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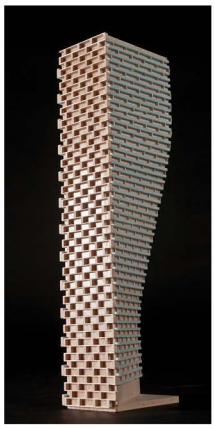
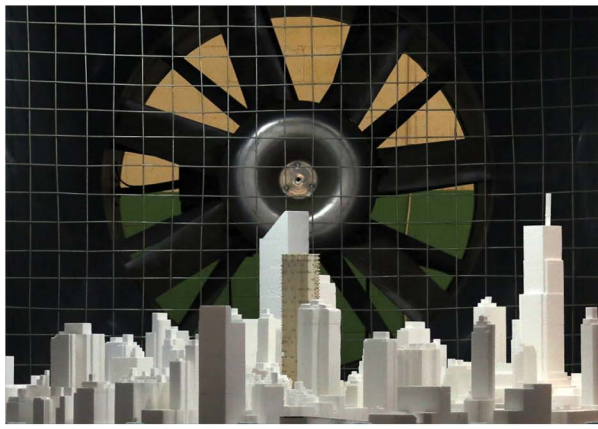
STATIONARY NOISE FEASIBILITY ASSESSMENT

180 Metcalfe Street
Ottawa, Ontario

REPORT: GWE18-115-Stationary Noise R1





March 18, 2019

PREPARED FOR

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EXECUTIVE SUMMARY

This report describes a stationary noise feasibility assessment performed for a proposed mixed-use development located at 180 Metcalfe Street in Ottawa, Ontario. The proposed development is a 27-storey mixed-use, residential and commercial building that will be integrated into an existing six-storey heritage building, a smaller part of which would be demolished. The development is located at the north corner of a city block bounded by Nepean Street to the north, Metcalfe Street to the east, Lisgar Street to the south, and O'Connor Street to the west. Outdoor amenity space is assumed to be provided on the 27th floor roof on either side of the mechanical penthouse. Surrounding the site is a mix of low and high rise, residential and commercial buildings, with plans for new tall buildings to the north and west. This study examines the noise impact of the proposed mechanical equipment of the development onto the surrounding area. Sources of stationary noise include rooftop air handling equipment, fluid cooler, and emergency generator. Figure 1 illustrates a site plan with surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) future residential and commercial developments in the surrounding area, and; (iv) architectural and mechanical drawings prepared by RLA Architect and Jain Sustainability Consultants Inc respectively.

The results of the current assessment for the proposed development indicates that, provided our assumptions for noise control in Section 2.1 are adhered to in the detailed design process, noise levels at nearby points of reception are expected to fall below the ENCG noise criteria at all receptors. As such, the proposed development is expected to be compatible with the existing on and off-site noise sensitive land uses. A review of final equipment selection and locations by a qualified acoustical engineer will be required prior to installation of the equipment.

To ensure compliance with the ENCG the following noise control measures are recommended:

- The intake side of the fluid cooler will be fitted with an acoustic louver off the end of the unit. The acoustic louver will have a minimum insertion loss as indicated in Table 3.

- The sound power level for the radiated noise from the make-up air handling unit should not exceed the values listed in Table 2 given the proposed current location.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Jadco Group Construction. to undertake a stationary noise feasibility assessment for the proposed development at 180 Metcalfe Street in Ottawa, Ontario. This report summarizes the methodology, results and recommendations related to a stationary noise feasibility assessment.

The present scope of work involves assessing exterior noise levels generated by rooftop air handling equipment, cooling tower, and emergency generator. The assessment was performed based on theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment, Conservation and Parks (MECP) NPC-300[2] guidelines; architectural drawings prepared by RLA Architects and mechanical information provided by Jain Sustainability Consultants Inc.; surrounding street layouts obtained from the City of Ottawa; and recent site imagery.

2. TERMS OF REFERENCE

The focus of this stationary noise assessment is a proposed mixed-use development at 180 Metcalfe Street in Ottawa, Ontario. The development is located at the north corner of a city block bounded by Nepean Street to the north, Metcalfe Street to the east, Lisgar Street to the south, and O'Connor Street to the west. There are two developments currently under construction: one directly to the west of the site (27-storey development at 96 Nepean Street) and another directly to the north of the site (two 27-storey towers with one tower located at 91 Nepean Street and the other located at 70 Gloucester Street, which are currently under construction). The remaining immediate surroundings comprise a mix of low-, medium-, and high-rise buildings, as well as surface-level parking.

The proposed development is a 27-storey mixed-use, residential and commercial building that will be integrated into an existing six-storey heritage building, a smaller part of which would be demolished. The building will contain six levels of below-grade parking with the entrance located at the northwest corner of the development. The first floor will comprise retail, utilities, amenities, and lobby space. The main building entrance is located on the east side. The second-floor plan steps back within the building on the

[1] City of Ottawa Environmental Noise Control Guidelines, January 2016
[2] Ministry of the Environment, Environmental Noise Guideline – Publication NPC-300, August 2013

east side, creating a space open to the floor below. The remainder of the floor area contains residential units. The third-floor plan steps back out on the east side within the structure, allowing for the entire floor plan to contain residential units. The floorplan remains constant up to the sixth floor. The seventh floor will include residential units and an amenity space located in the northeast corner. The floorplan remains constant from floors 8 to 27 and consist of residential units, with a mechanical penthouse on the roof. There is potential for a terrace on the roof of the 6th floor as well as two roof top amenity spaces on either side of the mechanical penthouse on the roof of Level 27. Although private balconies are located over the various floors, they are not considered to be outdoor points of reception (OPOR) as they are less than 4-metres in depth. The major source of traffic noise is due to Metcalfe Street to the east. The major sources of stationary noise are the rooftop mechanical equipment within the mechanical penthouse, including an air handling unit, a fluid cooler, and emergency generator. Figure 1 illustrates a complete site plan with surrounding context

2.1 Assumptions

Gradient Wind has been provided sound data of the roof top mechanical equipment by Jain Sustainability Consultants Inc.. The following assumptions have been made in the analysis:

(i) Sound data for rooftop units are based on manufacturer's data.
(ii) The rooftop mechanical units are assumed to operate continuously over a 1-hour period during the daytime and at 50% operation during the nighttime period.
(iii) The generator will only be tested during the daytime hours (07:00 to 19:00).
(iv) The intake of the fluid cooler is equipped with an acoustic louver as outlined in Section 4.3.

The equipment assumed in the model consisted of:

(i) MAU: Make-Up Air Unit (Engineered Air Model)
(ii) FC: Fluid Cooler Unit (Evapco Model eco-LSWE 10-4M18)
(iii) Gen: Emergency Generator (Genrac Model SD350)

Figure 3 illustrated the location of all the stationary sources within the development.

3. OBJECTIVES

The main goals of this work are to (i) calculate the future noise levels on the surrounding noise sensitive properties, dwellings and outdoor points of reception produced by stationary sources and (ii) ensure that exterior noise levels do not exceed the allowable limits specified by the ENCG, as outlined in Section 4 of this report.

4. METHODOLOGY

The impact of the external stationary noise sources on the nearby residential areas was determined by computer modelling. Stationary noise source modelling is based on the software program *Predictor-Lima* developed from the International Standards Organization (ISO) standard 9613 Parts 1 and 2. This computer program simulates three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. This methodology has been used on numerous assignments and has been accepted by the MECP as part of Environmental Compliance Approvals applications. Five receptor locations were selected for the study site, as illustrated in Figure 2.

4.1 Perception of Noise

Noise can be defined as any obtrusive sound. It is created at a source, transmitted through a medium, such as air, and intercepted by a receiver. Noise may be characterized in terms of the power of the source or the sound pressure at a specific distance. While the power of a source is characteristic of that source, the sound pressure depends on the location of the receiver and the path that the noise takes to reach the receiver. Its measurement is based on the decibel unit, dBA, which is a logarithmic ratio referenced to a standard noise level (2×10-5 Pascals). The 'A' suffix refers to a weighting scale, which represents the noise perceived by the human ear. With this scale, a doubling of sound power at the source results in a 3 dBA increase in measured noise levels at the receiver and is just perceptible to most people. An increase of 10 dBA is often perceived to be twice as loud.

Stationary sources are defined in NPC-300 as "a source of sound or combination of sources of sound that are included and normally operated within the property lines of a facility and includes the premises of a person as one stationary source, unless the dominant source of sound on those premises is construction"[3].

[3] NPC – 300, page 16

4.2 Stationary Noise Criteria

The equivalent sound energy level, L_{eq}, provides a weighted measure of the time varying noise levels, which is well correlated with the annoyance of sound. It is defined as the continuous sound level, which has the same energy as a time varying noise level over a selected period of time. For stationary sources, the L_{eq} is commonly calculated on an hourly interval, while for roadways, the L_{eq} is calculated on the basis of a 16-hour daytime/8-hour nighttime split.

Noise criteria taken from the ENCG and NPC-300 apply to outdoor points of reception (OPOR) and Plane of Window (POW) receivers. A POR is defined under NPC-300 as "any location on a noise sensitive land use where noise from a stationary source is received"[4]. An OPOR can be located on an existing or zoned for future use premises of permanent or seasonal residences, hotels/motels, nursing/retirement homes, rental residences, hospitals, camp grounds, and noise sensitive buildings such as schools, places of worship and daycare facilities. The recommended maximum noise levels for a Class 1 area in a suburban environment adjacent to arterial and collector roadways at a POR are outlined in Table 1 below. The study site is considered to be in a Class 1 area because it is located at the intersection of arterial roadways. These conditions indicate that the sound field is dominated by manmade sources. When analysing standby power equipment such as emergency generators, the ENCG specifies a noise level limit of 55 dBA for daytime testing. Generators are also considered separately, without the combined effect of other equipment.

TABLE 1: EXCLUSIONARY LIMITS FOR CLASS 1 AREA

Time of Day	Outdoor Points of Reception	Plane of Window
07:00 – 19:00	50	50
19:00 – 23:00	50	50
23:00 – 07:00	N/A	45

[4] NPC – 300, page 14

4.3 Determination of Noise Source Power Levels

Preliminary mechanical information for the development has been provided by Jain Sustainability Consultants Inc.. Table 2 summarizes the sound power of each source used in the analysis, which are illustrated in Figure 3. The intake of the fluid cooler (S1) will have an acoustic louver with a minimum insertion loss as described in Table 3. The Make up unit (S2) is located on the roof of the mechanical penthouse on the east side, and the generator (S3) is located on the west. *Predictor-Lima* sample calculations are provided in Appendix A.

TABLE 2: EQUIPMENT SOUND POWER LEVELS (dBA)

Source ID	Description	Height Above Grade (m)	Frequency (Hz)								
			63	125	250	500	1000	2000	4000	8000	Total
S1	Fluid Cooler Intake	29.45	74	83	86	91	89	83	86	81	96
S2	MUA Intake	29.45	61	72	75	79	83	78	74	63	86
S3	Emergency Generator	29.15	65	81	90	88	91	90	90	84	97

TABLE 3: ACOUSTIC LOUVER INSERTION LOSS REQUIREMENTS (dBA)

Source ID	Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
S1	3	11	16	26	23	24	18	10

4.4 Stationary Source Noise Predictions

The impact of stationary noise sources on nearby residential areas was determined by computer modelling using the software program Predictor-Lima. This program was developed from the International Standards Organization (ISO) standard 9613 Parts 1 and 2 and is capable of representing three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. The methodology has been used on numerous assignments and has been accepted by the Ministry of the Environment, Conservation and Parks (MECP) as part of Environmental Compliance Approval applications.

A total of 5 receptor locations were chosen around the site to measure the noise impact at points of reception (POR) during the daytime/evening period (07:00 – 23:00), as well as during the nighttime period (23:00 – 07:00). POR locations include outdoor points of reception (OPOR) and the plane of windows (POW) of the adjacent residential properties. Sensor locations are described in Table 4 and illustrated in Figure 2. MUA and generator were represented as point sources in the Predictor model, whereas the fluid cooler was represented as an emitting façade. Table 5 below contains Predictor-Lima calculation settings. These are typical settings that have been based on ISO 9613 standards and guidance from the MECP.

Ground absorption over the study area was determined based on topographical features (such as water, concrete, grassland, etc.). An absorption value of 0 is representative of hard ground, while a value of 1 represents grass and similar soft surface conditions. Given the urban environment hard ground was assumed. Existing and proposed buildings were added to the model to account for screening and reflection effects from building façades.

TABLE 4: RECEPTOR LOCATIONS

Receptor Number	Receptor Location	Storey's Above Grade
R1	OPOR – East Rooftop terrace	28
R2	OPOR – East Rooftop terrace	28
R3	POW – 193 Metcalfe Street	27
R4	POW – 89 Nepean Street	26
R5	POW – 96 Nepean Street	26

TABLE 5: CALCULATION SETTINGS

Parameter	Setting
Meteorological correction method	Single value for C0
Value C0	2.0
Default ground attenuation factor	0
Temperature (K)	283.15
Pressure (kPa)	101.33
Air humidity (%)	70

5. RESULTS AND DISCUSSION

Noise levels produced by the generator are presented in Table 6, while those due to the mechanical equipment are presented in Table 7. Emergency generators are only tested during the daytime period (07:00 – 19:00). Therefore, the criterion is 55 dBA. The emergency generator was evaluated separately from other sources of noise[5] (See NPC-300 C4.5.3). Noise levels at all outdoor points of reception and other plane of window receptors due to the generator fall below ENCG criteria provided our assumptions for noise control in Section 2.1 are adhered to.

TABLE 6: NOISE LEVELS FROM THE GENERATOR

Receptor Number	Plane of Window Receptor Location	Noise Level (dBA)	Sound Level Limits	Meets ENCG Class 1 Criteria
		Day	Day	Day
R1	OPOR – East Rooftop terrace	55	55	Yes
R2	OPOR – West Rooftop terrace	45	55	Yes
R3	POW – 193 Metcalfe Street	43	55	Yes
R4	POW – 89 Nepean Street	51	55	Yes
R5	POW – 96 Nepean Street	52	55	Yes

TABLE 7: NOISE LEVELS FROM STATIONARY SOURCES

Receptor Number	Plane of Window Receptor Location	Noise Level (dBA)		Sound Level Limits		Meets ENCG Class 1 Criteria	
		Day	Night	Day	Night	Day	Night
R1	OPOR – East Rooftop terrace	37	37	50	N/A	Yes	Yes
R2	OPOR – West Rooftop terrace	49	46	50	N/A	Yes	Yes
R3	POW – 193 Metcalfe Street	45	42	50	45	Yes	Yes
R4	POW – 89 Nepean Street	44	43	50	45	Yes	Yes
R5	POW – 96 Nepean Street	31	30	50	45	Yes	Yes

[5] Environmental Noise Guideline "Stationary and Transportation Sources – Approval and Planning" NPC-300

As Table 7 summarizes, noise levels at nearby sensitive receptors meet or fall below ENCG criteria for stationary noise, provided the assumptions in Section 2.1 are followed. The intake side of the fluid cooler (S1) will have an acoustic louver with a minimum insertion loss as described in Table 3. Suitable products for the fluid cooler acoustic louver include a Kinetics KCAL-2-T12, Vibro-Acoustics ALF-LV-18, or equivalent. Given the Make-up unit's sound power rating as well as its current location, the unit should not exceed the values stated in Table 2.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current assessment for the proposed development indicates that, provided our assumptions for noise control in Section 2.1 are adhered to in the detailed design process, noise levels at nearby points of reception are expected to fall below the ENCG noise criteria at all receptors. As such, the proposed development is expected to be compatible with the existing on and off-site noise sensitive land uses. A review of final equipment selection and locations by a qualified acoustical engineer will be required prior to installation of the equipment.

To ensure compliance with the ENCG the following noise control measures are recorded:

- The intake side of the fluid cooler will be fitted with an acoustic louver off the end of the unit. The acoustic louver will have a minimum insertion loss as indicated in Table 3.
- The sound power level for the radiated noise from the make-up air handling unit should not exceed the values listed in Table 2 given the proposed current location.

This concludes our assessment and report. If you have any questions or wish to discuss our findings, please advise us. In the interim, we thank you for the opportunity to be of service.

Sincerely,

Gradient Wind Engineering Inc.

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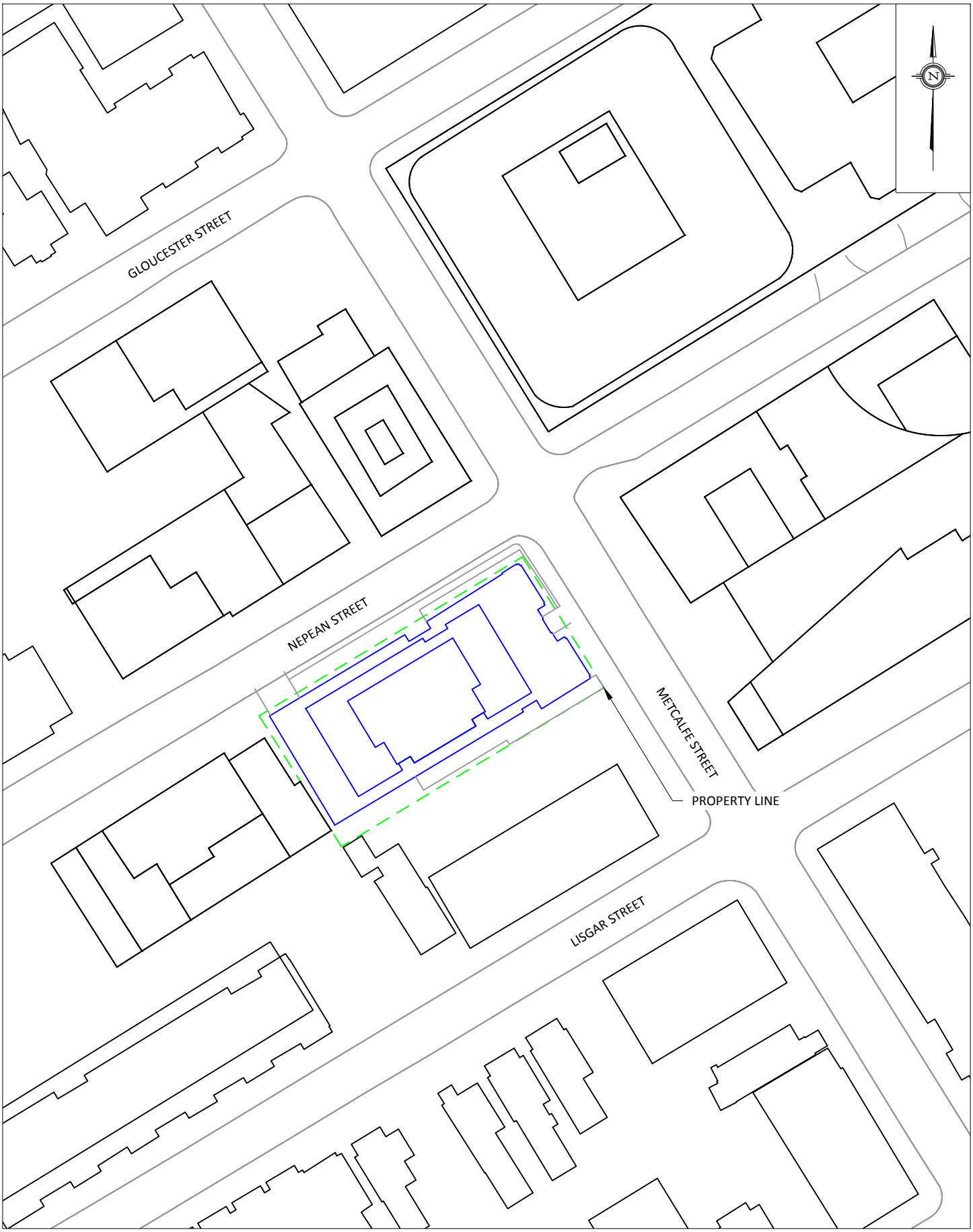
GWE18-115

Joshua Foster, P.Eng.
Principal



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PROJECT	180 METCALFE STREET - STATIONARY NOISE ASSESSMENT		DESCRIPTION
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE18-115-1
DATE	DECEMBER 20, 2018	DRAWN BY	G.G.

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

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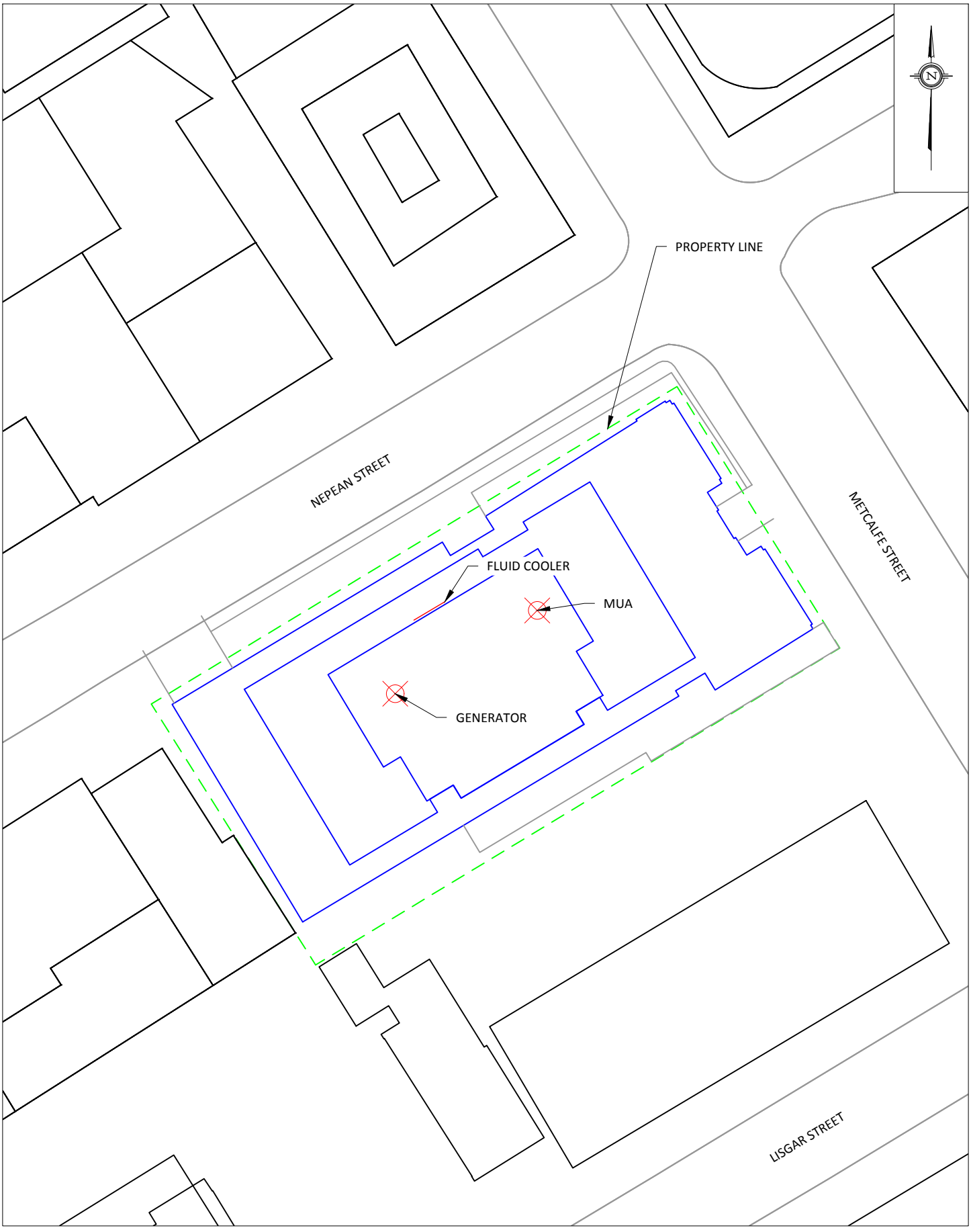
PROJECT	180 METCALFE STREET - STATIONARY NOISE ASSESSMENT		DESCRIPTION
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE18-115-2
DATE	DECEMBER 20, 2018	DRAWN BY	G.G.

FIGURE 2:
RECEPTOR LOCATIONS



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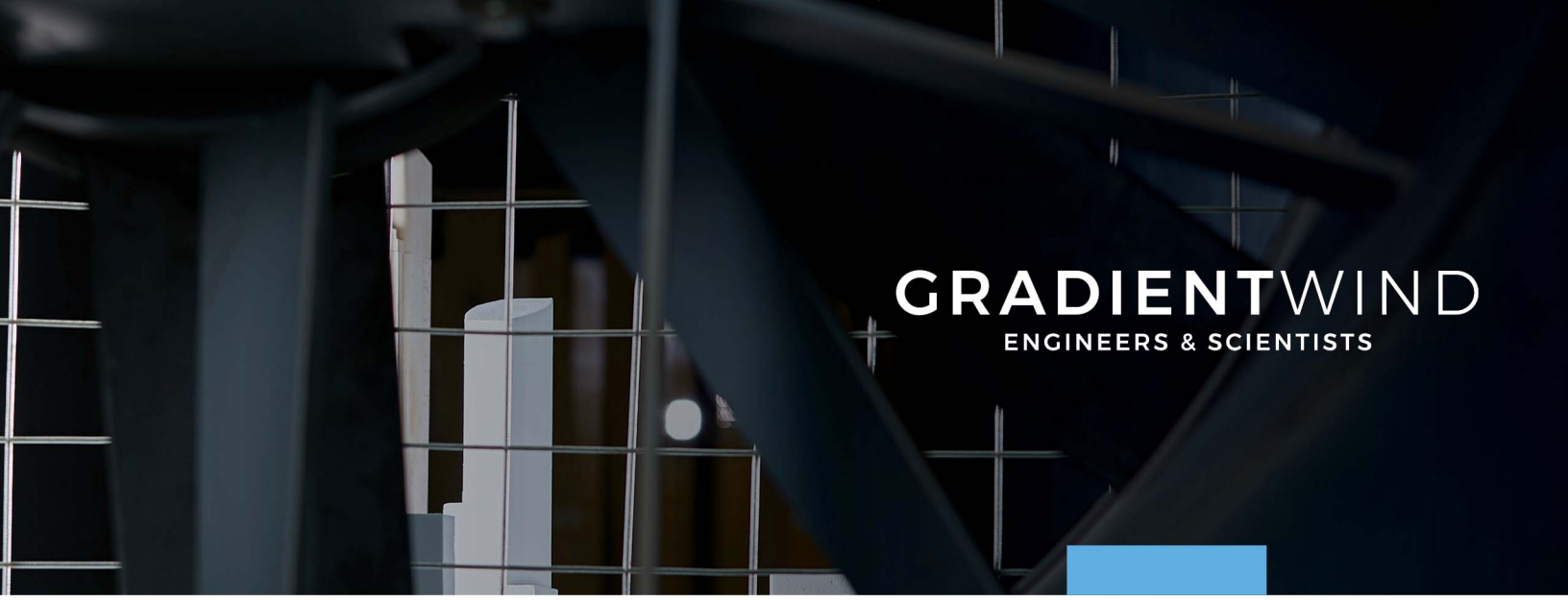
PROJECT	180 METCALFE STREET - STATIONARY NOISE ASSESSMENT		DESCRIPTION
SCALE	1:500 (APPROX.)	DRAWING NO.	GWE18-115-3
DATE	DECEMBER 20, 2018	DRAWN BY	G.G.

FIGURE 3:
STATIONARY NOISE SOURCE LOCATIONS



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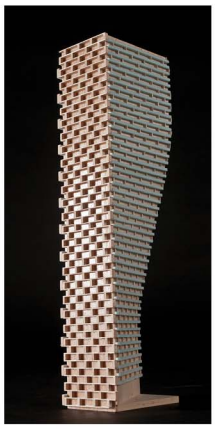

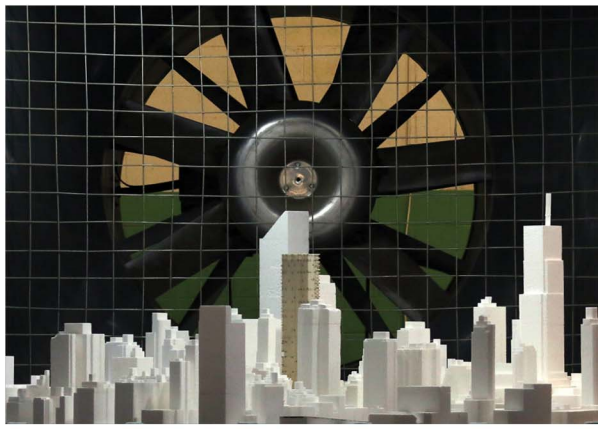

APPENDIX A

SAMPLE CALCULATION INPUT/OUTPUT

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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Rooftop Air Handling Equipment

Receiver: R1

Source(s): MUA and Cooling Tower

Cross section for receiver R1 (Id=-5) and source CT (Id=-2)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R1	0	367839.6	5031270	87.6	1.5	0			
Building	MP	3.896	367841.7	5031274	0	94	0	1		
Building	MP	16.409	367848.6	5031284	0	94	0	1		
Pointsourc	CT	16.997	367848.9	5031285	0	90.5	0			
L(wr)	--	71.8	71.9	70.4	67.8	63	65.2	68	70.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	6.83	9.29	12.18	15.34	18.2	20.34	22.05	23.28	24.05	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.01	0.02	0.03	0.06	0.17	0.56	2.01	
A(geo)	35.63	35.63	35.63	35.63	35.63	35.63	35.63	35.63	35.63	
D(i)	3	3	3	3	3	3	3	3	3	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	32.88	30.08	25.42	19.94	12.97	13.35	14.53	15.21	| 35.45

Cross section for receiver R1 (Id=-5) and source MUA (Id=4)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R1	0	367839.6	5031270	87.6	1.5	0			
Building	MP	3.546	367842.5	5031272	0	94	0	1		
Pointsourc	MUA	24.108	367859.2	5031284	94	2	0			
L(wr)	--	60.8	71.9	75.4	78.8	83	79.8	74	63.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	5.64	7.85	10.52	13.46	16.41	19.35	19.7	19.85	19.92	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.01	0.03	0.05	0.09	0.24	0.83	2.95	
A(geo)	38.98	38.98	38.98	38.98	38.98	38.98	38.98	38.98	38.98	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	16.97	25.39	25.93	26.37	27.59	23.88	17.35	5.05	| 33.22

Rooftop Air Handling Equipment

Receiver: R2

Source(s): MUA and Cooling Tower

Cross	section	for	receiver	R2	(Id=-11)	and	source	CT	(Id=-2)	
ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R2	0	367866.6	5031286	87.6	1.5	0			
Building	MP	4.538	367862	5031286	0	94	0	1		
Building	MP	17.138	367849.5	5031285	0	94	0	1		
Pointsourc	CT	17.731	367848.9	5031285	0	90.5	0			
L(wr)	--	71.8	71.9	70.4	67.8	63	65.2	68	70.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	6.65	9.08	11.94	15.07	17.96	20.13	21.9	23.17	23.99	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.01	0.02	0.03	0.06	0.17	0.59	2.09	
A(geo)	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	
D(i)	3	3	3	3	3	3	3	3	3	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	32.72	29.96	25.32	19.81	12.81	13.14	14.25	14.83	35.31

Cross	section	for	receiver	R2	(Id=-11)	and	source	MUA	(Id=4)	
ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R2	0	367866.6	5031286	87.6	1.5	0			
Building	MP	4.266	367862.4	5031285	0	94	0	1		
Pointsourc	MUA	7.609	367859.2	5031284	94	2	0			
L(wr)	--	60.8	71.9	75.4	78.8	83	79.8	74	63.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	3.64	4.37	5.23	6.33	7.82	9.76	12.11	14.74	17.54	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0	0.01	0.02	0.04	0.1	0.34	1.21	
A(geo)	31.22	31.22	31.22	31.22	31.22	31.22	31.22	31.22	31.22	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	28.2	38.45	40.83	42.73	44.97	39.37	30.7	16.93	49.02

Rooftop Air Handling Equipment

Receiver: R3

Source(s): MUA and Cooling Tower

Cross section for receiver R3 (Id=-1862) and source CT (Id=-2)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R3	0	367898	5031309	0	82	0			
Building	Pod	23.154	367877.2	5031298	0	20	0	1		
Building	tower	34.139	367867.3	5031294	0	87.6	0	1		
Building	MP	42.704	367859.6	5031290	0	94	0	1		
Building	MP	51.691	367851.6	5031286	0	94	0	1		
Pointsourc	CT	54.635	367848.9	5031285	0	90.5	0			
L(wr)	--	71.8	71.9	70.4	67.8	63	65.2	68	70.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	4.46	6.11	8.26	10.96	14.07	17.59	20.8	22.85	23.89	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.02	0.06	0.11	0.2	0.54	1.83	6.51	
A(geo)	45.85	45.85	45.85	45.85	45.85	45.85	45.85	45.85	45.85	
D(i)	3	3	3	3	3	3	3	3	3	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	25.83	23.77	19.54	13.77	5.36	4.01	3.47	0.66	28.72

Cross section for receiver R3 (Id=-1862) and source MUA (Id=4)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R3	0	367898	5031309	0	82	0			
Building	Pod	24.932	367876.8	5031295	0	20	0	1		
Building	tower	34.027	367869.1	5031291	0	87.6	0	1		
Building	MP	42.523	367861.9	5031286	0	94	0	1		
Pointsourc	MUA	45.724	367859.2	5031284	94	2	0			
L(wr)	--	60.8	71.9	75.4	78.8	83	79.8	74	63.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	4.38	3.95	2.95	0	0	0	0	0	0	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.02	0.05	0.09	0.17	0.46	1.58	5.63	
A(geo)	44.58	44.58	44.58	44.58	44.58	44.58	44.58	44.58	44.58	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	15.26	27.35	33.77	37.12	41.24	37.75	30.84	16.69	44.57

Rooftop Air Handling Equipment

Receiver: R4

Source(s): MUA and Cooling Tower

Cross	section	for	receiver	R4	(Id=-1868)	and	source	CT	(Id=-2)	
ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R4	0	367821.4	5031297	0	80	0			
Building	Pod	24.182	367843.3	5031287	0	20	0	1		
Building	tower	26.975	367845.8	5031286	0	87.6	0	1		
Pointsourc	CT	30.374	367848.9	5031285	0	90.5	0			
L(wr)	--	71.8	71.9	70.4	67.8	63	65.2	68	70.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	3.68	2.23	0	0	0	0	0	0	0	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.01	0.03	0.06	0.12	0.31	1.06	3.78	
A(geo)	41.13	41.13	41.13	41.13	41.13	41.13	41.13	41.13	41.13	
D(i)	3	3	3	3	3	3	3	3	3	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	34.43	36.75	35.23	32.61	27.75	29.76	31.81	31.99	42.38

Cross	section	for	receiver	R4	(Id=-1868)	and	source	MUA	(Id=4)	
ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R4	0	367821.4	5031297	0	80	0			
Building	Pod	26.149	367846.1	5031289	0	20	0	1		
Building	tower	29.195	367849	5031288	0	87.6	0	1		
Building	MP	33.193	367852.8	5031287	0	94	0	1		
Pointsourc	MUA	39.992	367859.2	5031284	94	2	0			
L(wr)	--	60.8	71.9	75.4	78.8	83	79.8	74	63.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	2.34	2.76	3.35	4.11	5.04	6.23	7.8	9.8	12.19	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.02	0.04	0.08	0.16	0.42	1.42	5.07	
A(geo)	43.68	43.68	43.68	43.68	43.68	43.68	43.68	43.68	43.68	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	17.36	27.86	30.57	33	35.93	30.9	22.1	5.97	39.6

Rooftop Air Handling Equipment

Receiver: R5

Source(s): MUA and Cooling Tower

Cross section for receiver R5 (Id=-1874) and source CT (Id=-2)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster
Receiver	R5	0	367821.8	5031257	0	80	0	
Building	Pod	11.878	367830.2	5031266	0	20	0	1
Building	tower	18.073	367834.6	5031270	0	87.6	0	1
Building	MP	26.128	367840.3	5031276	0	94	0	1
Building	MP	37.271	367848.2	5031284	0	94	0	1
Pointsourc	CT	38.337	367848.9	5031285	0	90.5	0	

L(wr)	--	71.8	71.9	70.4	67.8	63	65.2	68	70.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	6.72	9.25	12.49	16.63	20.69	22.64	23.72	24.32	24.65	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.02	0.04	0.08	0.15	0.39	1.31	4.68	
A(geo)	42.98	42.98	42.98	42.98	42.98	42.98	42.98	42.98	42.98	
D(i)	3	3	3	3	3	3	3	3	3	
C(meteo)	0	0	0	0	0	0	0	0	0	

L(p)	--	25.57	22.42	16.75	10.05	3.24	4.12	5.39	4.6 |	27.81

Cross section for receiver R5 (Id=-1874) and source MUA (Id=4)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster
Receiver	R5	0	367821.8	5031257	0	80	0	
Building	Pod	11.577	367831.2	5031264	0	20	0	1
Building	tower	17.524	367836	5031268	0	87.6	0	1
Building	MP	25.523	367842.5	5031272	0	94	0	1
Pointsourc	MUA	46.087	367859.2	5031284	94	2	0	

L(wr)	--	60.8	71.9	75.4	78.8	83	79.8	74	63.9	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	4.91	6.9	9.22	11.74	14.42	17.24	19.66	19.83	19.91	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.02	0.05	0.09	0.18	0.47	1.61	5.74	
A(geo)	44.76	44.76	44.76	44.76	44.76	44.76	44.76	44.76	44.76	
C(meteo)	0	0	0	0	0	0	0	0	0	

L(p)	--	12.14	20.9	21.85	22.52	23.82	17.91	10.8	-3.51 |	28.96

Rooftop Emergency Equipment
Receiver: R1
Source(s): Generator

Cross section for receiver R1 (Id=-5) and source Gen (Id=6)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R1	0	367840.2	5031271	87.6	1.5	0			
Building	MP	2.955	367842.2	5031273	0	94	0	1		
Pointsourc	Gen	7.738	367845.5	5031276	94	2	0			
L(wr)	--	65	81	90	88	91	90	90	59	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	4.59	5.97	7.66	9.79	12.29	15.05	17.97	19.85	19.93	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0	0.01	0.02	0.04	0.1	0.34	1.22	
A(geo)	31.31	31.31	31.31	31.31	31.31	31.31	31.31	31.31	31.31	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	30.73	45.03	51.89	47.39	47.61	43.63	41.5	9.54	55.28

Rooftop Emergency Equipment
Receiver: R2
Source(s): Generator

Cross section for receiver R2 (Id=-11) and source Gen (Id=6)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster		
Receiver	R2	0	367866.6	5031286	87.6	1.5	0			
Building	MP	4.109	367862.8	5031285	0	94	0	1		
Pointsourc	Gen	23.317	367845.5	5031276	94	2	0			
L(wr)	--	65	81	90	88	91	90	90	59	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	5.38	7.47	10.02	12.89	15.8	18.73	19.69	19.84	19.92	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.01	0.03	0.05	0.09	0.24	0.8	2.86	
A(geo)	38.71	38.71	38.71	38.71	38.71	38.71	38.71	38.71	38.71	
C(meteo)	0	0	0	0	0	0	0	0	0	
L(p)	--	21.82	35.26	41.37	36.44	36.47	34.36	33.64	0.51	44.93

Rooftop Emergency Equipment
Receiver: R3
Source(s): Generator

Cross section for receiver R3 (Id=-1862) and source Gen (Id=6)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster
Receiver	R3	0	367898	5031309	0	82	0	
Building	Pod	24.925	367876.7	5031296	0	20	0	1
Building	tower	34.023	367869	5031291	0	87.6	0	1
Building	MP	42.521	367861.7	5031286	0	94	0	1
Pointsourc	Gen	61.62	367845.5	5031276	94	2	0	

L(wr)	--	65	81	90	88	91	90	90	59	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	2.77	3.81	5.11	6.71	8.57	10.76	13.26	15.98	18.84	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.03	0.07	0.12	0.23	0.61	2.09	7.43	
A(geo)	47.01	47.01	47.01	47.01	47.01	47.01	47.01	47.01	47.01	
C(meteo)	0	0	0	0	0	0	0	0	0	

L(p)	--	17.17	31.86	39.22	35.3	36.01	32.13	27.93	-11.27	| 42.91

Rooftop Emergency Equipment
Receiver: R4
Source(s): Generator

Cross section for receiver R4 (Id=-1868) and source Gen (Id=6)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster
Receiver	R4	0	367821.4	5031297	0	80	0	
Building	Pod	21.098	367837.3	5031283	0	20	0	1
Building	tower	23.493	367839.1	5031282	0	87.6	0	1
Building	MP	26.739	367841.5	5031280	0	94	0	1
Pointsourc	Gen	32.019	367845.5	5031276	94	2	0	

L(wr)	--	65	81	90	88	91	90	90	59	
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3	
A(barrier)	1.82	2.66	3.53	4.38	5.27	6.38	7.86	9.79	12.13	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0	0.01	0.04	0.07	0.13	0.35	1.18	4.21	
A(geo)	42.07	42.07	42.07	42.07	42.07	42.07	42.07	42.07	42.07	
C(meteo)	0	0	0	0	0	0	0	0	0	

L(p)	--	23.26	38.38	46.51	43.59	45.43	42.73	39.96	3.59	| 51.41

Rooftop Emergency Equipment

Receiver: R5

Source(s): Generator

Cross section for receiver R5 (Id=-1874) and source Gen (Id=6)

ItemType	Id	Distance	X	Y	Hgrnd	Height	GrndFact	Cluster			
Receiver	R5	0	367821.8	5031257	0	80	0				
Building	Pod	11.634	367830.9	5031265	0	20	0	1			
Building	tower	17.637	367835.6	5031268	0	87.6	0	1			
Building	MP	25.631	367841.8	5031273	0	94	0	1			
Pointsourc	Gen	30.289	367845.5	5031276	94	2	0				

L(wr)	--	65	81	90	88	91	90	90	59		
A(ground)	-3	-3	-3	-3	-3	-3	-3	-3	-3		
A(barrier)	4.81	4.86	4.94	5.1	5.41	5.97	6.9	8.32	10.25		
A(veg)	0	0	0	0	0	0	0	0	0		
A(sit)	0	0	0	0	0	0	0	0	0		
A(bld)	0	0	0	0	0	0	0	0	0		
A(air)	0	0	0.01	0.04	0.07	0.13	0.33	1.13	4.03		
A(geo)	41.69	41.69	41.69	41.69	41.69	41.69	41.69	41.69	41.69		
C(meteo)	0	0	0	0	0	0	0	0	0		

L(p)	--	21.45	37.36	46.18	43.84	46.22	44.08	41.86	6.03	|	51.88