



Airflow Testing Report

Prepared for

Portland Public Schools

August 2021





9700 SW Capitol Hwy, Suite 110
Portland, OR 97219
ameresco.com

PROJECT OVERVIEW

As part of the continuing process to ensure a safe return to in-person learning, Portland Public Schools has contracted with Ameresco to test the airflow and ventilation of all educational and office spaces in each school. The data is reviewed by both Ameresco and PPS personnel to identify any potential shortcomings in the airflow from the HVAC systems. To accomplish this task, Ameresco has partnered with a local NEBB certified Test-Adjust-Balance (TAB) firm, Neudorfer Engineers, who will measure the airflow to each zone with calibrated measurement equipment in accordance with current testing standards and procedures. As part of this effort, HVAC professionals will review the operation of the HVAC equipment serving every educational and office space in each school.

Ameresco is pleased to have partnered with PPS over the last decade as the district's Energy Services Company (ESCO) on six energy efficiency construction projects, four service projects, and numerous energy audits. Our partnership has resulted in reducing over 3,000 tons of CO₂ and other GHG emissions and over \$1,000,000 in utility cost savings per year. Ameresco appreciates this opportunity to play a small role in the safe reopening of schools.

About Ameresco, Inc.

Founded in 2000, Ameresco, Inc. (NYSE:AMRC) is a leading cleantech integrator and renewable energy asset developer, owner and operator. Our comprehensive portfolio includes energy efficiency, infrastructure upgrades, asset sustainability and renewable energy solutions delivered to clients throughout North America and the United Kingdom. Ameresco's sustainability services in support of clients' pursuit of Net Zero include upgrades to a facility's energy infrastructure and the development, construction, and operation of distributed energy resources. Ameresco has successfully completed energy saving, environmentally responsible projects with Federal, state and local governments, healthcare and educational institutions, housing authorities, and commercial and industrial customers. With its corporate headquarters in Framingham, MA, Ameresco has more than 1,000 employees providing local expertise in the United States, Canada, and the United Kingdom. For more information, visit www.ameresco.com.

Explanation of ASHRAE Total Effective Air Changes per Hour (ACH_e) Calculation

ASHRAE has been updating their Building Readiness document to reflect the most current understanding in the engineering community for how to operate and maintain buildings during the pandemic. Their update on 4/27/2021 provided an explanation of the impact air filters and air cleaning devices have on the air in buildings. They provided the methodology, formulas, and an Excel-based tool for determining the equivalent outside air a space is receiving by having a mix of outside air, filtered recirculated air, and additional air filtration or cleaning devices in the room. Here is the explanation from ASHRAE:

Epidemic Conditions in Place



Equivalent Outdoor Air:

The equivalent outdoor air calculation indicates that the outdoor air can be calculated by using the combination of the actual outdoor air, impact of filtration or air cleaning technologies on recirculated air, and the impact of air cleaning technologies in the space.

This is using the principal of filters in series and the effectiveness at reducing particles. For items in series, the initial item would see the recirculated airflow to clean. The second item in the series would see the “cleaned” air from Item 1 and so the impact of Item 1 must be accounted for in Item 2.

As part of the airflow testing project that Portland Public Schools has partnered with Ameresco to complete, we are including the calculation of the Total Effective Air Changes per Hour (ACH_e) to show the impact of the air filtration that is active in nearly all spaces in the PPS schools. The formula for doing so is:

$$ACH_e = (ACH_{oa} + ACH_f) * E_z + ACH_{ir}$$

where:

- ACH_{oa} = air changes per hour of outside air = outside airflow in cubic feet per minute * 60 minutes per hour / room volume in cubic feet
- ACH_f = air changes per hour of clean air from filtered recirculated air with filters of the specified MERV rating as determined by ASHRAE
- E_z = Zone Air Distribution Effectiveness = how effective the HVAC system is at circulating and mixing the air to distribute the clean air throughout the room
- ACH_{ir} = the air changes per hour of clean air from portable air filters in the room = number of filters * CADR * 60 minutes per hour / room volume in cubic feet
 - CADR = Clear Air Delivery Rate = the CFM of clean air as specified by the manufacturer of the air filter

In order to include these calculations in the airflow testing reports, Ameresco and PPS have made the following assumptions as not all the variables are known:

1. PPS is in process of upgrading the air filters in their HVAC systems to MERV 13 and plans to be complete with that project for the start of the '21-'22 school year. In this report and for the sake of the ACH_e calculation, we are using the filters that are in place at the time of the measurements, so some of them are still MERV 8.
2. ASHRAE has guidelines for what should be used for the Zone Air Distribution Effectiveness (E_z) based on the HVAC system configuration, but they do not provide a value for every HVAC system and room configuration. For the majority of PPS rooms, an E_z of 0.8 – 1.0 would be most appropriate, so we have made the conservative assumption of using 0.8 for every space as that yields the lower ACH_e.
3. The CADR for a given air filter is from manufacturer ratings and is based on certain conditions (fan speed, particulate size, filter cleanliness, etc.) that change with operating conditions.



NEUDORFER ENGINEERS INC.

TEST REPORT TYPE: SURVEY REPORT

**Portland Public Schools Airflow Testing
Roosevelt HS
6941 N Central St, Portland, OR 97203**

Job Number: 2021-0297

Project Completion Date: 08/31/21

Revision Date:

-

Revision Number:

-



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Neudorfer Engineers, Inc.

Consulting Engineers Seattle, Washington - Portland, Oregon



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**Portland Public Schools Airflow Testing
Roosevelt HS**

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REPORT TITLE

CERTIFIED TEST: SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Roosevelt HS

NEI Job#: 2021-0297

Mechanical Engineer: NA

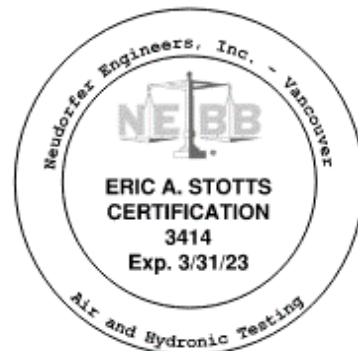
Architect: NA

HVAC Contractor: NA

TAB Firm: Neudorfer Engineers Inc
Test Engineer: Zach Mayer



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CERTIFICATION

Portland Public Schools Airflow Testing

The data presented in this report is a record of system measurements and final adjustments that have been obtained in accordance with the current edition of the NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems. Any variances from design quantities, which exceed NEBB tolerances, are noted in the Test-Adjust-Balance Report Project Summary.

Significant / Noteworthy Remarks are noted on the General Remarks and General Field Notes pages. Other remarks are noted on individual test sheets.

Noted deficiencies are not the TAB firms responsibility to repair. Prior to issuance of this report, Deficiency Reports are forwarded to our contracted agent.

Warranty is limited to one year from date of this report. Within that time, any discrepancies, ambiguities, or omissions found in this report will be retested, adjusted, or balanced as needed. A written notification will be required.

Submitted and Certified by:

NEBB TAB Firm: **Neudorfer Engineers Inc**

Certification No: **3414**

Expiration Date: **March 31, 2023**

Certification Date: **March 31, 2021**

(Date completed) **Signed and Sealed by:**

NEBB Supervisor: **Mike Vawter P.E.**

NEBB Supervisor: **Eric Stotts**





Neudorfer Engineers, Inc.

Consulting Engineers Seattle, Washington - Portland, Oregon



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TERMS AND ABBREVIATIONS

Project: **Portland Public Schools Airflow Testing**

AC or ACU Air Conditioner or Air Conditioning Unit	HEPA High Efficiency Particulate Arrestance
AH or AHU Air Handler or Air Handling Unit	HP Horsepower
AVG Average	HVAC Heating Ventilation and Air Conditioning
BHP Brake Horsepower	HWS Heating Water Supply
CAV Constant Air Volume	HWR Heating Water Return
CBV Calibrated Balancing Valve (Circuit Setter)	HX Heat Exchanger
CC Cooling Coil	HZ Hertz, cycle per second
CD Ceiling Diffuser	in. inches
CFM Cubic Feet per Minute	in.w.g. inches of water gauge
CH Chiller	Kfactor Correction factor to the free area need to calculate CFM.
CHWS Chilled Water Supply	KW Kilowatts
CHWR Chilled Water Return	LAT Leaving Air Temperature
CP Circulating Pump	LWG Low Wall Grille
CR Ceiling Register	LWR Low Wall Register
CRAC Computer Room Air Conditioner	LWT Leaving Water Temperature
CRU Computer Room Unit	MAU Make-up Air Hanging Unit
CT Cooling Tower	MBH 1,000 BTUH
CU Condenser Unit	N/A Not Applicable
CUH Cabinet Unit Heater	OSA Outside Air
CWS Condenser Water Supply	OBD Opposed Blade Damper
CWR Condenser Water Return	ΔP Pressure Drop.
DAT Discharge Air Temperature	PH Phase
DB Dyr Bulb	PSI Pounds per Square Inch
DD Direct Drive	RA Return Air
DDC Direct Digital Controls: EMS Control System for the HVAC	RAD Radiator
Des. Design	RAT Return Air Temperature
Dia. Diameter	RF Return Fan
Disch. Discharge	RH Relative Humidity
EA Exhaust Air	RHC Reheat Coil
EAT Entering Air Temperature	RPM Revolutions per Minute
Economizer Controls and components that allow an air handler to logically utilize outdoor air for cooling as opposed to the use of mechanical cooling.	RTU Roof Top Unit
EF Exhaust Fan	SA Supply Air
EG Exhaust Grille	SAT Supply Air Temperature
EMCS Energy Management Control System	S.F. Service Factor
ERU Energy Recovery Unit	SF Supply Fan
E.S.P. External Static Pressure	SFD Smoke/Fire Damper
HRC Heat Recovery Coil	SP Static Pressure
EWT Entering Water Temperature	sq.ft. square feet
FCU Fan Coil Unit	Suct. Suction
FD Fire Damper	SWG Sidewall Grille
FLA Full Load Amperage: Maximum amperage a motor can draw.	SWR Sidewall Register
Flow Hood Instrument that captures air and converts the reading to CFM.	TAB Test; Adjust; and Balance
FHT Fume Hood Test	TSP Total Static Pressure: Difference between the entering and leaving static pressure of a fan.
FPB Fan Powered Box	UH Unit Heater
FPM Feet per Minute	VAV Variable Air Volume; box that contains a motorized damper that modulates airflow.
FR Field Report	VD Volume Damper
FT Foot, Feet	VFD Variable Frequency Drive
FTU Fan Terminal Unit	Velgrid Instrument that reads used to read velocity in feet per minute.
GPM Gallons per Minute	VVT Variable Volume Terminal
HC Heating Coil	WC Water Column
TDH Pressure Difference across the entering and leaving side of a pump.	W.G. Water Gauge
	WB Wet Bulb

INSTRUMENT CALIBRATIONS

Portland Public Schools Airflow Testing

Instrument Type	Air Data Meter with Flowhood	Instrument Serial #	M00475
Instrument Manufacturer	Shortridge	Calibration Date	11/4/2020
Instrument Model Number	ADM 870	Calibration Due	11/4/2021
Instrument Type	Differential Pressure Water Meter	Instrument Serial #	W14090
Instrument Manufacturer	Shortridge	Calibration Date	10/16/2020
Instrument Model Number	HDM-250	Calibration Due	10/16/2021
Instrument Type	Psychrometer	Instrument Serial #	8084305
Instrument Manufacturer	Extech	Calibration Date	10/13/2020
Instrument Model Number	RH390	Calibration Due	10/13/2021
Instrument Type	Tachometer	Instrument Serial #	B185B5022P
Instrument Manufacturer	Nidec	Calibration Date	10/11/2020
Instrument Model Number	MT-200	Calibration Due	10/11/2021
Instrument Type	Amp Probe	Instrument Serial #	33380179WS
Instrument Manufacturer	Fluke	Calibration Date	10/9/2020
Instrument Model Number	323 Clamp Meter	Calibration Due	10/9/2021
Instrument Type	Digital Thermometer	Instrument Serial #	45400509WS
Instrument Manufacturer	Fluke	Calibration Date	10/9/2020
Instrument Model Number	52 II	Calibration Due	10/9/2021
Instrument Type	Manometer	Instrument Serial #	M00475
Instrument Manufacturer	Shortridge	Calibration Date	11/4/2020
Instrument Model Number	ADM 870	Calibration Due	11/4/2021
Instrument Type	Thermal Anemometer	Instrument Serial #	AVM440742003
Instrument Manufacturer	Alnor Instruments	Calibration Date	11/9/2020
Instrument Model Number	AVM 440	Calibration Due	11/9/2021
Instrument Type	Ultrasonic Flow Meter	Instrument Serial #	N5K1435T
Instrument Manufacturer	Fuji	Calibration Date	10/14/2020
Instrument Model Number	Portaflow-C	Calibration Due	10/14/2021



PROJECT	Portland Public Schools Airflow Testing
LOCATION	Roosevelt HS; 6941 N Central St, Portland, OR 97203

REPORT SUMMARY

This project has been surveyed per plans and specifications using the National Environmental Balancing Bureau (NEBB) standards and procedures.

The scope of work for this project was to assess the current airflows for each classroom, office, and special purpose space. Air changes per hour were calculated along with the % of OSA for the spaces and any deficiencies found for each piece of equipment has been noted in the following report.

All ventilation equipment was commanded to run by the BMS system. Ventilation units were measured with a flowhood on the supply outlets. Outside air was recorded with a flowhood on the OSA louvre where accessible. AK factors were calculated from flowhood readings. The remaining OSA values were recorded with a velgrid. AHU supply air was recorded by a summation of the outlets as recorded by flowhood or velgrid when appropriate. Outside air was recorded with a velgrid or airfoil and calculated by the free area method.

The measured airflows in this report represent the performance of the equipment at the time of measurement, which vary over time based on operating conditions. There are factors outside the control of Neudorfer that impact airflow, and variance in those factors is expected and normal. One significant factor is the MERV rating and condition of the air filters on the equipment. During the summer of 2021, PPS began upgrading the filters on all their fan systems to MERV 13. Those upgraded filters are more effective at capturing particles but also impact the amount of airflow from the equipment. These filter changes were occurring while the airflow measurement project was happening, so some schools had the new filters, and some had the old filters at the time of measurement. On the data page included this report, there is a line stating whether or not the upgraded filters were in place at the time of measurement.

AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
 Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
 Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
First Floor - Bldg A																
Performance Rm 9	DOAU-4	DOAU	45.0	34.5	1,553	18.0	27,945	1,295	1,295	100%	2.8	2.8	1	4.3	2.2	
Dressing Room 09A	DOAU-4	DOAU	13.4	14.0	188	9.0	1,688	175	175	100%	6.2	6.2	1	38.7	5.0	
Dressing Room 09B	DOAU-4	DOAU	13.5	14.1	190	9.0	1,713	215	215	100%	7.5	7.5	1	39.3	6.0	
Make-Up 09D	DOAU-4	DOAU	11.5	24.7	284	12.0	3,409	810	810	100%	14.3	14.3	1	28.1	11.4	
Faculty 013	DOAU-4	DOAU	10.3	19.1	197	10.0	1,967	60	60	100%	1.8	1.8	1	30.4	1.5	
Class Rm 15	DOAU-4	DOAU	32.2	51.7	1,665	12.0	19,977	670	670	100%	2.0	2.0	1	4.5	1.6	This room is combined with Class Rm 17. This is part of Class Rm 15.
Class Rm 17	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	0.0	
Rm 16	DOAU-4	DOAU	10.6	8.0	85	9.0	763	60	60	100%	4.7	4.7	1	78.5	3.8	
Shop Rm 19	FC-019	DOAU	45.3	37.2	1,685	11.0	18,537	2,365	755	32%	7.7	2.4	1	8.8	5.7	
Flex 019C	DOAU-4	DOAU	21.3	23.0	490	10.0	4,899	200	200	100%	2.4	2.4	1	13.6	2.0	
Flex 019B	DOAU-4	DOAU	21.2	23.0	488	10.0	4,876	205	205	100%	2.5	2.5	1	13.7	2.0	
Second Floor - Bldg A																
Class Rm 127	DOAU-4	DOAU	23.1	37.4	864	10.0	8,639	350	350	100%	2.4	2.4	1	8.5	1.9	
Class Rm 125	DOAU-4	DOAU	27.9	30.8	859	10.0	8,593	320	320	100%	2.2	2.2	1	8.4	1.8	
Class Rm 123	DOAU-4	DOAU	35.3	22.9	808	10.0	8,084	340	340	100%	2.5	2.5	1	9.1	2.0	
Rm 122	DOAU-4	DOAU	11.7	8.5	99	9.0	895	35	35	100%	2.3	2.3	1	65.6	1.9	

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
First Floor - Bldg B1																
Mech Rm 81	DOAU-5	DOAU	32.5	18.8	611	15.5	9,471	260	260	100%	1.6	1.6	1	7.3	1.3	
Art Rm 85	DOAU-5	DOAU	26.7	51.3	1,370	12.6	17,258	580	580	100%	2.0	2.0	1	4.9	1.6	
Art Rm 87	DOAU-5	DOAU	26.8	41.8	1,120	12.6	14,115	680	680	100%	2.9	2.9	1	6.4	2.3	
Storage Rm 89	DOAU-5	DOAU	29.3	16.7	489	14.6	7,144	135	135	100%	1.1	1.1	0	N/A	0.9	
Storage Rm 091B	FC-091	FCU	22.6	64.2	1,451	12.8	18,572	1,620	0	0%	5.2	0.0	1	6.8	3.8	Not ducted for OSA.
Computer Rm 88	DOAU-5	DOAU	28.7	32.6	936	16.5	15,438	315	315	100%	1.2	1.2	1	4.7	1.0	
Class Rm 86	DOAU-5	DOAU	31.5	27.0	851	16.5	14,033	365	365	100%	1.6	1.6	1	5.3	1.2	
Class Rm 84	DOAU-5	DOAU	31.7	27.5	872	12.3	10,723	290	290	100%	1.6	1.6	1	6.6	1.3	
Second Floor - Bldg B1																
Flex 112	AHU-3	AHU	11.4	18.0	205	10.0	2,052	165	165	100%	4.8	4.8	1	31.6	3.9	Note #1
Office Rm 113C	AHU-3	AHU	9.6	18.0	173	10.0	1,728	165	165	100%	5.7	5.7	1	37.6	4.6	Note #1
Office Rm 113	AHU-3	AHU	28.8	22.2	639	12.0	7,672	165	165	100%	1.3	1.3	1	8.5	1.0	Note #1
Office Rm 113B	AHU-3	AHU	9.4	17.5	165	10.0	1,645	165	165	100%	6.0	6.0	1	39.5	4.8	Note #1
Office Rm 113A	AHU-3	AHU	13.6	17.5	238	10.0	2,380	165	165	100%	4.2	4.2	1	27.3	3.3	Note #1
Recep 115	DOAU-5	DOAU	26.5	12.6	334	9.3	3,105	200	200	100%	3.9	3.9	1	21.4	3.1	
Conf. Rm 115H	DOAU-5	DOAU	13.0	11.0	143	9.3	1,330	90	90	100%	4.1	4.1	1	46.1	3.2	
Rm 115G	DOAU-5	DOAU	8.0	11.0	88	9.4	827	50	50	100%	3.6	3.6	1	71.8	2.9	
Exam 115C	DOAU-5	DOAU	11.2	10.3	115	9.4	1,084	60	60	100%	3.3	3.3	1	55.2	2.7	
115B	DOAU-5	DOAU	13.7	9.0	123	9.4	1,159	80	80	100%	4.1	4.1	1	52.5	3.3	
Exam 115D	DOAU-5	DOAU	7.2	13.3	96	9.4	900	70	70	100%	4.7	4.7	1	67.1	3.7	
Exam 115E	DOAU-5	DOAU	7.5	13.3	100	9.4	938	70	70	100%	4.5	4.5	1	64.4	3.6	
Rm 115F	DOAU-5	DOAU	8.8	13.3	117	9.4	1,100	90	90	100%	4.9	4.9	1	55.7	3.9	
Office Rm 117A	DOAU-5	DOAU	9.5	33.1	314	9.6	3,019	80	80	100%	1.6	1.6	1	20.2	1.3	
Office Rm 117B	DOAU-5	DOAU	17.3	12.1	209	9.6	2,010	120	120	100%	3.6	3.6	1	31.2	2.9	

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
Second Floor - Bldg B1																
Conf. Rm 117C	DOAU-5	DOAU	15.4	9.4	145	9.6	1,390	105	105	100%	4.5	4.5	1	44.6	3.6	
Storage Rm 117	DOAU-5	DOAU	7.0	35.0	245	14.0	3,430	85	85	100%	1.5	1.5	0	N/A	1.2	
Library	DOAU-5	DOAU	13.0	11.5	150	10.0	1,495	40	40	100%	1.6	1.6	1	39.4	1.3	
Flex 117E	DOAU-5	DOAU	21.7	18.0	391	10.0	3,906	105	105	100%	1.6	1.6	1	15.9	1.3	
Office Rm 117G	DOAU-5	DOAU	9.7	14.7	143	10.0	1,426	60	60	100%	2.5	2.5	1	42.0	2.0	
Performance Rm 119	DOAU-6	DOAU	55.0	39.2	2,156	18.2	39,239	685	685	100%	1.0	1.0	1	2.3	0.8	
Flex 119A	DOAU-6	DOAU	19.9	13.2	263	8.8	2,312	60	60	100%	1.6	1.6	1	25.9	1.2	
Flex 119C	DOAU-6	DOAU	20.0	14.5	290	8.8	2,552	65	65	100%	1.5	1.5	1	23.6	1.2	
Faculty 121	DOAU-6	DOAU	8.2	39.0	320	9.0	2,878	70	70	100%	1.5	1.5	1	21.0	1.2	
Practice Room 119G	DOAU-6	DOAU	9.0	10.8	97	8.4	816	70	70	100%	5.1	5.1	1	73.9	4.1	
Practice Room 119H	DOAU-6	DOAU	9.0	10.8	97	8.4	816	75	75	100%	5.5	5.5	1	74.2	4.4	
Practice Room 119J	DOAU-6	DOAU	9.0	10.7	96	8.4	809	90	90	100%	6.7	6.7	1	75.8	5.3	
Third Floor - Building B1																
Computer Rm 291	AHU-3	AHU	28.2	33.6	948	10.0	9,475	645	645	100%	4.1	4.1	1	9.3	3.3	Note #1
Class Rm 293	AHU-3	AHU	22.7	31.0	704	10.0	7,037	515	515	100%	4.4	4.4	1	11.6	3.5	Note #1
Class Rm 296	AHU-3	AHU	31.2	26.6	830	12.8	10,623	465	465	100%	2.6	2.6	1	7.5	2.1	Note #1
Class Rm 292	AHU-3	AHU	32.6	26.0	848	13.7	11,612	565	565	100%	2.9	2.9	1	7.2	2.3	Note #1
Office Rm 294	AHU-3	AHU	16.2	10.6	172	10.2	1,752	90	90	100%	3.1	3.1	1	35.0	2.5	Note #1

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

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	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
First Floor - Bldg B2																
Science Rm 37	DOAU-7	DOAU	44.5	33.0	1,469	8.0	11,748	645	645	100%	3.3	3.3	1	7.5	2.6	
Flex 037A	DOAU-7	DOAU	37.7	8.5	320	8.3	2,660	645	645	100%	14.6	14.6	1	33.1	11.6	
Class Rm 35	DOAU-7	DOAU	22.5	37.5	844	8.2	6,919	645	645	100%	5.6	5.6	1	12.7	4.5	
Class Rm 33	DOAU-7	DOAU	37.1	26.0	965	8.1	7,813	645	645	100%	5.0	5.0	1	11.3	4.0	
Faculty 34	DOAU-7	DOAU	15.6	36.5	569	8.1	4,612	645	645	100%	8.4	8.4	1	19.1	6.7	
Office Rm 36	DOAU-7	DOAU	16.2	12.3	199	8.0	1,594	645	645	100%	24.3	24.3	1	55.2	19.4	
Second Floor - Bldg B2																
Science Rm 139	DOAU-8	DOAU	28.2	45.0	1,269	10.0	12,690	640	640	100%	3.0	3.0	1	6.9	2.4	
Flex 139A	DOAU-8	DOAU	37.2	8.5	316	8.3	2,624	290	290	100%	6.6	6.6	1	27.0	5.3	
Class Rm 137	DOAU-9	DOAU	37.7	22.3	841	10.0	8,407	350	350	100%	2.5	2.5	1	8.8	2.0	
Class Rm 135	DOAU-9	DOAU	25.6	40.0	1,024	10.0	10,240	350	350	100%	2.1	2.1	1	7.2	1.6	
Class Rm 133	DOAU-9	DOAU	25.5	40.0	1,020	10.0	10,200	360	360	100%	2.1	2.1	1	7.3	1.7	
Faculty 138	DOAU-8	DOAU	35.8	15.5	555	9.5	5,272	60	60	100%	0.7	0.7	1	11.4	0.5	
Office Rm 140	DOAU-8	DOAU	12.1	16.7	202	9.5	1,920	50	50	100%	1.6	1.6	1	30.9	1.3	
Office Rm 103E	DOAU-10	DOAU	11.4	13.0	148	9.6	1,423	45	45	100%	1.9	1.9	1	41.6	1.5	
Rm 103D	DOAU-10	DOAU	11.3	11.1	125	9.5	1,192	30	30	100%	1.5	1.5	1	49.0	1.2	
Rm 103C	DOAU-10	DOAU	11.2	11.5	129	9.5	1,224	45	45	100%	2.2	2.2	1	48.3	1.8	
Office Rm 103B	DOAU-10	DOAU	11.3	18.0	203	9.5	1,932	50	50	100%	1.6	1.6	1	30.7	1.2	
Office Rm 103J	DOAU-10	DOAU	9.5	24.8	236	9.5	2,238	60	60	100%	1.6	1.6	1	26.8	1.3	
Rm 103H	DOAU-10	DOAU	8.5	14.0	119	9.5	1,131	40	40	100%	2.1	2.1	1	52.1	1.7	
Office Rm 102	DOAU-10	DOAU	12.4	20.6	255	9.6	2,452	50	50	100%	1.2	1.2	1	24.2	1.0	
Work Area 103A	DOAU-10	DOAU	34.1	14.1	481	9.5	4,568	90	90	100%	1.2	1.2	1	13.4	0.9	
Office Rm 105B	DOAU-13	DOAU	12.5	10.5	131	9.5	1,247	80	80	100%	3.8	3.8	1	48.8	3.1	
Rm 105C	DOAU-13	DOAU	12.5	10.5	131	9.5	1,247	80	80	100%	3.8	3.8	1	48.8	3.1	

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
Second Floor - Bldg B2																
Office Rm 105D	DOAU-13	DOAU	12.5	10.5	131	9.5	1,247	60	60	100%	2.9	2.9	1	48.0	2.3	
Rm 105F1	DOAU-13	DOAU	11.0	10.5	116	9.5	1,097	75	75	100%	4.1	4.1	1	55.2	3.3	
Office Rm 105A	DOAU-13	DOAU	15.0	22.7	341	9.3	3,167	80	80	100%	1.5	1.5	1	19.2	1.2	
Rm 105E	DOAU-13	DOAU	13.9	8.4	117	9.5	1,109	85	85	100%	4.6	4.6	1	55.1	3.7	
105F	DOAU-13	DOAU	21.8	24.6	536	9.5	5,095	210	210	100%	2.5	2.5	1	13.2	2.0	
Faculty 104	DOAU-12	DOAU	21.5	12.8	275	9.5	2,614	115	115	100%	2.6	2.6	1	23.9	2.1	
Sick Room 106	DOAU-12	DOAU	11.0	15.5	171	9.5	1,620	55	55	100%	2.0	2.0	1	36.8	1.6	
Health 108	DOAU-12	DOAU	11.5	10.7	123	8.8	1,083	75	75	100%	4.2	4.2	1	56.0	3.3	
Daycare 107J	DOAU-12	DOAU	19.9	29.9	595	9.5	5,653	120	120	100%	1.3	1.3	1	11.1	1.0	
Office 107H	DOAU-12	DOAU	8.0	12.3	98	9.0	886	120	120	100%	8.1	8.1	1	70.9	6.5	
Kitchen 107D	DOAU-12	DOAU	12.5	10.6	133	9.0	1,193	75	75	100%	3.8	3.8	1	50.8	3.0	
Daycare 107G	DOAU-12	DOAU	20.0	25.9	518	9.5	4,921	145	145	100%	1.8	1.8	1	13.0	1.4	
Infant 107G	DOAU-12	DOAU	30.6	14.1	431	9.5	4,099	265	265	100%	3.9	3.9	1	17.0	3.1	
Pump Room 107E	DOAU-12	DOAU	7.9	6.5	51	8.3	426	50	50	100%	7.0	7.0	0	N/A	5.6	
Mediation 109M	DOAU-12	DOAU	26.4	28.4	750	9.5	7,123	175	175	100%	1.5	1.5	1	9.2	1.2	
Mediation Conf 114	DOAU-12	DOAU	14.1	23.4	330	9.0	2,969	120	120	100%	2.4	2.4	1	21.1	1.9	
Office 109N	AHU-3	AHU	11.6	10.8	125	9.5	1,190	110	110	100%	5.5	5.5	1	52.3	4.4	Note #1
Office 109P	AHU-3	AHU	11.4	10.7	122	9.5	1,159	100	100	100%	5.2	5.2	1	53.3	4.1	Note #1
Office 109Q	AHU-3	AHU	11.4	10.7	122	9.5	1,159	100	100	100%	5.2	5.2	1	53.3	4.1	Note #1
Office 109R	AHU-3	AHU	11.4	10.7	122	9.5	1,159	100	100	100%	5.2	5.2	1	53.3	4.1	Note #1
VP Office 109S	AHU-3	AHU	13.3	10.7	142	9.5	1,352	110	110	100%	4.9	4.9	1	46.1	3.9	Note #1
Conference 109L	AHU-3	AHU	14.0	9.3	130	9.3	1,211	85	85	100%	4.2	4.2	1	50.4	3.4	Note #1
Conference 106H	AHU-3	AHU	18.6	10.0	186	9.3	1,730	75	75	100%	2.6	2.6	1	35.0	2.1	Note #1
Office 109G	AHU-3	AHU	11.5	10.0	115	9.5	1,093	35	35	100%	1.9	1.9	1	53.7	1.5	Note #1

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
Second Floor - Bldg B2																
Office 109F	AHU-3	AHU	11.5	10.0	115	9.5	1,093	45	45	100%	2.5	2.5	1	54.2	2.0	Note #1
Office 109E	AHU-3	AHU	11.5	10.0	115	9.5	1,093	30	30	100%	1.6	1.6	1	53.5	1.3	Note #1
Office 109D	AHU-3	AHU	11.5	10.0	115	9.5	1,093	40	40	100%	2.2	2.2	1	53.9	1.8	Note #1
Conference 109C	AHU-3	AHU	15.8	9.8	155	9.5	1,471	65	65	100%	2.7	2.7	1	40.9	2.1	Note #1
Records Storage 109B	AHU-3	AHU	12.5	14.0	175	9.5	1,663	35	35	100%	1.3	1.3	0	N/A	1.0	Note #1
Career Resource 109A	AHU-3	AHU	37.1	42.2	1,566	9.5	14,873	575	575	100%	2.3	2.3	1	5.7	1.9	Note #1
Third Floor - Bldg B2																
Class Rm 211	DOAU-12	DOAU	24.5	34.2	838	9.6	8,044	385	385	100%	2.9	2.9	1	9.4	2.3	
Class Rm 213	DOAU-14	DOAU	23.2	37.0	858	9.5	8,155	360	360	100%	2.6	2.6	1	9.1	2.1	
Class Rm 215	DOAU-14	DOAU	23.0	37.0	851	9.5	8,085	355	355	100%	2.6	2.6	1	9.2	2.1	
Class Rm 217	DOAU-14	DOAU	29.5	25.4	749	9.5	7,118	365	365	100%	3.1	3.1	1	10.5	2.5	
Class Rm 219	DOAU-14	DOAU	36.6	25.3	926	9.5	8,797	355	355	100%	2.4	2.4	1	8.4	1.9	
Faculty 226	DOAU-14	DOAU	50.0	15.5	775	9.5	7,363	125	125	100%	1.0	1.0	1	8.6	0.8	
Rm 212	DOAU-14	DOAU	8.7	10.7	93	9.0	838	45	45	100%	3.2	3.2	1	70.6	2.6	
Class Rm 201	DOAU-13	DOAU	24.6	36.5	898	10.0	8,979	285	285	100%	1.9	1.9	1	7.9	1.5	
Class Rm 203	DOAU-13	DOAU	24.5	36.5	894	10.0	8,943	305	305	100%	2.0	2.0	1	8.0	1.6	
Computer Rm 205	DOAU-13	DOAU	47.9	24.3	1,164	12.6	14,666	430	430	100%	1.8	1.8	1	5.3	1.4	
Faculty 207	DOAU-13	DOAU	24.9	23.1	575	10.0	5,752	65	65	100%	0.7	0.7	1	10.5	0.5	
Class Rm 209	DOAU-10	DOAU	36.8	24.7	909	10.0	9,090	330	330	100%	2.2	2.2	1	8.0	1.7	
Class Rm 233	DOAU-11	DOAU	24.6	34.7	854	10.0	8,536	235	235	100%	1.7	1.7	1	8.0	1.3	
Class Rm 235	DOAU-11	DOAU	23.4	34.8	814	10.0	8,143	235	235	100%	1.7	1.7	1	8.4	1.4	
Class Rm 237	DOAU-11	DOAU	23.1	38.0	878	10.0	8,778	215	215	100%	1.5	1.5	1	7.7	1.2	
Science 239	DOAU-11	DOAU	44.8	28.9	1,295	10.0	12,947	500	500	100%	2.3	2.3	1	6.3	1.9	
Flex 239A	DOAU-11	DOAU	37.7	8.4	317	9.5	3,008	220	220	100%	4.4	4.4	1	22.5	3.5	

Date: 8/27/2021

Readings By: Mayer/Warnick

AIRFLOW SURVEY REPORT

Project:	Portland Public Schools Airflow Testing
Location:	Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status:	Upgraded

[illegible]

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH						Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter		
First Floor - Bldg C																	
Science Rm 78	FC-078	FCU	26.5	38.5	1,020	9.0	9,182	825	590	72%	5.4	3.9	1	10.4	4.2		
Science Rm 078D	FC-078B	FCU	48.5	44.4	2,153	9.0	19,381	1,025	1,025	100%	3.2	3.2	1	5.5	2.5		
Flex 79	FC-079	FCU	30.0	15.3	459	8.4	3,856	275	275	100%	4.3	4.3	1	18.2	3.4		
Science Rm 51	DOAU-2	DOAU	38.1	37.4	1,425	9.0	12,824	580	580	100%	2.7	2.7	1	6.6	2.2		
Faculty 056	DOAU-2	DOAU	21.2	26.7	566	9.0	5,094	70	70	100%	0.8	0.8	1	11.8	0.7		
Class Rm 53	DOAU-2	DOAU	29.5	28.8	850	9.0	7,646	395	395	100%	3.1	3.1	1	9.9	2.5		
Class Rm 57	DOAU-2	DOAU	39.7	31.0	1,231	9.0	11,076	395	395	100%	2.1	2.1	1	6.9	1.7		
Class Rm 59	DOAU-2	DOAU	38.6	29.2	1,127	9.0	10,144	390	390	100%	2.3	2.3	1	7.5	1.8		
Class Rm 61	DOAU-2	DOAU	30.1	29.3	882	9.0	7,937	400	400	100%	3.0	3.0	1	9.6	2.4		
Conference 060	DOAU-2	DOAU	8.0	10.0	80	9.0	720	65	65	100%	5.4	5.4	1	83.5	4.3		
Girls Locker 065	FC-065	FCU	29.2	44.5	1,299	8.5	11,045	1,055	0	0%	5.7	0.0	1	9.3	4.1	Not ducted for OSA.	
Office 065A	DOAU-1	DOAU	12.2	12.9	157	8.4	1,322	50	50	100%	2.3	2.3	1	44.9	1.8		
Team Room 065B	DOAU-1	DOAU	23.9	16.7	399	8.4	3,353	650	650	100%	11.6	11.6	1	26.3	9.3		
Training Room 068	DOAU-1	DOAU	20.3	19.2	390	8.9	3,469	95	95	100%	1.6	1.6	1	17.7	1.3		
Boys Locker 067	FC-67	FCU	29.7	40.4	1,200	8.5	10,199	1,025	0	0%	6.0	0.0	1	9.9	4.3	Not ducted for OSA.	
Team Room 067B	FC-067B	FCU	24.2	16.7	404	8.4	3,395	310	0	0%	5.5	0.0	1	20.7	3.9	Not ducted for OSA.	
Office 067A	DOAU-1	DOAU	14.0	12.2	171	8.5	1,452	50	50	100%	2.1	2.1	1	40.9	1.7		
Aux Gym 71	AHU-02	AHU	60.5	98.0	5,929	34.5	204,551	6,155	6,155	100%	1.8	1.8	1	1.7	1.4	OSA damper 100% open. Return damper 0% open.	
Main Gym 73	AHU-01	AHU	113.3	98.1	11,115	34.5	383,458	18,200	18,200	100%	2.8	2.8	1	2.4	2.3	OSA damper 100% open. Return damper 0% open.	
Second Floor - Bldg C																	
Class Rm 197	DOAU-3	DOAU	35.4	24.8	878	10.0	8,779	370	370	100%	2.5	2.5	1	8.5	2.0		
ESL Class Rm 195	DOAU-3	DOAU	35.4	23.4	828	10.0	8,284	340	340	100%	2.5	2.5	1	8.9	2.0		
Class Rm 193	DOAU-3	DOAU	35.3	24.9	879	10.0	8,790	370	370	100%	2.5	2.5	1	8.5	2.0		
Science Rm 191	DOAU-3	DOAU	43.2	32.8	1,417	10.0	14,170	775	775	100%	3.3	3.3	1	6.6	2.6		

Date: 8/27/2021

Readings By: Mayer/Warnick



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
Second Floor - Bldg C																
Science Rm 151	DOAU-2	DOAU	38.1	37.3	1,421	10.0	14,211	1,655	1,655	100%	7.0	7.0	1	9.6	5.6	
Class Rm 153	DOAU-2	DOAU	29.1	29.4	856	10.0	8,555	400	400	100%	2.8	2.8	1	8.9	2.2	
Faculty 158	DOAU-2	DOAU	26.4	15.1	399	9.0	3,588	75	75	100%	1.3	1.3	1	16.9	1.0	
Rm 160	DOAU-2	DOAU	12.9	7.8	101	9.0	906	55	55	100%	3.6	3.6	1	65.9	2.9	
Class Rm 155	DOAU-2	DOAU	29.9	29.6	885	10.0	8,850	410	410	100%	2.8	2.8	1	8.7	2.2	
Class Rm 157	DOAU-2	DOAU	29.1	29.9	870	10.0	8,701	410	410	100%	2.8	2.8	1	8.8	2.3	
Class Rm 159	DOAU-2	DOAU	29.9	29.3	876	10.0	8,761	395	395	100%	2.7	2.7	1	8.7	2.2	
Rm 161	DOAU-2	DOAU	9.9	9.5	94	9.5	893	50	50	100%	3.4	3.4	1	66.5	2.7	
Rm 163	DOAU-2	DOAU	9.9	9.5	94	9.5	893	50	50	100%	3.4	3.4	1	66.5	2.7	
Rm 165	DOAU-2	DOAU	9.9	9.5	94	9.5	893	50	50	100%	3.4	3.4	1	66.5	2.7	
Rm 167	DOAU-2	DOAU	9.9	9.5	94	9.5	893	50	50	100%	3.4	3.4	1	66.5	2.7	
Conference 180	DOAU-2	DOAU	12.4	9.0	112	9.0	1,004	50	50	100%	3.0	3.0	1	59.1	2.4	
Rm 178	DOAU-2	DOAU	9.0	11.3	102	9.0	915	45	45	100%	2.9	2.9	1	64.6	2.4	
Rm 164	DOAU-2	DOAU	11.9	8.0	95	9.0	857	50	50	100%	3.5	3.5	1	69.3	2.8	
Rm 166	DOAU-2	DOAU	13.8	9.7	134	9.0	1,205	60	60	100%	3.0	3.0	1	49.7	2.4	
Athletics 173	DOAU-1	DOAU	39.7	51.9	2,060	19.6	40,384	1,120	1,120	100%	1.7	1.7	1	2.7	1.3	
Athletics 175	DOAU-1	DOAU	47.2	51.9	2,450	18.4	45,074	1,080	1,080	100%	1.4	1.4	1	2.4	1.2	
Third Floor - Bldg C																
Class Rm 279	DOAU-2	DOAU	24.9	35.4	881	10.0	8,815	340	340	100%	2.3	2.3	1	8.3	1.9	
Class Rm 277	DOAU-2	DOAU	23.3	35.4	825	10.0	8,248	300	300	100%	2.2	2.2	1	8.7	1.7	
Class Rm 275	DOAU-2	DOAU	24.8	35.3	875	10.0	8,754	315	315	100%	2.2	2.2	1	8.2	1.7	
Class Rm 273	DOAU-2	DOAU	30.9	27.7	856	9.0	7,703	305	305	100%	2.4	2.4	1	9.3	1.9	
Faculty 271	DOAU-2	DOAU	11.7	32.6	381	7.8	2,975	65	65	100%	1.3	1.3	1	20.2	1.0	
Science Rm 251	DOAU-2	DOAU	38.0	37.4	1,421	10.0	14,212	340	340	100%	1.4	1.4	1	5.2	1.1	

Date: 8/27/2021

Readings By: Mayer/Warnick

Portland Public Schools Airflow Testing
Roosevelt HS; 6941 N Central St, Portland, OR 97203
Upgraded

[illegible]

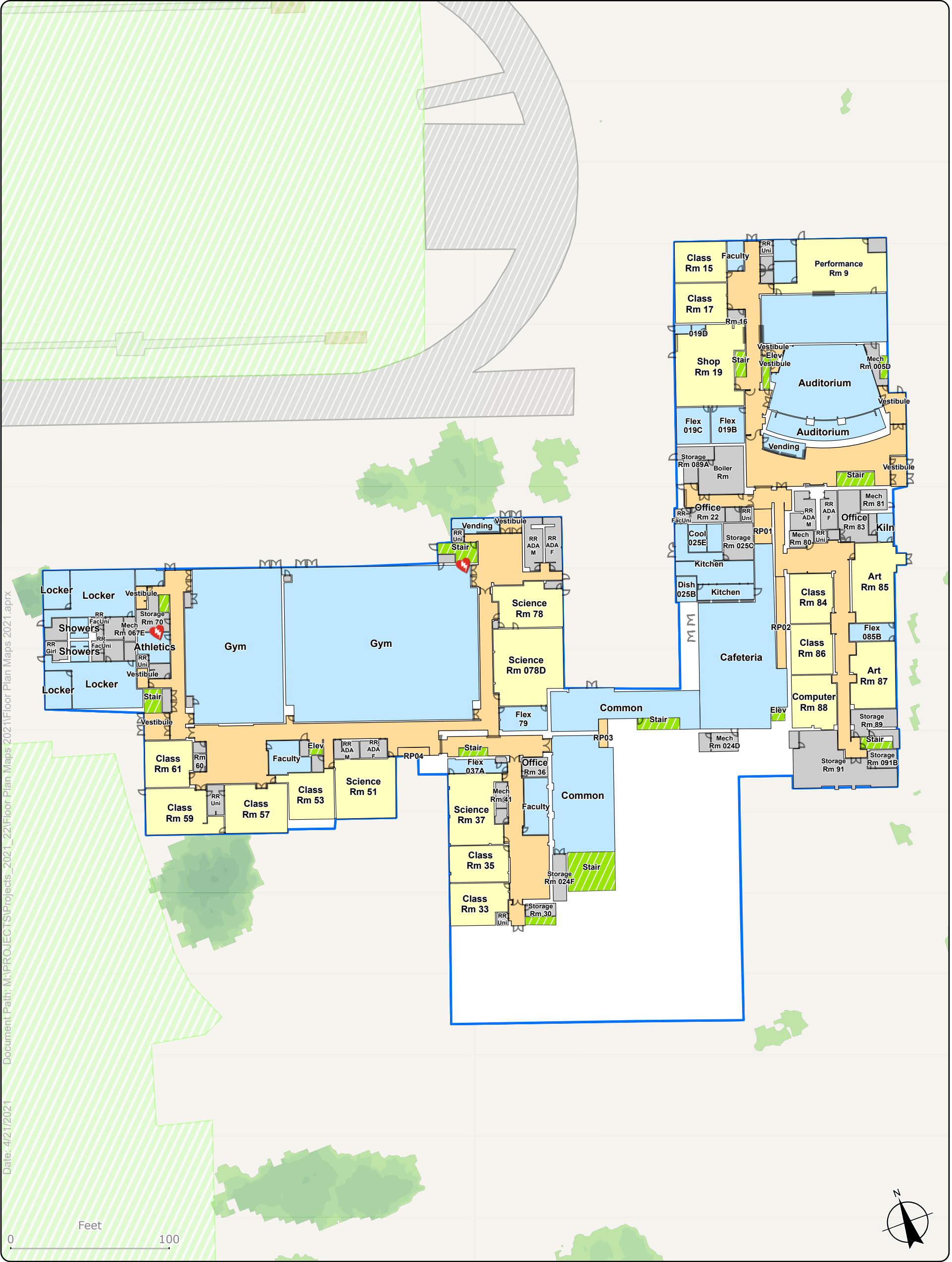
Readings By: Mayer/Warnick

Project: Portland Public Schools Airflow Testing

Location: Roosevelt HS; 6941 N Central St, Portland, OR 97203

NOTE #	NOTE DESCRIPTION
1	AHU-3 not ducted for return.

ROOSEVELT : First Floor



Space Use

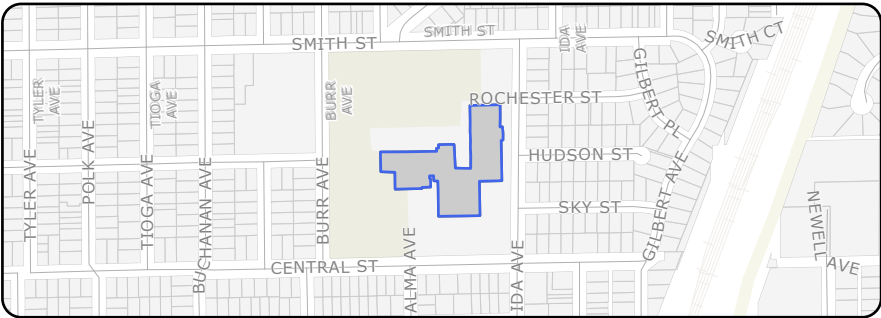
- Classrooms
- Office, Rest Rooms, Storage, Mechanical
- Special Purpose, Flex Classrooms
- Corridor, Foyer, Vestibule, Ramp
- Stairs/Elevator

School Grounds

- Campus Footprints
- Athletic Field
- Playground: Paved
- Playground: Unpaved
- Streets

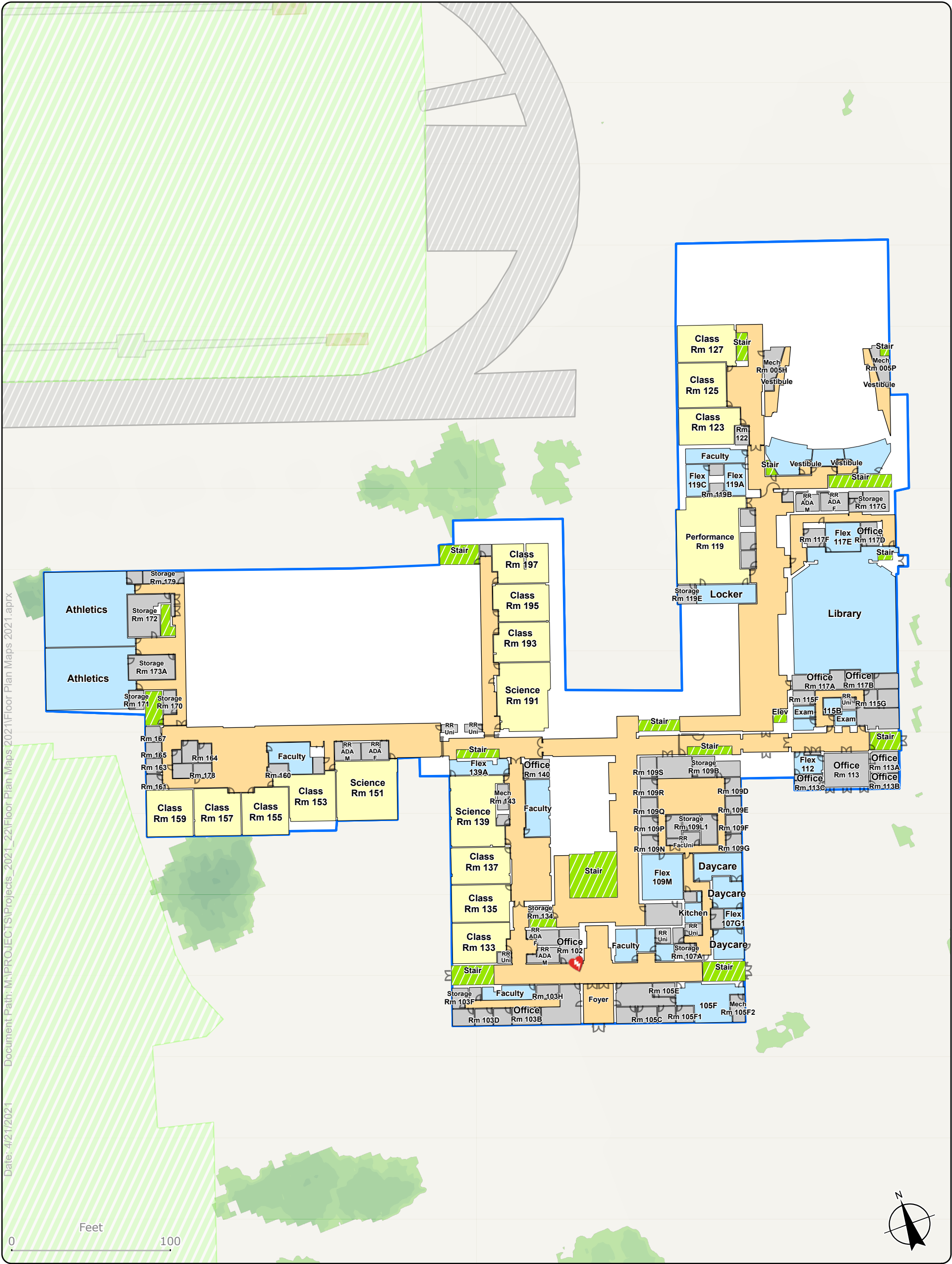
Automated Electronic Defibrillator

Doors



Campus Overview

ROOSEVELT : Second Floor

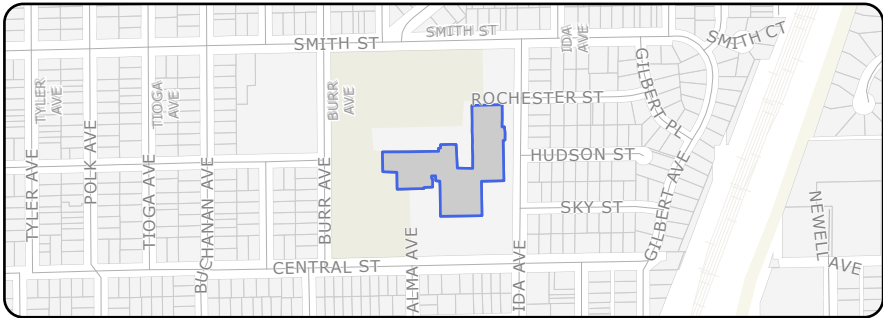


Space Use

- Classrooms
- Office, Rest Rooms, Storage, Mechanical
- Special Purpose, Flex Classrooms
- Corridor, Foyer, Vestibule, Ramp
- Stairs/Elevator

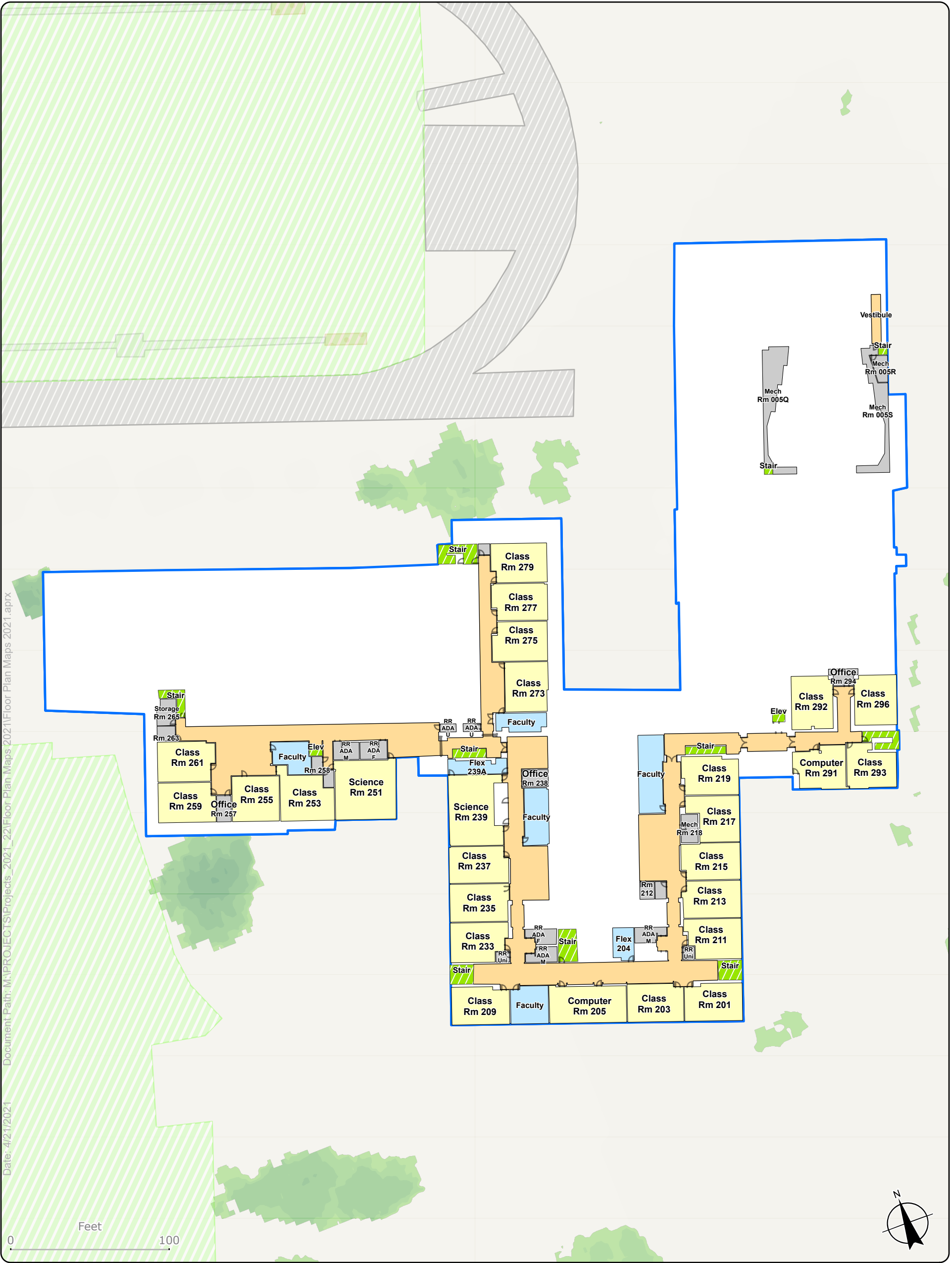
School Grounds

- Campus Footprints
- Athletic Field
- Playground: Paved
- Playground: Unpaved
- Streets
- Automated Electronic Defibrillator
- Doors



Campus Overview

ROOSEVELT : Third Floor

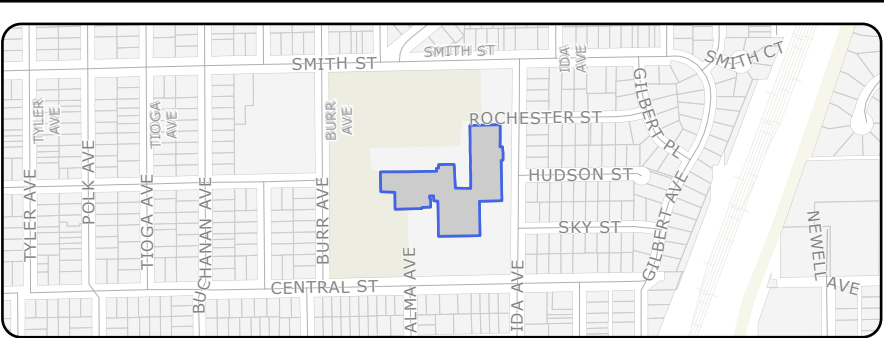


Space Use

- Classrooms
- Office, Rest Rooms, Storage, Mechanical
- Special Purpose, Flex Classrooms
- Corridor, Foyer, Vestibule, Ramp
- Stairs/Elevator

School Grounds

- Campus Footprints
- Athletic Field
- Playground: Paved
- Playground: Unpaved
- Streets
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Campus Overview