

Indoor Air Quality and Rodent Droppings Assessment

Pacific Highway Border Crossing,
Traffic and Commercial
Operations Building
26 176th Street, Surrey, BC

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Prepared by:
Stantec Consulting Ltd.
500 – 4730 Kingsway
Burnaby, BC V5H 0C6



INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

Table of Contents

Executive Summary.....	i
1.0 Introduction	1
1.1 SCOPE OF WORK	1
1.1.1 HVAC System Inspection	2
1.1.2 Air Sampling and Analysis	2
2.0 Air Handling Systems Assessment.....	2
2.1 GENERAL DESCRIPTION OF THE BUILDING	2
2.2 GENERAL DESCRIPTION OF THE AIR HANDLING SYSTEMS.....	2
2.3 RESULTS AND CONCLUSIONS.....	2
3.0 Environmental Monitoring	3
3.1 AIRBORNE DUST PARTICLES	5
3.1.1 Background	5
3.1.2 Standards & Guidelines	6
3.1.3 Methodology.....	7
3.1.4 Results & Conclusions.....	7
3.2 CARBON DIOXIDE.....	7
3.2.1 Background	7
3.2.2 Standards & Guidelines	8
3.2.3 Methodology.....	8
3.2.4 Results & Conclusions.....	8
3.3 CARBON MONOXIDE.....	9
3.3.1 Background	9
3.3.2 Standards & Guidelines	9
3.3.3 Methodology.....	9
3.3.4 Results & Conclusions.....	9
3.4 TEMPERATURE	10
3.4.1 Background	10
3.4.2 Standards & Guidelines	10
3.4.3 Methodology.....	10
3.4.4 Results & Conclusions.....	10
3.5 RELATIVE HUMIDITY	11
3.5.1 Background	11
3.5.2 Standards & Guidelines	11
3.5.3 Methodology.....	11
3.5.4 Results & Conclusions.....	11
3.6 TOTAL VOLATILE ORGANIC COMPOUNDS.....	11
3.6.1 Background	11
3.6.2 Standards & Guidelines	12
3.6.3 Methodology.....	12
3.6.4 Results & Conclusions.....	12

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

3.7	RODENT PROTEIN ALLERGEN.....	12
3.7.1	Background	12
3.7.2	Standards & Guidelines	13
3.7.3	Methodology.....	13
3.7.4	Results & Conclusions.....	13
4.0	Visual Assessment for Rodent Droppings	14
4.1.1	Background	14
4.1.2	Standards & Guidelines	14
4.1.3	Methodology.....	14
4.1.4	Results & Conclusions.....	14
5.0	Recommendations	15
6.0	Closure	16

LIST OF TABLES

Table 3-1	Summary of Guideline Criteria	4
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LIST OF APPENDICES

APPENDIX A	FLOOR PLAN DRAWING WITH SAMPLING LOCATIONS.....	A.1
APPENDIX B	ENVIRONMENTAL MONITORING – SUMMARY OF RESULTS.....	B.1
APPENDIX C	RODENT PROTEIN ALLERGEN CERTIFICATE OF ANALYSIS	C.1

Executive Summary

Rodent droppings have been identified within the ceiling space throughout the Traffic and Commercial Operations building located at 26 176th Street, Surrey, BC (subject building). The ceiling space forms the return air plenum of the building's heating, ventilation and air conditioning (HVAC) system. Stantec understands that as a precautionary measure, PWGSC maintenance staff currently have the HVAC system operating using 100% outdoor air for supply to the subject building (with return air being vented to the outdoors), to mitigate the potential for circulation of the ceiling space contamination throughout the building, and that this strategy will be employed until remediation can occur.

Given the altered operating conditions for the building's HVAC system, Stantec was retained to assess the indoor air quality (IAQ) within the subject building, including assessing the potential impacts that the rodent droppings within the ceiling spaces may be having on the IAQ.

As part of our assessment Stantec conducted the following in various locations throughout the subject building:








- A general IAQ assessment (measurement of typical IAQ parameters including: Respirable Particulate (PM2.5, PM10), Carbon Dioxide (CO₂), Carbon Monoxide (CO), Temperature, Relative Humidity (RH), and Total Volatile Organic Compounds (TVOCs))
- A visual investigation into the extent of rodent waste contamination
- Air sampling for rodent protein allergen

The assessment was conducted on March 24, 2016. Stantec understands that the assessment was completed during a normal (representative) work day.


A brief summary of the assessment findings follows.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

Environmental Monitoring

Parameter	Score	Range	Average	Guidelines (based on typical offices)	Comment
Airborne Particulate, dust as PM _{2.5}		<1 – 9 µg/m ³	3 µg/m ³	Long Term Exposure: < 40 µg/m ³ Short Term Exposure: < 100 µg/m ³	Concentrations of airborne particulate were within the accepted guideline.
Airborne Particulate, dust as PM ₁₀		<1 – 10 µg/m ³	4 µg/m ³	<50 µg/m ³	Concentrations of airborne particulate were within the accepted guideline.
Carbon Dioxide (CO ₂)		433 – 862 ppm	573 ppm	700 ppm above outdoor (or 1140)	Concentrations were within the accepted guideline.
Carbon Monoxide (CO)		<1 - 1 ppm	0.3 ppm	<2 ppm	No significant levels of carbon monoxide were detected.
Temperature		18.8 – 21.7 °C	20.3°C	In winter: approx. 21.3 - 25.6 °C at 20% RH In summer: 23.7-27.0 °C at 50% RH	The majority of temperatures measured during this assessment were below the recommended range for comfort.
Relative Humidity (RH)		33.4 – 41.3 %	36.1%	20-60 %	Relative humidity levels were within the comfort range.
Total Volatile Organic Compounds (TVOC)		<1 – 20 ppb	<1	<440 ppb using an PID instrument calibrated to isobutylene	No significant levels of total volatile organic compounds were detected.

Rodent Protein Allergen

Item	Score	Comment
Airborne Rodent Protein Allergen		These results do not indicate that there is airborne rodent protein allergen in the areas tested.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

Visual Assessment

A visual assessment for rodent dropping contamination was conducted in the ceiling spaces throughout the subject building. The following ceiling space locations were observed to have visible contamination:

- Main floor of the Traffic building near the bus area
- West stairwell/Export area of the Traffic building
- Superintendent's office located in the North end of the Commercial building

Trace rodent droppings were observed in various other locations assessed.

Staining, presumed to be from rodent urine, was also observed on the back (ceiling space) side of suspended ceiling tiles in various locations.

In each area where smoke tests were performed, the air flow direction was observed to be "into" the ceiling space with the exception of the following:

- Area adjacent to the bottom of Traffic building's central stairwell, where the corrugated ceiling panels had been removed

Conclusions

HVAC systems in the subject building appear to be operating as intended. Environmental monitoring of IAQ parameters (RH, CO₂, CO, airborne particulate and TVOC) within the subject building on March 24, 2016 were within the recommended indoor air quality ranges as outlined in this report.

The temperatures measured during this assessment are less than the CSA recommended range and ASHRAE's referenced guidelines in the majority of the areas. As temperature is a comfort factor related to occupant preference and the activities being conducted, action is not necessarily required. Unless complaints arise regarding building temperature as it relates to occupant comfort the building HVAC can continue to be operated as-is.

The samples collected indicate the indoor areas tested do not contain measureable rodent protein allergen counts.

Recommendations

Based on the results and conclusions outlined above, Stantec recommends the following:

- For continued operations, maintenance or any other activity that will require access to the ceiling space in the short term (before remediation work can be undertaken), the following recommendations are provided:

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

- Other personnel in the immediate vicinity of the work area (i.e., at desks or workstations beneath the access area and for an approximately 3m radius) should be vacated while the access/work takes place.
- Personnel entering the ceiling space should be notified of the presence of rodent waste contamination, and instructed to conduct access with caution.
- Personnel accessing the ceiling space should utilize respiratory protection (minimum N95 respirator), hand protection (nitrile or latex gloves) and should appropriately decontaminate subsequent to access activities (immediate hand/face/respirator wash).
- A high efficiency particulate arresting (HEPA) vacuum should be on-hand to address/clean-up any debris that results from access activities.
- The HVAC system can continue to be operated in 100% fresh mode until such time that rodent contamination in the ceiling space can be abated.
- Develop and implement a strategy to address the presence of rodents and rodent contamination. The WorkSafeBC publication "*A Hantavirus Exposure Control Program For Employers and Workers*" (2006, further referred to as the Hantavirus ECP) provides a rodent control strategy that includes the following:
 - Ongoing inspection for rodents and signs of rodent presence
 - Sanitation (i.e., reducing the number of locations, both inside the worksite and in the immediate vicinity, where rodents may feed or find shelter)
 - Rodent proofing (exclusion)
 - Rodent population reduction by trapping or poisoning
- Stantec understands that a strategy including some or all of the above measures may currently be in place. A review of the Hantavirus ECP may help identify opportunities for implementation of additional measures and/or improved implementation of measure that are currently in place.
- Once effective rodent exclusion and population control have been achieved undertake abatement of rodent contamination from affected areas. Based on the conditions observed during this assessment, this will require removal and disposal of ceiling tiles and cleaning of t-bar grid and other surfaces within the ceiling spaces throughout the following areas:
 - The main floor of the Traffic Building
 - The main floor office space of the Commercial Building
 - The west stairwell/Export area of the Traffic building
- Additional areas where the presence of rodent contamination is identified subsequent to this assessment should also be included in the abatement scope of work.
- When abatement of rodent contamination is undertaken work procedures must be employed to minimize the risk of exposure for building occupants as well as for the workers conducting the abatement. This would likely include, but not be limited to, the following:
 - Isolation of the work area by constructing an enclosure operated under continuous negative pressure
 - Providing workers with appropriate personal protective equipment (i.e., respiratory protection, coveralls, hand and eye protection)
 - Providing workers with facilities to properly wash themselves and their equipment prior to exiting the work area enclosure

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

- If significant renovations are planned for the subject building within the near future, then the rodent control strategies outlined above may be sufficient to effectively manage rodent contamination until such time that abatement can be conducted as part of those renovation activities.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

1.0 Introduction

Rodent droppings have been identified within the ceiling space throughout the Traffic and Commercial Operations building located at 26 176th Street, Surrey, BC (subject building). The ceiling space forms the return air plenum of the building's heating, ventilation and air conditioning (HVAC) system. Stantec understands that as a precautionary measure, PWGSC maintenance staff currently have the HVAC system operating using 100% outdoor air for supply to the subject building (with return air being vented to the outdoors), to mitigate the potential for circulation of the ceiling space contamination throughout the building, and that this strategy will be employed until remediation can occur.

Given the altered operating conditions for the building's HVAC system, Stantec was retained to assess the indoor air quality (IAQ) within the subject building, including assessing the potential impacts that the rodent droppings within the ceiling spaces may be having on the IAQ.

As part of our assessment Stantec conducted the following in various locations throughout the subject building:

- A general IAQ assessment (measurement of typical IAQ parameters including: Respirable Particulate (PM2.5, PM10), Carbon Dioxide (CO₂), Carbon Monoxide (CO), Temperature, Relative Humidity (RH), and Total Volatile Organic Compounds (TVOCs))
- A visual investigation into the extent of rodent waste contamination
- Air sampling for rodent protein allergen.

1.1 SCOPE OF WORK

The objective was to assess the extent of rodent dropping contamination throughout the ceiling spaces within the subject building, as well as assess the indoor environmental conditions to identify potential problems or risks that may exist with respect to IAQ due to the rodent presence or due to the operation of the HVAC system in 100% outdoor air mode.

In general terms, the study involved the following:

- A site assessment to visually assess the ceiling spaces and evaluate the potential for pathways for the rodent waste contamination to impact work areas below
- Review of the operation of the HVAC systems as it relates to the indoor environment under current operating conditions
- Assessment for unusual pollutant sources
- Evaluation of air quality through monitoring of key indicators. This assessment allows for the identification of variations in air quality with time and generally assesses whether the quality of the air being supplied by the air handling units and their associated ductwork remains within applicable limits.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

1.1.1 HVAC System Inspection

Visual inspection of ceiling spaces which serve the as return air plenum of the building's heating, ventilation and air conditioning (HVAC) system.

1.1.2 Air Sampling and Analysis

The measurements shown below were collected in representative areas in both the morning and afternoon. Airborne rodent protein allergen samples were taken in representative areas.

- Measurement of respirable suspended particulates as PM_{2.5} (particles less than 2.5 micrometers in aerodynamic diameter) and PM₁₀ (particles less than 10 micrometers in aerodynamic diameter) in the occupied areas as an indication of airborne dust concentrations. These measurements were taken using a direct reading instrument incorporating light scattering principles.
- Measurement of carbon dioxide (CO₂) levels using monitors incorporating non-dispersive infrared absorption techniques. Airborne concentrations were compared against carbon dioxide in outdoor air as an indicator of ventilation rates.
- Measurement of carbon monoxide (CO) levels using direct reading electrochemical monitors
- Measurement of temperature using a junction diode sensor
- Measurement of relative humidity (RH) using a capacitive sensor
- Measurement of Total Volatile Organic Compound concentrations using a direct reading photoionization detector (PID)
- Collection of air samples in representative areas for airborne rodent protein allergen

2.0 Air Handling Systems Assessment

2.1 GENERAL DESCRIPTION OF THE BUILDING

The subject building consists of two floors. The main floor is shared by the Traffic Area and Commercial Office area. In addition there is a second floor area above the Traffic that contains office space, training/board rooms, a lunch room as well as the Nexus and IT offices.

2.2 GENERAL DESCRIPTION OF THE AIR HANDLING SYSTEMS

The subject building is heated by radiant water baseboard heaters/ceiling mounted space heaters and cooled by rooftop air conditioning units. At the time of the assessment the HVAC system was reportedly operating in 100% outdoor air mode for supply air.

2.3 RESULTS AND CONCLUSIONS

HVAC systems in the subject building appear to be operating as intended, with the intentional operation using 100% outdoor air for supply.

3.0 Environmental Monitoring

Representative monitoring of the indoor air was performed throughout the building. The monitoring results are presented in this section, along with pertinent background information, test methods, and applicable standards and guidelines.

The scope of work and the assessment procedures are based on the guidance and recommendations provided in the documents discussed in the following:

- Health Canada, *Indoor Air Quality in Office Buildings: A Technical Guide*, 1995
- WorkSafe BC, *Indoor Air Quality: A Guide for Building Owners, Managers, and Occupants*, 2005
- CSA (Canadian Standard Association) *Guideline on Office Ergonomics* (Z412-00 (Reaffirmed 2003))
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Inc. (ASHRAE) Standard No. 55-2010, *Thermal Environmental Conditions for Human Occupancy*
- ASHRAE Standard No. 62.1-2013, *Ventilation for Acceptable Indoor Air Quality*
- AIHA Guideline 2 *Recommendations for the Management, Operating, Testing, and Maintenance of HVAC Systems: Maintaining Acceptable indoor Air Quality in Non-Industrial Employee Occupancies through Dilution Ventilation* (American Industrial Hygiene Association, 2004)
- Health Canada *Exposure Guidelines for Residential Indoor Air Quality*, a report by the Federal-Provincial Advisory Council on Environmental and Occupational Health
- LEED Canada Design and Construction 2009, LEED (Leadership in Energy & Environmental Design): *Green Building Rating System Reference Package for Design and Construction*. Canada, Canada Green Building Council, 2009

A summary of the general guidelines used to assess indoor air quality are presented in Table 3-1 below.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

Table 3-1 Summary of Guideline Criteria

Criteria Parameter	Reference Guidelines (based on typical offices)	Source
Airborne Particulate	PM ₁₀ <50 µg/m ³	Recommended by Stantec
	PM _{2.5} Acceptable Long Term Exposure Range (ALTER) : <40 µg/m ³	
	PM _{2.5} Acceptable Short Term Exposure Range (ASTER) : <100 µg/m ³	
	PM ₁₀ <50 µg/m ³	Referenced by ASHRAE 62.1-2016
	PM ₁₀ , Maximum 50 µg/m ³	Canada Green Building Council, 2009
	PM _{2.5} Acceptable Long Term Exposure Range (ALTER) : <40 µg/m ³	Health Canada
	PM _{2.5} Acceptable Short Term Exposure Range (ASTER) : <100 µg/m ³	
Carbon Dioxide (CO ₂)	<700 ppm above outdoor air (approx. 1050 ppm)	Recommended by Stantec
	< 850 ppm	Health Canada
	700 ppm above outdoor air (approx. 1050 ppm)	ASHRAE 62.1-2016
	650 ppm above outdoor air (approx. 1000 ppm)	WorkSafe BC
Carbon Monoxide (CO)	<2 ppm	Recommended by Stantec
	9 ppm (over 8 hours)	Referenced by ASHRAE 62.1-2016
	>5 ppm as an investigation threshold	Health Canada, 1995
	Maximum 9 ppm and no greater than 2 ppm above outdoor concentration	Canada Green Building Council, 2009
Temperature	In winter: approx. 21.3 - 25.6 °C at 20% RH In summer: 23.7-27.0 °C at 50% RH	Recommended by Stantec
	In winter: approx. 21.3 - 25.6 °C at 20% RH In summer: 23.7-27.0 °C at 50% RH Many factors impact these guidelines including clothing, air speed, relative humidity, radiant heat	ASHRAE 55-2010
	In summer: 23-26 °C; In winter: 20-23.5 °C	CSA
Relative Humidity	20 – 60 %	Recommended by Stantec
	30 – 60 % (30 – 50% preferred with regard to control of dust mites)	US EPA I-BEAM
	>20% or higher to avoid risk of dryness of the nose, throat and eyes, static electricity build-up on the body and potential discomfort among those wearing contact lens.	CSA

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

Table 3-1 Summary of Guideline Criteria

Criteria Parameter	Reference Guidelines (based on typical offices)	Source
Total Volatile Organic Compounds (TVOC)	Target range: <1000 µg/m ³ (<440 ppb using an PID instrument calibrated to isobutylene); Action Level: 5000 µg/m ³ (2200 ppb)	Recommended by Stantec
	Target range: <1000 µg/m ³ (<440 ppb using an PID instrument calibrated to isobutylene); Action Level: 5000 µg/m ³ (2200 ppb)	Health Canada
	Investigation threshold (above the typical indoor concentration in non-industrial employee occupancies): 500 – 3000 µg/m ³ (220 – 1350 ppb using an instrument calibrated to isobutylene).	AIHA
	Maximum 500 µg/m ³	Canada Green Building Council, 2009
Rodent Protein Allergen Mus m 1	No guidelines currently exist for this parameter.	

Air monitoring was completed at representative locations throughout the building during both the morning and afternoon. Sampling locations are indicated on floor plan drawing provided in **Appendix A**. Outdoor readings were recorded for comparison purposes.

Measurements were taken at a height of approximately one meter from floor level and results were recorded once a stable reading was obtained. Ranges of measurements were recorded where levels fluctuated during the sampling times of approximately one to three minutes at each location.

A summary of the monitoring results is shown in **Appendix B**.

3.1 AIRBORNE DUST PARTICLES

3.1.1 Background

The level of airborne particle inside a building depends on many factors. Firstly, the outside air entering into a building may contain varying amounts of particulate due to changes in weather, prevailing winds, activities from adjacent industrial operations, building sites, stack emissions, chimneys, traffic density and seasonal variations. Secondly, the condition and integrity of the HVAC system components such as the type of filtration installed and its condition, the type and condition of the humidifying system installed, the type and condition of the main and supply ducts. The amount of recirculated air within the building as well as occupant activities will also impact the amount of particulate matter in the air.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

Airborne particulates in office spaces can include dust, fumes, smoke and bioaerosols. Indoor particles can come from both indoor and outdoor sources and may result from the infiltration of outdoor air. In some cases, the HVAC system may be a source of particles. Within office environments, equipment such as photocopiers and fax machines, paper handling and poor housekeeping practices can contribute to elevated airborne particulate levels.

During renovation or construction activities, elevated airborne particulate can be generated through the disturbance of various building materials (e.g., concrete, plaster, drywall, ductwork, flooring, and insulation), dusts originating from products used in the construction and by equipment that may emit combustion products.

Once the supply air enters the receiving areas, dust levels vary with the types of activities carried out there, the number of people in each area served, and the type and condition of the final distribution equipment in the areas.

Building operations personnel are concerned with three main factors with respect to the dust content of the indoor air:

- The quantity of dust in the air and how it relates to filter efficiency
- The health implications of the dusts
- The soiling characteristics of the dusts

3.1.2 Standards & Guidelines

3.1.2.1 Airborne Particulate

General airborne particulate that would be present in a non-industrial setting is normally measured using instruments with PM_{2.5} and PM₁₀ size selective samplers. The notation PM₁₀ is used to describe particles of 10 micrometers or less and PM_{2.5} represents particles less than 2.5 micrometers in aerodynamic diameter. This PM₁₀ airborne particulate (dust) is in the size range that can be drawn directly into a person's lungs during normal breathing activity and is referred to as respirable suspended particulate.

ASHRAE 62.1-2016 references guideline levels of 50 µg/m³ for PM₁₀ particulate. Health Canada and The Federal-Provincial Advisory Committee on Environmental and Occupational Health published "Exposure Guidelines for Residential Indoor Air Quality". In the guidelines, an ALTER (acceptable long-term exposure range, based on PM_{2.5}) of < 40 µg/m³ and a one-hour ASTER (acceptable short-term exposure range, based on PM_{2.5}) of < 100 µg/m³ are specified for Canadian residences.

In our experience, a level of less than 50 µg/m³ of PM₁₀ and a level of less than 40 µg/m³ of PM_{2.5} can be achieved in a well-ventilated and properly maintained commercial office building. These levels are recommended as a realistic upper limit for occupied areas.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

3.1.3 Methodology

3.1.3.1 Airborne Particulate (PM_{2.5} & PM₁₀)

Measurement of airborne concentrations of particulate was conducted using direct reading instrumentation incorporating a detector using light scattering technology (3M EVM-7) with a size selective PM_{2.5} and PM₁₀ sampling inlet.

3.1.4 Results & Conclusions

3.1.4.1 Airborne Particulate (PM_{2.5} & PM₁₀)

A summary of the results is provided in the table below.

Parameter	Range (µg/m ³)	Average (µg/m ³)	Guidelines (based on typical offices)
Airborne Particulate (PM _{2.5})	<1 - 9	3	Long Term Exposure: <40 µg/m ³ Short Term Exposure: <100 µg/m ³
Airborne Particulate (PM ₁₀)	<1 - 10	4	<50 µg/m ³

Based on our experience, we believe that a realistic upper limit for PM_{2.5} over a long term exposure is 40 micrograms per cubic meter (µg/m³) and over a short term exposure is 100 micrograms per cubic meter (µg/m³). During this assessment the concentrations of PM_{2.5} ranged from <1 to 9 micrograms per cubic metre, well below the limit at the locations tested.

Based on our experience, we believe that a realistic upper limit for PM₁₀ airborne particulate is 50 micrograms per cubic metre (µg/m³). During this assessment the concentration of PM₁₀ ranged from <1 to 10 micrograms per cubic metre, well below the limit at the locations tested.

Concentrations of airborne particulate were within the accepted guidelines.

3.2 CARBON DIOXIDE

3.2.1 Background

Carbon dioxide (CO₂) is a gas that exists in the outdoor environment. It is a product of combustion, being produced from gasoline and diesel powered engines, combustion of natural gas for home heating and from a variety of other industrial sources. It is also produced through normal human respiration, making it important to the study of the indoor environment. It is typically present in the outdoors at concentrations ranging from about 350 ppm to 450 ppm.

Carbon dioxide concentrations in the indoors are directly related to the volume of outside air provided to a space as well as occupancy levels. The value of measuring these levels over a representative time-period as a surrogate indicator of the effectiveness of overall ventilation is therefore recognized. In general, a high carbon dioxide concentration may indicate

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

inadequate ventilation for the occupancy level. This may result in an increase in other indoor pollutants or general conditions that give rise to other health effects or discomfort.

3.2.2 Standards & Guidelines

Health Canada and The Federal-Provincial Advisory Committee on Environmental and Occupational Health published *Exposure Guidelines for Residential Indoor Air Quality*. In the guidelines, an ALTER (acceptable long-term exposure range) of < 3500 ppm has been established for residential indoor air.

In evaluating the adequacy of outdoor air ventilation in an office setting, carbon dioxide concentrations in occupied area are typically measured as a surrogate measurement, reflecting the rate of outdoor airflow to the space relative to the occupancy level.

ASHRAE Standard 62.1-2016 indicates that for sedentary persons, maintaining about 15 cfm/person (7.5 l/s) of outdoor air will dilute odours from human bioeffluents to levels that will satisfy a substantial majority (about 80%) of unadapted visitors to a space. This translates to a steady-state concentration of CO₂ of 700 ppm above outdoor air levels. So with outdoor air at 350 ppm, this translates to 1050 ppm indoors.

As specified in section 4.79 of British Columbia's *Occupational Health and Safety Regulation*, an investigation should include assessment of the ventilation rate, unless the indoor carbon dioxide levels are less than 650 ppm above the ambient outdoor levels. So with outdoor air at 350 ppm, this translates to 1000 ppm indoors.

3.2.3 Methodology

To assess the effectiveness of the building ventilation system, measurement of the concentration of carbon dioxide in representative areas was collected using a direct reading instrument incorporating a non-dispersive infrared detector (3M EVM-7).

3.2.4 Results & Conclusions

3.2.4.1 Spot Measurements

A summary of the results is provided in the table below.

Parameter	Range (ppm)	Average (ppm)	Guidelines (based on typical offices)
Carbon dioxide	433 - 862	573	Maximum of 700 ppm above outdoor (or 1100 ppm)

Carbon dioxide levels were below the comfort criteria of 700 ppm above ambient (400 ppm) referenced in ASHRAE 62.1-2016.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

3.3 CARBON MONOXIDE

3.3.1 Background

Carbon monoxide (CO) is a colourless, odourless, toxic gas that is a product of incomplete combustion. CO pollution occurs where combustion gases are not properly exhausted or are being re-entrained into the building. CO should be measured if there are complaints of exhaust odours or if there is some other reason to suspect a problem with internal combustion gases.

In office and commercial buildings, important sources of combustion products include tobacco smoke, garages, and loading docks that are attached or have a pathway to working spaces. Air intakes located at ground level or adjacent to vehicles or other combustion sources can transport contaminants to areas served by the air handling system. An airborne concentration of up to 1 ppm is considered typical for non-industrial employee occupancies. Higher concentrations would indicate the need to investigate further and identify possible sources.

3.3.2 Standards & Guidelines

The Federal-Provincial Advisory Committee on Environmental and Occupational Health “Exposure Guidelines for Residential Indoor Air Quality” specifies a 24 hour average exposure limit of 10 ppm and a one-hour exposure limit of 25 ppm. The regulated Time Weighted Average (TWA) workplace exposure limit in BC is 25 ppm (averaged over an 8-hour work day). ASHRAE 62.1-2016 references a guideline of 9 ppm over an eight hour period. The Canada Green Building Council indicates a limit of < 2 ppm. This is the recommended limit suggested by Stantec. Any concentrations above outdoor reference levels should be investigated to determine the source.

3.3.3 Methodology

To confirm that indoor concentrations of carbon monoxide are present at levels at or below outdoor concentrations, measurement was conducted using a direct reading monitor with an electro-chemical detector (3M EVM-7).

3.3.4 Results & Conclusions

A summary of the results is provided in the table below.

Parameter	Range (ppm)	Average (ppm)	Guidelines (based on typical offices)
Carbon monoxide	<1 - 1	0.3	<2 ppm

No significant sources of carbon monoxide were detected in the building over the test period.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

3.4 TEMPERATURE

3.4.1 Background

One of the major purposes of heating, ventilation and air conditioning (HVAC) systems is to supply air to the occupied areas of a building in what is generally accepted as the most comfortable range of temperature for the majority of the building users (at least 80%).

3.4.2 Standards & Guidelines

This "acceptable" range will vary depending on the use and location of the specific building, but for most practical purposes the ranges recommended by ASHRAE for office and similar buildings should be suitable.

Thermal comfort in a building is influenced by many factors including radiant impacts from surface and windows, air speed, clothing levels, occupant activities, and relative humidity.

ASHRAE Standard 55-2010 recommends approximate ranges of 21.3 - 25.6 °C at 20% RH for winter (heavier clothing), and 23.7-27.0 °C at 50% RH in the summer (lighter clothing).

3.4.3 Methodology

To compare temperatures in representative areas of the building to accepted comfort ranges, measurements were collected using a direct reading monitor with a junction diode sensor (3M EVM-7).

3.4.4 Results & Conclusions

A summary of the results is provided in the table below.

Parameter	Range (°C)	Average (°C)	Guidelines (based on typical offices)
Temperature	18.8 – 21.7	20.3	In winter: approx. 21.3 - 25.6 °C at 20% RH In summer: 23.7-27.0 °C at 50% RH

The temperatures measured during this assessment are less than the CSA recommended range and ASHRAE's referenced guidelines in the majority of the areas. As temperature is a comfort factor related to occupant preference and the activities being conducted action is not necessarily required. Unless complaints arise regarding building temperature as it relates to occupant comfort the building HVAC can continue to be operated as is.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

3.5 RELATIVE HUMIDITY

3.5.1 Background

When relative humidity is below 20%, the mucus membranes of the nasal passages, throat, and eyes of people begin to dry out, possibly rendering them more susceptible to microbial infections. These low levels often cause contact lens wearers particular discomfort. With the drier conditions produced by low relative humidity, static electricity builds up and causes discomfort. Airborne dust and spore levels will also increase and aggravate these conditions.

At the other end of the scale, at relative humidity levels of 70% and above, the amount of moisture in the air may lead to condensation on cooler surfaces. This may result in a film of moisture being present which will allow microbes such as bacteria and fungi to multiply and add their spores, vegetative cells and by-products into the air to be inhaled by building occupants.

3.5.2 Standards & Guidelines

CSA suggests a minimum of 20% RH be maintained. The US EPA I-BEAM suggests a range of 30-60 % (30 – 50% preferred with regard to control of dust mites). From a practical standpoint Stantec suggests arrange of >20 – 60%.

3.5.3 Methodology

To compare relative humidity levels in representative areas of the building to acceptable ranges, measurements were collected using a direct reading monitor with a capacitive sensor (3M EVM-7).

3.5.4 Results & Conclusions

A summary of the results is provided in the table below.

Parameter	Range (%)	Average (%)	Guidelines (based on typical offices)
Relative humidity	33.4 – 41.3	36.1	20-60%

The relative humidity levels recorded were within the recommended comfort range for this season.

3.6 TOTAL VOLATILE ORGANIC COMPOUNDS

3.6.1 Background

An organic chemical is one that contains the element, carbon (C) which is vital to all living forms on the earth. There are many common classes of these compounds identified in indoor air. Volatile Organic Compounds are typically released from the following sources; solvents in paints,

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

coatings, paint removers, paint thinners, adhesives, caulking, carpets, photocopiers, acoustic ceiling tiles, air fresheners, cleaning agents, organic solvents, fabric softeners, and tobacco smoke.

3.6.2 Standards & Guidelines

TVOCs include a wide range of compounds which vary in the odour characteristics and in their potential to cause health effects, and the concentration of TVOCs measured depends on the type of measurement methodology utilized. However, Health Canada suggests an indoor air quality target concentration of $<1000 \mu\text{g}/\text{m}^3$ for TVOCs in office buildings ($<440 \text{ ppb}$) and an action level of $5,000 \mu\text{g}/\text{m}^3$ ($<2200 \text{ ppb}$). An AIHA guideline suggests that $500 \mu\text{g}/\text{m}^3$ to $3,000 \mu\text{g}/\text{m}^3$ be used as a trigger concentration meaning further investigation may be appropriate. In general, investigation of the source of measured TVOC concentrations above $500 \mu\text{g}/\text{m}^3$ (220 ppb) is recommended.

3.6.3 Methodology

Airborne TVOCs were measured using a 3M EVM-7 instrument, which is equipped with a sensitive ppb-range photo-ionization detector (PID) (calibrated to isobutylene).

3.6.4 Results & Conclusions

A summary of the results is provided in the table below.

Parameter	Range (ppb)	Average (ppb)	Guidelines (based on typical offices)
Total volatile organic compounds	$<1 - 20$	<1	Target range: $<1000 \mu\text{g}/\text{m}^3$ ($<440 \text{ ppb}$ using an instrument calibrated to isobutylene); Action Level: $5000 \mu\text{g}/\text{m}^3$ (2200 ppb)

No significant sources of total volatile organic compounds were detected in the building over the test period.

3.7 RODENT PROTEIN ALLERGEN

3.7.1 Background

Inhalation of mouse urinary proteins has been linked to allergenic symptoms and asthma. The specific protein Mus m 1 has been linked to the allergenic properties of mouse urine. As such, the airborne presence of this protein could provide an indicator of the risk of symptoms related to the presence of rodents in a building.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

3.7.2 Standards & Guidelines

At present, there are no specific laws or regulations governing acceptable levels of rodent protein allergen in buildings. With a lack of defined exposure criteria exposure control measures should be based on prudent avoidance (i.e., seal off potential points of entry into the building, set rodent traps, clean up any rodent droppings found).

3.7.3 Methodology

For this investigation, individual air samples for analysis of rodent protein allergen were collected over a two hour period, using an air sampling pump (calibrated to operate at 15 litres per minute) with a PVC air sampling cassette. The results are airborne rodent protein allergen counts expressed in nanograms per cubic metre (ng/m³). The samples were submitted to Sporometrics Inc. for analysis.

3.7.4 Results & Conclusions

Sampling locations are indicated on floor plan drawing provided in **Appendix A**. Laboratory Certificates of Analysis for the samples are provided in **Appendix C**. Results are summarized in the following table.

Sample No.	Location	Rodent protein allergen found per cubic metre of air (ng/m ³)		
		Volume (L)	LOD (ng/m ³)	Total Count (ng/m ³)
RD-01	Bus area	1,710.00	0.01	<LOD
RD-02	Lunch Room – Traffic building	1,788.00	0.01	<LOD
RD-03	Office – North side of Nexus building	1,831.25	0.01	<LOD
RD-04	Superintendent Office – South end of Commercial building	1,815.00	0.01	<LOD
Blank	Blank	N/A	0.01	<LOD

Key:

LOD = limit of detection

These samples show the indoor areas tested do not contain significant rodent protein allergen counts. The results do not suggest that there is an airborne contamination from rodent presence within the subject building.

4.0 Visual Assessment for Rodent Droppings

4.1.1 Background

The presence of rodent droppings can lead to airborne microbial contaminants that may present exposure hazards to building occupants. Rodent droppings are a potential growth source for organisms that may present risk to human health by inhalation. The exposure risk can be limited if the contamination is undisturbed and if proper procedures are followed when accessing contaminated areas.

Hantavirus, a rodent transmitted infection most commonly associated with deer mice, can also cause illness in humans. In rare cases individuals exposed to airborne dust from infected rodents can develop severe flu-like and pneumonia-like symptoms.

4.1.2 Standards & Guidelines

The Hantavirus ECP provides more information about Hantavirus and can also be used as a guidance document for controlling rodent infestations in general.

4.1.3 Methodology

The ceiling space was visually inspected in various locations throughout the subject building where access was available and as directed by PWGSC and CBSA staff. The presence of rodent droppings and/or suspected urine staining on suspended ceiling tiles was noted in each location.

Multiple smoke tests were performed around openings to the ceiling space throughout the subject building to assess whether the general air flow direction was “into” the ceiling space from the occupied area. Smoke test locations are indicated on floor plan drawing provided in **Appendix A**.

4.1.4 Results & Conclusions

The following locations were observed to have visible contamination:

- Main floor of the Traffic building near the bus area
- West stairwell/Export area of the Traffic building
- Superintendent’s office located in the North end of the Commercial building

Trace rodent droppings were observed in the various other locations assessed.

Staining, presumed to be from rodent urine, was also observed on the back side of suspended ceiling tiles in various locations.

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

In each area where smoke tests were performed the air flow direction was observed to be “into” the ceiling space with the exception of the following:

- Area adjacent to the bottom of Traffic buildings central stairwell where the corrugated ceiling panels had been removed

5.0 Recommendations

Based on the results and conclusions outlined above, Stantec recommends the following:

- For continued operations, maintenance or any other activity that will require access to the ceiling space in the short term (before remediation work can be undertaken), the following recommendations are provided:
 - Other personnel in the immediate vicinity of the work area (i.e., at desks or workstations beneath the access area and for an approximately 3m radius) should be vacated while the access/work takes place.
 - Personnel entering the ceiling space should be notified of the presence of rodent waste contamination, and instructed to conduct access with caution.
 - Personnel accessing the ceiling space should utilize respiratory protection (minimum N95 respirator), hand protection (nitrile or latex gloves) and should appropriately decontaminate subsequent to access activities (immediate hand/face/respirator wash).
 - A high efficiency particulate arresting (HEPA) vacuum should be on-hand to address/clean-up any debris that results from access activities.
- The HVAC system can continue to be operated in 100% fresh mode until such time that rodent contamination in the ceiling space can be abated.
- Develop and implement a strategy to address the presence of rodents and rodent contamination. The WorkSafeBC publication “*A Hantavirus Exposure Control Program For Employers and Workers*” (2006, further referred to as the Hantavirus ECP) provides a rodent control strategy that includes the following:
 - Ongoing inspection for rodents and signs of rodent presence
 - Sanitation (i.e., reducing the number of locations, both inside the worksite and in the immediate vicinity, where rodents may feed or find shelter)
 - Rodent proofing (exclusion)
 - Rodent population reduction by trapping or poisoning
- Stantec understands that a strategy including some or all of the above measures may currently be in place. A review of the Hantavirus ECP may help identify opportunities for implementation of additional measures and/or improved implementation of measure that are currently in place.
- Once effective rodent exclusion and population control have been achieved undertake abatement of rodent contamination from affected areas. Based on the conditions observed during this assessment, this will require removal and disposal of ceiling tiles and cleaning of t-bar grid and other surfaces within the ceiling spaces throughout the following areas:

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

- The main floor of the Traffic Building
- The main floor office space of the Commercial Building
- The west stairwell/Export area of the Traffic building
- Additional areas where the presence of rodent contamination is identified subsequent to this assessment should also be included in the abatement scope of work.
- When abatement of rodent contamination is undertaken work procedures must be employed to minimize the risk of exposure for building occupants as well as for the workers conducting the abatement. This would likely include, but not be limited to, the following:
 - Isolation of the work area by constructing an enclosure operated under continuous negative pressure
 - Providing workers with appropriate personal protective equipment (i.e., respiratory protection, coveralls, hand and eye protection)
 - Providing workers with facilities to properly wash themselves and their equipment prior to exiting the work area enclosure
- If significant renovations are planned for the subject building within the near future, then the rodent control strategies outlined above may be sufficient to effectively manage rodent contamination until such time that abatement can be conducted as part of those renovation activities.

6.0 Closure

This report reflects the air monitoring data collected within the subject building on the date(s), at the time(s) and in the areas cited in this report. Monitoring results reflect the conditions within the area(s) sampled on the date(s) and at the time(s) the monitoring was conducted and may not be representative of building conditions under all operational conditions or under all seasonal weather conditions.

In the preparation of this report, Stantec provides the benefit of its professional judgment based on experience and in accordance with generally accepted professional standards. Stantec relied on information gathered during the site investigation and data collected using instrumentation described herein. This report has been prepared for the exclusive use of PWGSC/CBSA for the purpose of assessing general conditions in the subject building. The report may not be relied upon by any other person or entity without the express written consent of Stantec and PWGSC/CBSA. Any use that a third party makes this report, or reliance on, or decisions to be made on it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The conclusions presented in this report represent the best judgment of the assessor based on current environmental and health and safety standards, the site conditions on the day of testing and sample results that can only be extrapolated to undefined, limited areas surrounding individual sampling locations. It should not be inferred that other potential contaminants are not

INDOOR AIR QUALITY AND RODENT DROPPINGS ASSESSMENT

present. Due to the nature of the investigation and the limited data available, the assessor cannot warrant against undiscovered environmental liabilities.

Should additional information become available, Stantec requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

We trust that this information is sufficient for your requirements at the present time. Should you or your colleagues have any questions or require any additional information, please do not hesitate to contact us at your convenience.

Regards,

STANTEC CONSULTING LTD.



Amanda Bell, B.Sc., EPT
Environmental Technologist
Phone: (604) 412-3006
Fax: (604) 436-3752
Amanda.Bell@stantec.com



Rob Robinson, P.Eng.
Principal
Phone: (905) 817-2070
Fax: (905) 858-4226
Rob.Robinson@stantec.com

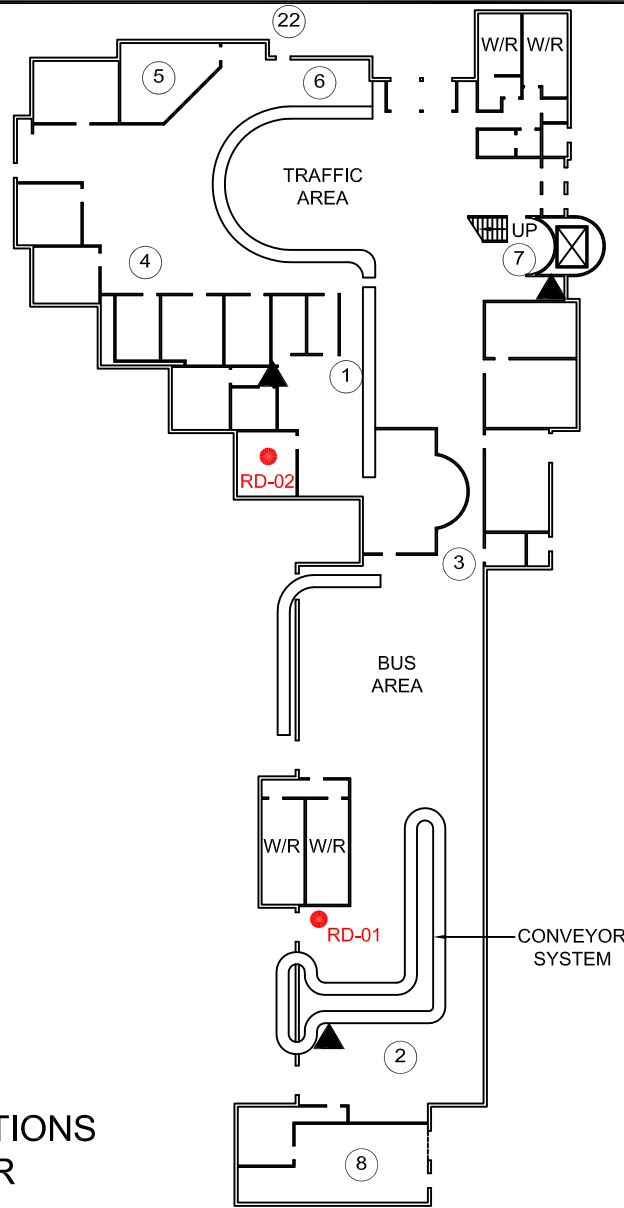


Sean Brigden, B.Sc., P.B.Dipl., CRSP
Associate
Phone: (250) 389-2346
Fax: (250) 382-0514
Sean.Brigden@stantec.com

AB/SB/RR/tt

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Appendix A
Floor Plan Drawing with Sampling Locations



**TRAFFIC OPERATIONS
FIRST FLOOR**

LEGEND

- AIR SAMPLE LOCATIONS
- Ⓝ ENVIRONMENTAL MONITORING LOCATIONS
- ▲ SMOKE TEST

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

**FLOOR PLAN SHOWING ENVIRONMENTAL MONITORING
AND AIR SAMPLE LOCATIONS**

PACIFIC HIGHWAY BORDER CROSSING
28 - 176 STREET, SURREY, BC

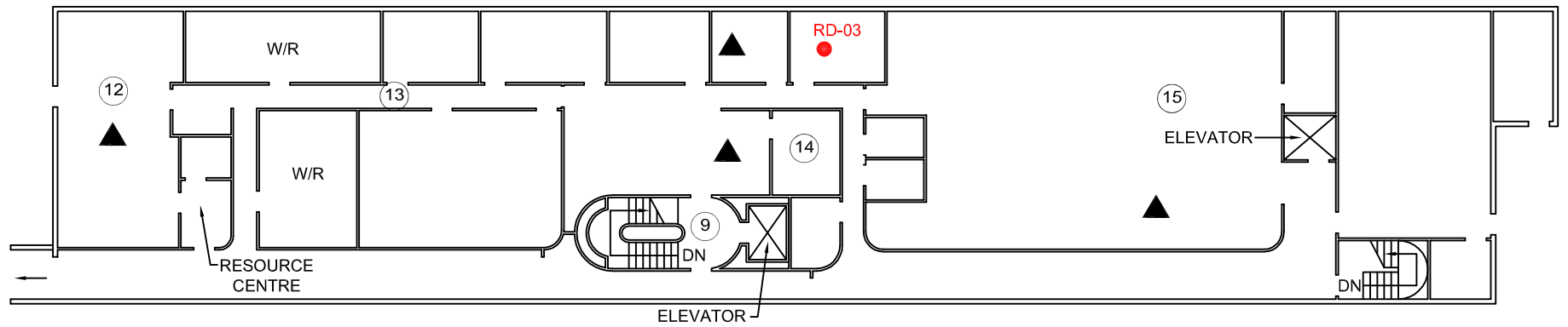
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Project No.: 123220547
Scale: N.T.S.
Date: 16/04/02
Dwn. By: CD _{DM} SL2016040005
App'd By: TW

Dwg. No.:

B1





TRAFFIC AND COMMERCIAL OPERATIONS SECOND FLOOR

LEGEND

- AIR SAMPLE LOCATIONS
- # ENVIRONMENTAL MONITORING LOCATIONS
- ▲ SMOKE TEST

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

FLOOR PLAN SHOWING ENVIRONMENTAL MONITORING AND AIR SAMPLE LOCATIONS

PACIFIC HIGHWAY BORDER CROSSING
28 - 176 STREET, SURREY, BC

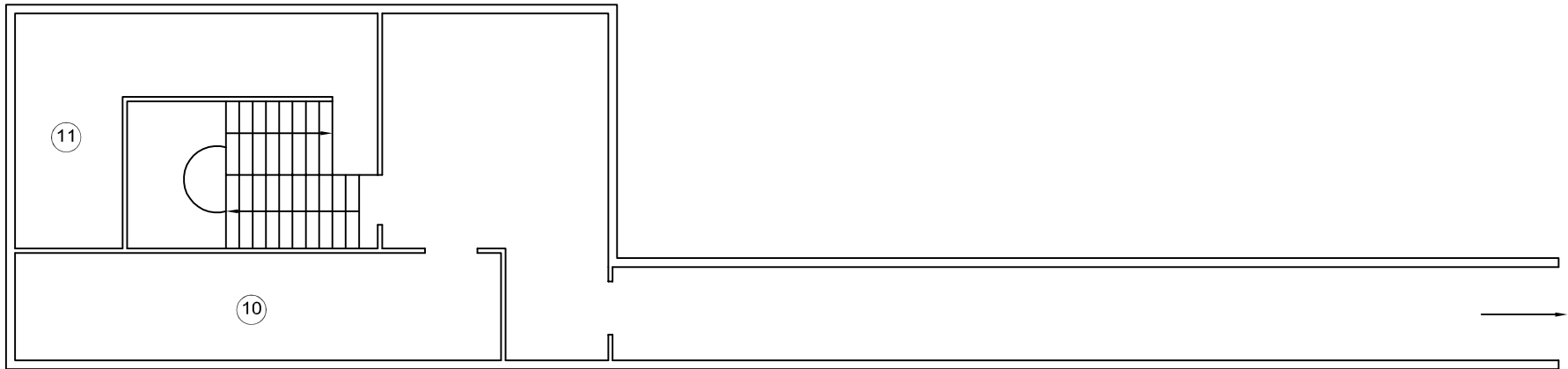
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Project No.: 123220547
Scale: N.T.S.
Date: 16/04/02
Dwn. By: CD <small>SL2016040006</small>
App'd By: TW

Dwg. No.:

B2





**IT AND EXPORT AREA STAIRWELL
SECOND FLOOR**

LEGEND

ENVIRONMENTAL MONITORING LOCATIONS

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

**FLOOR PLAN SHOWING ENVIRONMENTAL MONITORING
AND AIR SAMPLE LOCATIONS**

PACIFIC HIGHWAY BORDER CROSSING
28 - 176 STREET, SURREY, BC

Client: PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

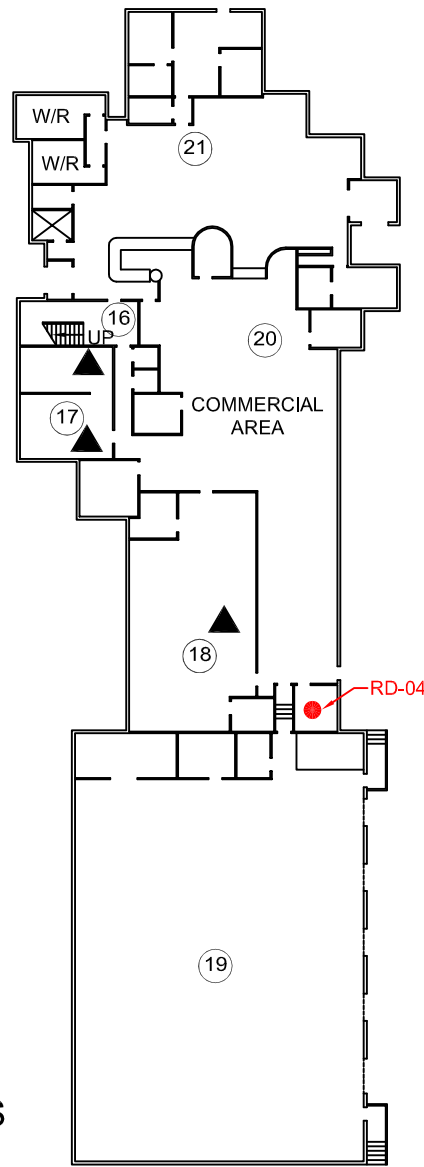
Project No.: 123220547
Scale: N.T.S.
Date: 16/04/02
Dwn. By: CD <small>DM</small> SL2016040007
App'd By: TW

Dwg. No.:

B3



COMMERCIAL OPERATIONS FIRST FLOOR



LEGEND

- AIR SAMPLE LOCATIONS
- # ENVIRONMENTAL MONITORING LOCATIONS
- ▲ SMOKE TEST

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

FLOOR PLAN SHOWING ENVIRONMENTAL MONITORING AND AIR SAMPLE LOCATIONS

PACIFIC HIGHWAY BORDER CROSSING
28 - 176 STREET, SURREY, BC

Client: PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Project No.: 123220547
Scale: N.T.S.
Date: 16/04/02
Dwn. By: CD <small>DM</small> <small>SL2016040008</small>
App'd By: TW

Dwg. No.:

B4



Appendix B
Environmental Monitoring – Summary of Results

INDOOR AIR QUALITY ASSESSMENT

Appendix B: Environmental Monitoring – Summary of Results – Spot Measurements
26 176th Street, Surrey, BC V3Z 9R9
March 24, 2016

Sample Location	Time	Temp. (°C)	RH (%)	CO ₂ (ppm)	CO (ppm)	Airborne PM2.5 Particulate (µg/m ³)	Airborne PM10 Particulate (µg/m ³)	TVOCs (ppb)
1. Traffic Office Area – Outside Lunch Room	10:15 am	20.7	34.3	458	1	1	1	0
	1:16 pm	20.0	36.0	533	0	5	9	0
2. Traffic Bus Area – Beside Baggage Conveyer Belt	10:22 am	19.9	35.4	501	1	1	<1	0
	1:20 pm	18.8	39.5	528	0	3	8	0
3. Traffic Customs – Outside First Aid Room	10:28 am	19.5	36.4	437	1	1	3	0
	1:22 pm	18.8	39.2	538	0	5	5	0
4. Traffic Office – Outside Cells	10:30 am	20.0	35.7	435	1	2	9	0
	1:24 pm	19.5	37.4	584	0	3	9	0
5. Traffic Operations Room	10:32 am	20.2	35.8	472	0	1	<1	0
	1:25 pm	19.8	37.0	630	0	7	7	0
6. Traffic Office Area – North End of Building	10:33 am	20.3	35.3	505	0	9	1	0
	1:26 pm	20.0	36.7	598	1	3	5	0
7. Bottom of Traffic Building Main Stairs	10:35 am	20.5	34.5	459	1	<1	6	0
	1:27 pm	20.2	36.0	566	0	7	4	0
8. Public Works Workshop – Traffic Building Near Buses	10:40 am	19.3	38.3	433	1	2	3	0
	1:19 pm	18.8	41.3	600	0	4	6	0
9. Top of Traffic Building Main Stairs	10:44 am	19.9	36.5	530	0	7	3	0
	1:29 pm	20.3	35.6	724	0	3	4	0
10. IT Office	10:47 am	18.8	39.9	733	0	<1	1	0
	1:31 pm	19.7	37.6	529	0	1	2	0
11. Bottom of West Stairwell – Export Area	10:50 am	19.0	38.1	609	1	<1	3	0
	1:33 pm	19.7	37.4	598	1	3	5	0



INDOOR AIR QUALITY ASSESSMENT

Sample Location	Time	Temp. (°C)	RH (%)	CO ₂ (ppm)	CO (ppm)	Airborne PM2.5 Particulate (µg/m ³)	Airborne PM10 Particulate (µg/m ³)	TVOCs (ppb)
12. Second Floor Lunch Room	10:54 am	19.8	37.3	546	0	1	3	0
	1:36 pm	20.3	36.3	556	0	4	2	0
13. Second Floor Hallway – Between Lunch Room and Reception	10:55 am	20.5	37.5	796	0	1	2	0
	1:38 pm	20.6	35.5	598	0	2	9	0
14. Nexus Office – North End of Building	10:58 am	20.8	34.9	605	0	<1	3	0
	1:39 pm	20.9	35.7	862	0	5	10	0
15. Nexus Cubical Space	11:00 am	21.0	35.2	583	0	2	2	0
	1:40 pm	21.0	34.5	720	0	2	4	0
16. Bottom of Commercial Stairwell	11:01 am	21.4	34.1	602	0	1	2	0
	1:42 pm	21.5	35.3	586	0	2	5	0
17. Commercial File Room	11:02 am	21.5	33.8	526	0	3	4	0
	1:43 pm	21.4	34.5	616	0	3	5	0
18. Commercial Offices – Outside of Chief’s Office	11:04 am	21.3	34.3	688	0	2	2	0
	1:44 pm	21.0	33.6	538	0	2	2	0
19. Old Commercial Warehouse	11:06 am	20.8	36.4	536	0	1	2	0
	1:45 pm	20.8	36.3	464	0	1	2	0
20. Commercial Offices North – Outside of Superintendent’s Office	11:08 am	21.0	35.1	594	0	1	3	0
	1:47 pm	20.9	34.2	582	0	3	2	0
21. Commercial Lobby	11:10 am	21.7	33.6	552	1	1	4	0
	1:49 pm	21.5	33.4	525	1	2	1	20
22. Outside – Secondary Inspection	11:13 am	13.6	51.0	428	0	5	18	0
	1:51 pm	14.3	47.1	521	1	3	9	30



Appendix C
Rodent Protein Allergen Certificate of Analysis

**RESULTS OF LABORATORY ANALYSES:****JOB NO. 26304.00**

To:	Keith Irwin, Tiffany Waite	Date of report:	2016/04/07
Company:	Stantec Consulting Ltd. – Burnaby	Date of sampling:	2016/03/24
Client Project:	123220547	Analyst:	Subcontracted
Client Address:	500 – 4730 Kingsway, Burnaby, BC V5H 0C6	Date Received:	2016/03/30

ALLERGEN ^a SAMPLE NO.:	RD-01	RD-02	RD-03	RD-04	Blank	-
Location:	Traffic Building: bus unloading area	Traffic Building: lunch room	Nexus: N. office	Commercial Building: S. Superintendents Office	Blank	
Volume (L):	1,710	1,788	1,831.25	1,815	N/A	
LOD^b (ng / m³):	0.01	0.01	0.01	0.01	0.01	
TOTAL (ng / m³):	<LOD	<LOD	<LOD	<LOD	<LOD	

^a Allergen analysis is a subcontracted service. Sporometrics transforms raw data and adjusts for air volume.

^b LOD = Limit of detection; Allergen units per m³ based on 0.01 ng/mL LOD for the Mouse Urinary Protein (MUP) allergen, Mus m 1

END OF REPORT

Examined by:

Released by:

Stephanie Filep, BS
Subcontracted Analyst

Yordanka G Guardiola, MSc
Analyst