avenue, Antigonish, Nova Scotia
Pinchin File: 01-05-00479

Pinchin LeBlanc Environmental Limited (Pinchin) was retained by the Strait Regional School Board (Client) to investigate concrete slab conditions within the basement level of Dr. John Hugh Gillis High School, located at 105 Braemore Avenue, Antigonish, Nova Scotia (Site Building).

BACKGROUND

On January 17, 2017, Chris Webber of Pinchin met with Mr. Michael Chisholm, Maintenance Supervisor (Site Representative), who provided an overview of the Site Building layout and conditions. It is Pinchin's understanding that ongoing air quality issues are being observed in isolated areas near the northwestern corner of the building, where Pinchin noted a large hill that slopes towards the building. Past or active flooding has not been observed; however, musty odors are regularly noted within classroom 1010, as well as within a nearby stairwell. Intrusive investigation previously completed within classroom 1010 determined that there are no observable moisture impacts/damages to building materials within the wall systems. Mould has been observed near the base of the stairwell wall system, which has been subsequently thoroughly cleaned multiple times; however, appears to be recurrent. It was reported that the building weeping tile drainage system at the northwestern corner was recently inspected and a blockage was observed. It is therefore likely that there is insufficient drainage around the perimeter of the building, which may result in water accumulation at the perimeters and/or under the concrete slab. The concrete moisture vapour emissions rate (MVER) testing was conducted in order to determine the moisture content within the concrete slab and whether sub-slab moisture accumulation is therefore likely. It was also reported that a hazardous material assessment was completed on the vinyl floor tile adhesive within classroom 1010, which determined that asbestos is not present.

The Site Building is constructed with cast-in-place concrete foundation walls and slab (i.e. full height basement level which is partially above grade). The footprint area of the Site Building was not reported; however, Pinchin estimated the total footprint area to be approximately 80,000 ft^2 (via Google Earth estimation tools). Pinchin conducting testing within classroom 1010, the nearby stairwell and the nearest

janitor's closet. The total work areas were estimated at ~ 1,200 ft^2. As a result of current work within classroom 1010, the vinyl tile floor finishes had been removed prior to the time of the testing and they appeared to have been previously installed directly to the concrete slab via two types of adhesive. The flooring within the stairwell consists of vinyl floor tiles installed directly to the concrete slab via two types of adhesive, and the flooring in the janitor's closet consists of an unfinished concrete slab.

INVESTIGATION

Pinchin completed the testing in accordance with the ASTM Standard F1869-04 *Standard Test Method for Measuring Moisture Vapour Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride*. Four locations were determined for Moisture Vapour Emissions Rate (MVER) testing, each located near a corner of the work area and further described in Table 1 below. Pinchin was aided by Matrix Construction with the initial preparation of the concrete (i.e. removal of the adhesives and painted surfaces of the concrete slab) within the four test locations, each with the dimensions of 18" by 18".

Three tests were carried out at each test location, consisting of the following:

Concrete Floor Slab Moisture Vapour Emissions Rate (MVER) Testing:

This test measures the rate at which moisture is transmitting through the concrete floor slab. Flooring manufacturers and installers refer to this test method in their installation procedures and product specifications. The tests were conducted according to ASTM F1869 protocols and using ASTM F1869-11 compliant Anhydrous Calcium Chloride Test Kits. The kits ("Vapor Score" – Moisture Vapor Emission Test Kits) where installed, after cleaning of the concrete surface with a combination of hand-held scrapers and various power tools, and thoroughly cleaning any residue/dust from the concrete surface. The kits were removed in the interval between 60 and 72 hours as required by the ASTM protocols (i.e. at approximately 72 hours). The kits were installed on Tuesday, January 17, 2017 and removed on Friday, January 20, 2017. Refer to Table 1 for the results. Based on the area of testing and in accordance to the ASTM Standard, four (4) test locations were required for MVER testing; however, one additional test location (i.e. in the janitor's closet) was selected in order to provide a measurement which should not have been effected by any concealed deficiencies in the building drainage systems.

General Conditions Testing:

This testing includes measurement of the ambient conditions (i.e. air temperature and relative humidity) present at the time of the initial MVER testing and final test weighing. The results of the testing were measured using an "Extech Precision Hygro-thermometer", model RH490. The results of the test were recorded after the instrument reached steady-state conditions. Refer to Table 2 for the ambient conditions at the time of the initial testing. Similar results were measured at the time of the final test weighing but were not reported.

Concrete Slab Surface Relative Humidity (RH), Concrete Slab Sub-Surface RH, Temperature In-Situ Testing and pH measurement:

These tests were completed prior to the completion of the MVER testing on Tuesday, January 17, 2017. The concrete slab surface and sub-surface RH were measured using a "Delmhorst Pinned Moisture Meter", model BD-2100. Those measurements were completed using drilled pilot holes at a minimal depth for surface RH and at a depth of ~ 2 ½" for sub-surface RH. For comparison, surface RH measurements were also completed using a "Tramex Pinless Moisture Meter", model Moisture Encounter Plus (those measurements found similar results which are not provided within this report). It should be noted that the surface and sub-surface moisture content measurements are reported on a scale from 1 to 100 and do not represent % RH. Measurements made on materials were compared to measurements made on the same materials in reference locations, believed to be unaffected by water damage. The moisture meter is useful for measuring elevated surface moisture, but would not detect moist conditions well below the surface For the purpose of comparison, additional concrete slab and sub-slab RH measurements were completed in three locations of classroom 1010; along the western perimeter wall, at the southwestern corner and along the southern perimeter (those measurements found similar results to those made in the test locations and are not provided within this report). Refer to Table 2 for the results of the surface and sub-surface measurements.

The temperature of the concrete slab was measured at the time of the initial testing using an "Extech Infrared Thermometer", model 42500. The pH of the concrete slab was also conducted at this time, with pH strips provided by the MVER kit manufacturer. Refer to Table 2 for the results of this testing.

MEASUREMENTS

Table 1 - Vapour Emission Measurement of the Concrete Slab

Location No., Location Description	**Weight (grams)**			**Test Duration (hrs)**			**Results (lbs/ 1000sqft/24hrs)**
	Start (b)	**Finish (c)**	**Gain (d) = (c - b)**	**Start Time (e)**	**Finish Time (f)**	**Duration (hrs) (g) = (f - e)**	**MVER (h) = (d) x 117.707/(g)**
1. Classroom 1010, along western perimeter	23.3	25.1	1.8	Tuesday, January 17, 2:51 pm	Friday, January 20, 2:55 pm	72.07	2.94

Table 1 - Vapour Emission Measurement of the Concrete Slab

Location No., Location Description	Weight (grams)			Test Duration (hrs)			Results (lbs/ 1000sqft/24hrs)
	Start (b)	Finish (c)	Gain (d) = (c - b)	Start Time (e)	Finish Time (f)	Duration (hrs) (g) = (f - e)	MVER (h) = (d) x 117.707/(g)
2. Classroom 1010, along southern perimeter	23.3	24.3	1.0	Tuesday, January 17, 2:55 pm	Friday, January 20, 3:00 pm	72.08	1.63
3. Classroom 1010, central	23.4	25.5	2.1	Tuesday, January 17, 2:47 pm	Friday, January 20, 3:04 pm	72.28	3.42
4. Stairwell, along western perimeter	23.4	27.1	3.7	Tuesday, January 17, 3:09 pm	Friday, January 20, 3:10 pm	72.02	6.05
5. Janitor's closet, central portion of northwestern building section	23.3	24.1	0.8	Tuesday, January 17, 2:43 pm	Friday, January 20, 3:15 pm	72.53	1.30

Table 2 – General Conditions and Conditions of the Concrete Slab

Location No., Location Description	Air Temperature (°C)	Air RH (%)	Concrete Temperature (°C)	Qualitative Concrete surface RH (scale from 1 to 100)	Qualitative Concrete sub-surface RH (scale from 1 to 100)	Concrete pH
1. Classroom 1010, along western perimeter	19.6	21.2	18.3	65 to 70 (mid -range)	Up to 97 (very high-range)	~ 9

Table 2 – General Conditions and Conditions of the Concrete Slab

Location No., Location Description	Air Temperature (°C)	Air RH (%)	Concrete Temperature (°C)	Qualitative Concrete surface RH (scale from 1 to 100)	Qualitative Concrete sub-surface RH (scale from 1 to 100)	Concrete pH
2. Classroom 1010, along southern perimeter	19.7	20.6	17.2	50 to 60 (mid-range)	Up to 92 (high-range)	~ 8.5
3. Classroom 1010, central	19.7	20.3	19.4	50 to 60 (mid-range)	Up to 94 (high-range)	~ 8.5
4. Stairwell, along western perimeter	21.1	17.0	21.7	70 to 90 (mid to high-range)	Up to 100 (very high-range)	~ 8.5
5. Janitor's closet, central portion of northwestern building section	21.6	20.9	21.7	30 to 35 (low-range)	55 to 60 (mid-range)	~ 8.5

FINDINGS

Our testing and review of the building conditions identified the following:

- Two areas of peeling paint on concrete masonry unit back-up wall systems were observed in two locations; under a window within classroom 1010 (dry at very low moisture content) and in a corner of the stairwell near classroom 1010 (very low moisture content found at a height of ~ 5' but very high at base of wall; i.e. ~ 90%). Pinchin did not observe other moisture impacts to the exterior wall surfaces and interior finishes, nor was there evidence of moisture infiltration through the building envelope in the areas of review (northwestern section – west and south elevations). The area under the window appears likely from past/active leaking at the window sealants, while the area in the stairwell is likely due to leaking through the foundation walls; and
- By visible observation, the pre-existing vinyl flooring tiles in the stairwell were well-adhered with exception of an isolated area at the western perimeter foundation wall. The floor adhesives appeared to be thoroughly applied throughout the work areas and well-adhered. When creating test locations Pinchin noted that the adhesives were of varying

types and as such, the difficulty of adhesive removal varied. Pinchin noted that the primary adhesive used in classroom 1010 is more rigid and brittle, therefore was easy to remove despite being well-adhered to the concrete slab. The two adhesives used in the stairwell were very well-adhered to the concrete slab and difficult to remove. There were smaller areas of adhesive-like materials on the floor within the janitor's closet, which were well-adhered and difficult to remove.

PHOTOGRAPHIC DOCUMENTATION

View of a typical test area (as shown within the stairwell).

DISCUSSION

The indoor air temperature was relatively consistent in the work areas during both the setup and final weighing and within the normal range, while the air relative humidity was low. As such, the interior air conditions within the Site Building at the time of the testing would promote drying of building materials and is not likely to contribute to adding moisture to the concrete floor slabs.

The concrete slab temperature varied depending on the proximity to the exterior walls, and was found lowest at the northwestern corner of classroom 1010 (in comparison to the areas examined). The concrete surface relative humidity was normal within the janitor's closet (i.e. ~ 30% to 35%); however, was found to be in the mid to high-range within classroom 1010 and the stairwell (i.e. between ~ 50% to 90%). The concrete sub-surface relative humidity was in the mid-range within the janitor's closet (i.e. 55% to 60%); however, was otherwise found to be high within classroom 1010 and the stairwell (i.e. between 92% to 100%).

Pinchin noted that the sub-surface RH values were generally higher than the surface RH values found at each test location. It is therefore presumed that the concrete slab surface RH may not be indicative of the overall concrete RH, and it is possible that the surface of the concrete has been able to dry out faster than the remainder of the slab (i.e. via air flow and ventilation systems). It is generally described that

concrete moisture content values are acceptable between 0% and 85%, while values between 85% to 95% generally indicate elevated measure content, and values above 95% indicate conditions that are generally not acceptable for flooring or painting applications.

The minimum and maximum MVER measurements were found at 1.30 and 6.05 lbs/1000sqft/24hrs. Most vinyl tile flooring manufacturers' installation guidelines generally require vapour emission rates below 3.0 lbs/1000sqft/24hrs. The lowest value (at low end of normal MVER range) was found in the janitor's closet near the central portion of the northwestern section of the building. Of the three tests completed in classroom 1010, the samples at the western perimeter and central portion of the room were at or higher than the recommended MVER (i.e. at 2.94 and 3.42, respectively), while the sample at the southern perimeter was within the normal MVER range (i.e. at 1.63). The highest measurement was the sample taken within the stairwell which was twice the recommended MVER (i.e. 6.05).

The concrete slab pH values were all found to be basic (i.e. ~ pH 8.5 to 9). The general acceptable range for installation of vinyl flooring systems is pH 5 to 9, and as such the tested areas of the concrete slab are at the highest recommended pH.

RECOMMENDATIONS

Due to the measurements of high moisture content and vapour emissions of the concrete slabs Pinchin recommends further work is considered. The results of the testing suggest that higher than ideal amounts of moisture are moving through the concrete slab from the underside, presumably from a sub-surface moisture source. The following recommendations are made based on the testing results and the observed conditions:

1. Further review of the Site conditions and building systems to determine the cause(s) of the high moisture emissions, including inspection of the building drainage systems (i.e. perimeter weeping tile system) and other mechanical deficiencies which may contribute to high sub-slab moisture levels. Blockages within the perimeter drainage system should be removed and it should be ensured that the drainage system is working properly.
2. Complete retrofits to address the identified cause(s) of the moisture issue in order to reduce the sub-slab moisture content and the resultant emission through the concrete slab. Those retrofits may include:
    - Site grading to direct water away from the building at the western perimeter of the foundation;
    - Installation of a trench drainage system at the base of the hill near the western perimeter;
    - Installation of a concrete slab vapour barrier; and/or

- Installation/replacement of foundation moisture barrier systems (if not present or effective) and tying this system into the perimeter drainage. The foundation wall moisture barrier could be upgraded to a engineered waterproofing system consisting of a membrane and water redirection system.

LIMITATIONS

The findings are limited to the extent that the assessment could be made visually and with the MVER and concrete RH testing. It should be noted that Pinchin has attempted to identify all the deficiencies associated with this project. Pinchin does not accept any liability for deficiencies that were not identified within the scope of the investigation.

The assessment is based, in part, on information provided by others. Unless specifically noted, Pinchin has assumed that this information was correct and has relied on it in developing the conclusions. Environmental audits, or the identification of designated substances, hazardous materials and mould are excluded from this report.

The intent of Pinchin's comments on water infiltration inspection is for the sole purpose of identifying areas where Pinchin has observed a noteworthy condition.

It is possible that unexpected conditions may be encountered at the Site that has not been explored within the scope of this report. Should such an event occur, Pinchin should be notified in order to determine if modifications to the conclusions are necessary.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of the third parties. If additional parties require reliance on this report, written authorization from Pinchin will be required. Pinchin disclaims responsibility of consequential financial effects on transactions or property values, or requirements for follow-up actions and costs. No other warranties are implied or expressed.

This report presents an overview on issues of the building condition, reflecting Pinchin's best judgment using information reasonably available at the time of Pinchin's review and Site assessment. Pinchin has prepared this report using information understood to be factual and correct and shall not be responsible for conditions arising from information or facts that were concealed or not fully disclosed to Pinchin at the time of the Site assessment.

Pinchin has prepared this inspection report for the exclusive use of the Client, in the evaluation of the building at the time of Pinchin's Site visits. The Pinchin investigation was conducted in accordance with Pinchin's proposed scope of work and verbal direction provided by the client, and generally accepted building condition assessment practices. No other warranty, expressed or implied is made.

CLOSURE

We trust that the aforementioned report addresses your requirements. Pinchin provides a full service Building Sciences Group that can assist in solutions for all building related problems and is capable to oversee all aspects of the work from investigation, to design to management of completion. Pinchin would be pleased to provide further assistances in addressing any of the recommendations made within this investigation. Should you require clarification or information regarding this report or require further assistance in this matter, please contact the undersigned at 902.461.9999.

Yours truly,

Pinchin LeBlanc Environmental Limited

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SRSB_MVER Testing_Dr JH Gillis High School, Antigonish, NS-AI

Template: Master Letterhead Template – January.22.2016