Ventilation Systems Assessment

Swampscott Public Schools
Swampscott, Massachusetts

August 21, 2020

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Executive Summary

Lavallee Brensinger Architects, and our consultant CES Inc, were retained to conduct a Facility Assessment to assist the Swampscott Public Schools with determining which spaces could be utilized within their existing facilities for re-opening schools in the Fall of 2020.

Each school listed below was assessed by our team on-site using existing spatial diagrams of the existing schools and documentation available for the existing ventilation and exhaust systems. This Report, in addition to published re-opening guidance from Massachusetts Department of Elementary and Secondary Education (DESE) and American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE) may be used to decide how the Swampscott Schools may reopen in the Fall of 2020. Each School has a unique age, ventilation and exhaust system configuration, spatial layout, and construction type.

- **Stanley Elementary School,** 10 Whitman Rd, Swampscott
- **Clarke Elementary School,** 100 Middlesex Ave, Swampscott
- **Hadley Elementary School,** 24 Redington St, Swampscott
- **Swampscott Middle School,** 207 Forest Ave, Swampscott
- **Swampscott High School,** 200 Essex St, Swampscott

The recommendations included are based on the best available knowledge at the time of writing and include information from DESE released June 25, 2020 and July 22, 2020 along with recommendations from the ASHRAE released July 17, 2020. Referenced information is attached for review as needed.

Swampscott elementary schools require the most immediate attention as two out the three schools visited, Stanley and Clarke, did not have properly operating exhaust systems for part or all of the school buildings. Hadley school ventilation systems were found to be operating properly with only minor modifications needed to office areas without ventilation currently. See attached floor plan diagrams of spaces with color coded annotations of issues and modifications required.

Swampscott Middle School ventilation systems were operating properly for the most part and meet code required ventilation rates. Office areas need to be updated so that fresh outside air and exhaust flow is maintained to all spaces. Non-operating equipment needs to be repaired or replaced in areas identified. Swampscott High School ventilation systems were operating properly and meet or exceed code required ventilation rates in all areas. See attached floor plan diagrams of spaces with color coded annotations of issues and modifications required.

Further consideration should be given to supplementary technologies to help improve indoor air quality in spaces that have limited or no access to outside air ventilation. Refer to bi-polar ionization and ultraviolet germicidal irradiation technology summary included in the Industry

Consensus section of report. Portable air purifier systems that contain a combination of these technologies should be considered for deficient areas as a short term remediation.

It should be noted that the following summary and recommendations are not fully engineered solutions and as such are not ready to be implemented without further analysis in some cases. Follow up is required to provide construction documents and analysis of specific systems and areas as noted.

Overview

General

The scope of this assessment is with respect to the existing ventilation systems, including recommendations and options to improve the performance of the ventilation systems, and to addresses potential methods of air treatment with respect to Covid-19 and viruses similar to Covid-19.

The intent of this assessment with respect to recommendations and options is to provide basic descriptions and options for the varying types of ventilation systems serving the school building.

The recommendations included are based on the best available knowledge at the time of writing and include information from Massachusetts Department of Elementary and Secondary Education (DESE) released June 25, 2020 and July 22, 2020 along with recommendations from the American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE) released July 17, 2020.

Industry Consensus

As, to the best of CES's knowledge as of the date of this assessment, there is no general consensus within the architectural/engineering, hygiene, science, and similar communities with respect to correlations between air movement within spaces/buildings and virus transmission for schools and similar facilities, this assessment does not evaluate air movement within spaces, nor does it include recommendations to modify the air movement within spaces. That is not to say that air movement within spaces does not affect virus transmission; it is to say only that the science is too incomplete to confidently determine the effect of air movement on virus transmission.

As, to the best of CES's knowledge as of the date of this assessment, there is general consensus within the architectural/engineering, hygiene, science, and similar communities with respect to correlations between outside air ventilation within spaces/buildings and virus transmission for schools and similar facilities, this assessment assumes that in general the greater the outside air ventilation rates the lower the virus transmission rates.

As, to the best of CES's knowledge as of the date of this assessment, there is general consensus within the architectural/engineering, hygiene, science, and similar communities with respect to correlations between relative humidity and virus transmission for schools and similar facilities, this assessment assumes that relative humidity in the 40% to 60% range are optimum with respect to minimizing virus transmission rates.

As, to the best of CES's knowledge as of the date of this assessment, there is general consensus within the architectural/engineering, hygiene, science, and similar communities that the various technologies available to reduce virus transmission, including particulate filtration, ultraviolet germicidal irradiation (UVGI), and bi-polar ionization, as well as increasing outside air ventilation rates, are complementary technologies to adequate ventilation, in that they

employ different methods of reducing virus transmission. That is, the more technologies implemented the greater the possibility of reducing virus transmission.

With respect to bi-polar ionization, CES' experience is that much of the literature supporting it and explaining the science behind it is produced by either manufacturers of bi-polar ionization equipment, or by companies or individuals paid by the manufacturers of bi-polar ionization equipment to validate their claims with respect to product effectiveness. The literature produced by such organizations appears to CES to have scientific merit, however such determination of scientific merit is beyond the expertise of CES, therefore any recommendations herein with respect to bi-polar ionization are based on assumption that the manufacturer's claims are scientifically valid. As of the date of this assessment, The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has not taken a position on the effectiveness of bi-polar ionization technologies.

Information Available

For Stanley, Clarke, Hadley, and Swampscott Middle School there were no existing mechanical (HVAC) system drawings made available, so the information in this assessment with respect to the operation of the systems, the outside air ventilation rates, and similar, is based solely on the information gathered in the field during CES' site visits conducted August 10, 2020 and August 13, 2020 along with CES' experience with the operation of mechanical systems similar to the systems serving the school.

Mechanical (HVAC) system drawings were made available to CES for the Swampscott High School, so the information in this assessment with respect to the operation of the systems, the outside air ventilation rates, and similar, is based on the information gathered in the field during CES' site visit August 10, 2020, along with the information on the drawings, and on CES' experience with the operation of mechanical systems similar to the systems serving the school.

Increasing Outside Air Ventilation Rates

In general, mechanical equipment and systems are sized and selected to meet the heating and cooling loads on design winter days and design summer days respectively. Since there are typically less than a dozen such design winter days and design summer days every year, mechanical equipment and systems almost invariably have excess heating and cooling capacity on all the other days of the year, and that excess capacity can be used to temper additional outside air ventilation.

This generally leads to three options for increasing the outside air ventilation rates:

Option 1: Provide controls that allow for increasing the outside air ventilation rates, except that when the spaces served are not being maintained at the space heating and cooling temperature setpoints, as might be the case on design winter days and design summer days respectively, the outside air ventilation rates are reduced.

In addition to using space temperature setpoints for limiting the outside air ventilation rates, relative humidity ideally would also be used as a limiting criteria, because in general increasing outside air ventilation rates in the winter leads to reduced relative humidity and increasing outside air ventilation rates in the summer leads to increased relative humidity (see the Industry Consensus paragraph above regarding relative humidity).

Digital control systems typically have the capability to provide such control, however implementing such control will in many cases involve adding sensors, replacing actuators, reprogramming, and similar costs.

Option 2: Balance the equipment and systems for outside air ventilation rates higher than design.

In this case the space heating and cooling temperature setpoints will still likely be maintained during much of the year, and possibly during all of the year with the exception of design and near design winter days and design and near design summer days, with the understanding and the expectation that on the design and near design winter days the spaces may be maintained at temperatures several degrees below the space heating temperature setpoints and that on the design and near design summer days the spaces may be maintained at temperatures several degrees above the space cooling temperature setpoints.

Similarly, there should be both an understanding and an expectation that with increased ventilation rates the relative humidity in the spaces will likely be lower than they would otherwise be through much of the winter and higher than they would otherwise be through much of the summer (see the Industry Consensus paragraph above regarding relative humidity).

This option is likely the primary option for non-digital control systems (short of replacing such control systems with new control systems).

Option 3: The same as Option 2, but provide manual controls that allow the maintenance staff to manually reduce the outside air ventilation if/when the space temperatures and/or relative humidity is unacceptable.

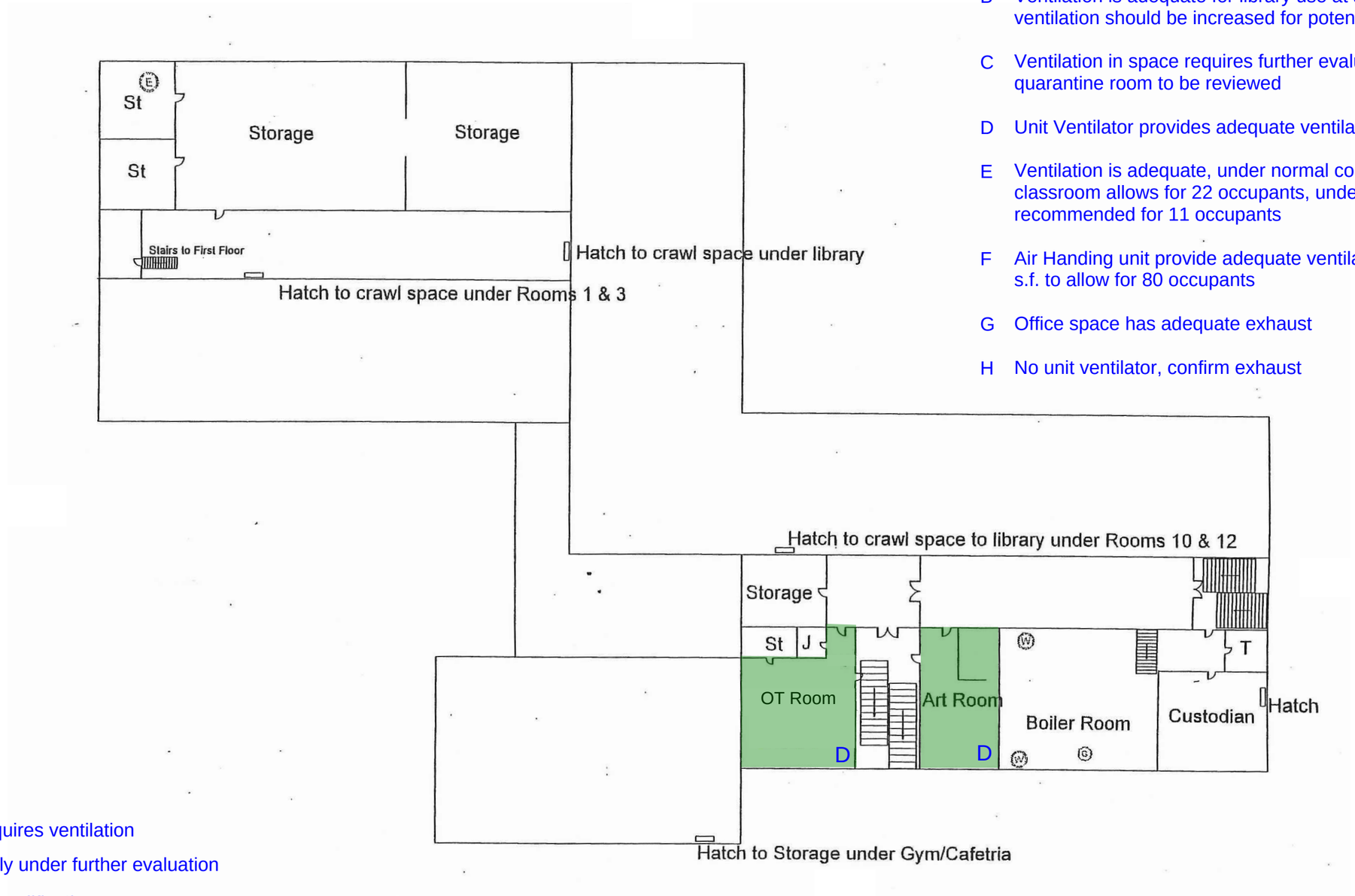
The maintenance staff would also have to readjust for the additional outside air ventilation when the outside air conditions appeared favorable enough that increasing the outside air ventilation rates would likely not lead to unacceptable space temperatures and/or relative humidity.

This option is included primarily for comprehensiveness, as manually adjusting the outside air ventilation would place a significant burden on the maintenance staff, not only with respect to labor hours but also with respect to training; such adjustment should only be done by maintenance staff that is trained and informed as to the implications and potential outcomes of manually adjusting ventilation rates. That is, from CES' experience for most school districts this option would be considered too

onerous and impractical to implement, and for that reason this option is recommended only if the school district is fully aware of the implications of implementing manual control.

As tempering outside air to room temperature for schools and similar facilities is a significant operational cost with respect to energy consumption, higher utility bills (both fuel and power as applicable) should be expected if the outside air ventilation rates are increased (unless new energy recovery systems are implemented along with increasing the outside air ventilation rates). In addition, increasing outside air rates should be done with caution in the Northeast as this region is subject to outdoor air temperatures that can freeze heating coils.

BASEMENT FLOOR:



Legend Notes:

A No existing mechanical ventilation

B Ventilation is adequate for library use at approximately 12 occupants, ventilation should be increased for potential classroom use in this area

C Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

D Unit Ventilator provides adequate ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit provide adequate ventilation for multi-use space at 2,200 s.f. to allow for 80 occupants

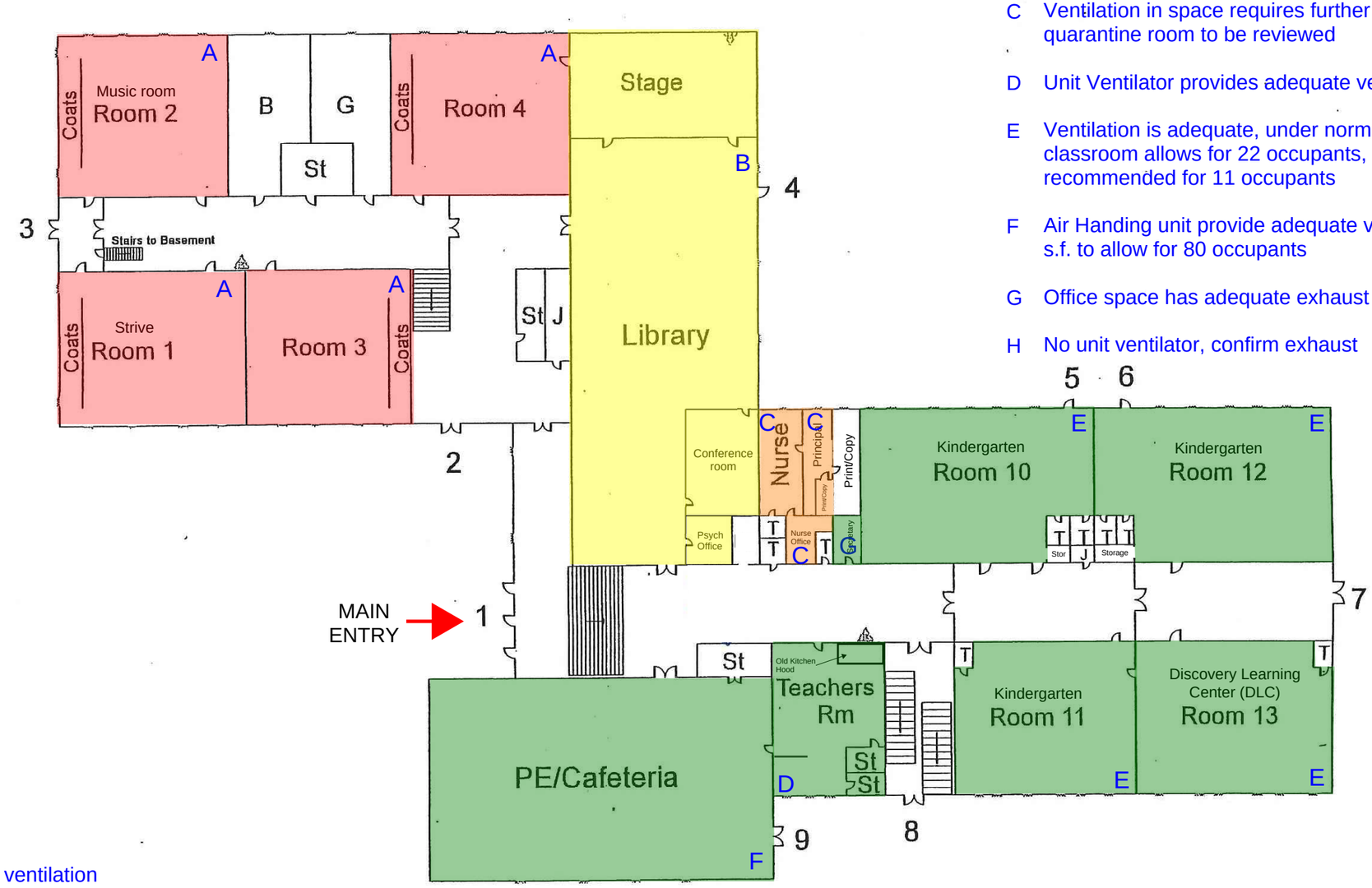
G Office space has adequate exhaust

H No unit ventilator, confirm exhaust

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

GROUND FLOOR:



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G Office space has adequate exhaust

H No unit ventilator, confirm exhaust

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

TOWN OF SWAMPSCOTT

08/21/2020

STANLEY ELEMENTARY SCHOOL

EXISTING FLOOR PLANS

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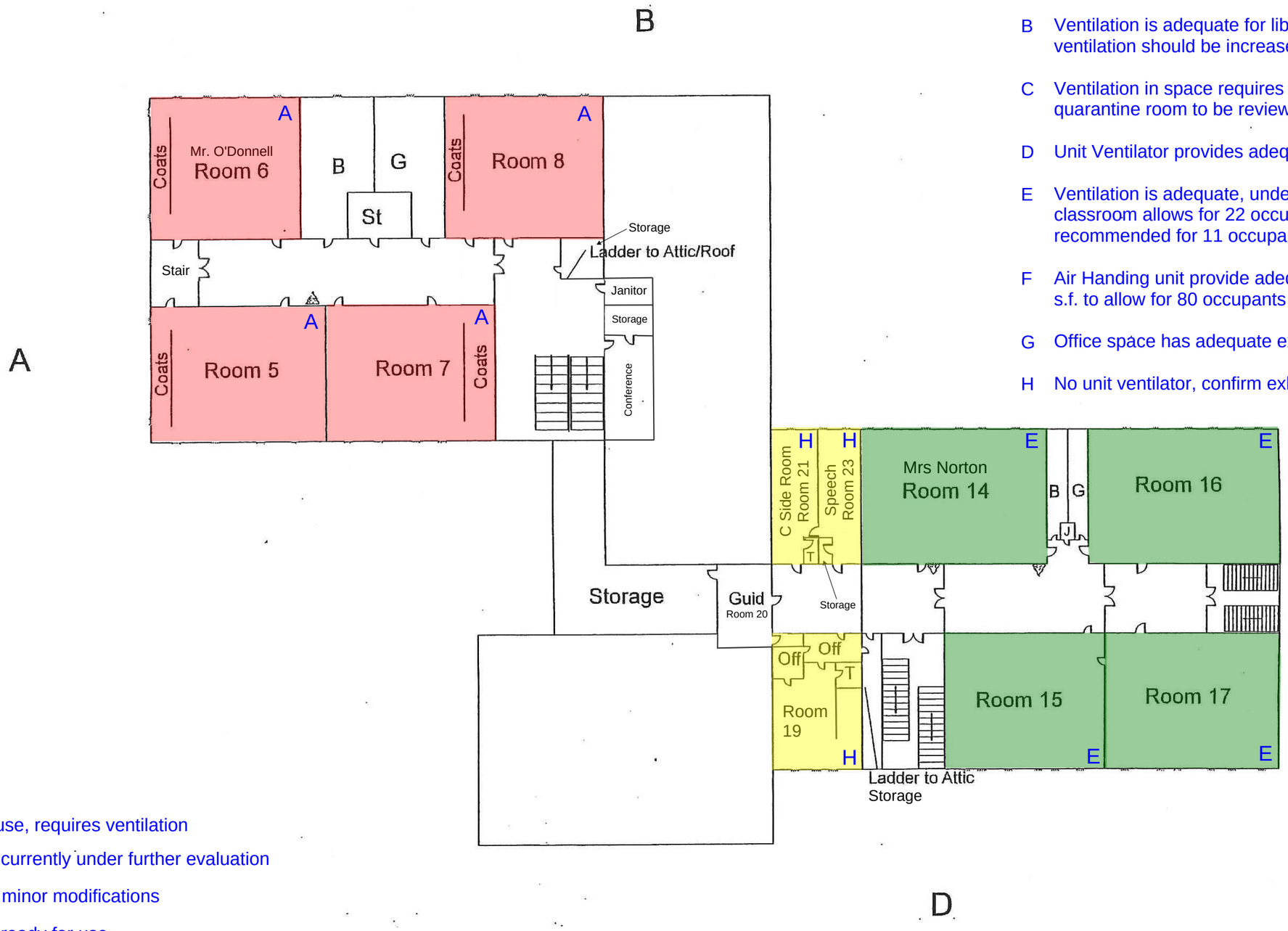
SECOND FLOOR:



Legend Notes:

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C Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

D Unit Ventilator provides adequate ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit provide adequate ventilation for multi-use space at 2,200 s.f. to allow for 80 occupants

G Office space has adequate exhaust

H No unit ventilator, confirm exhaust

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

TOWN OF SWAMPSCOTT

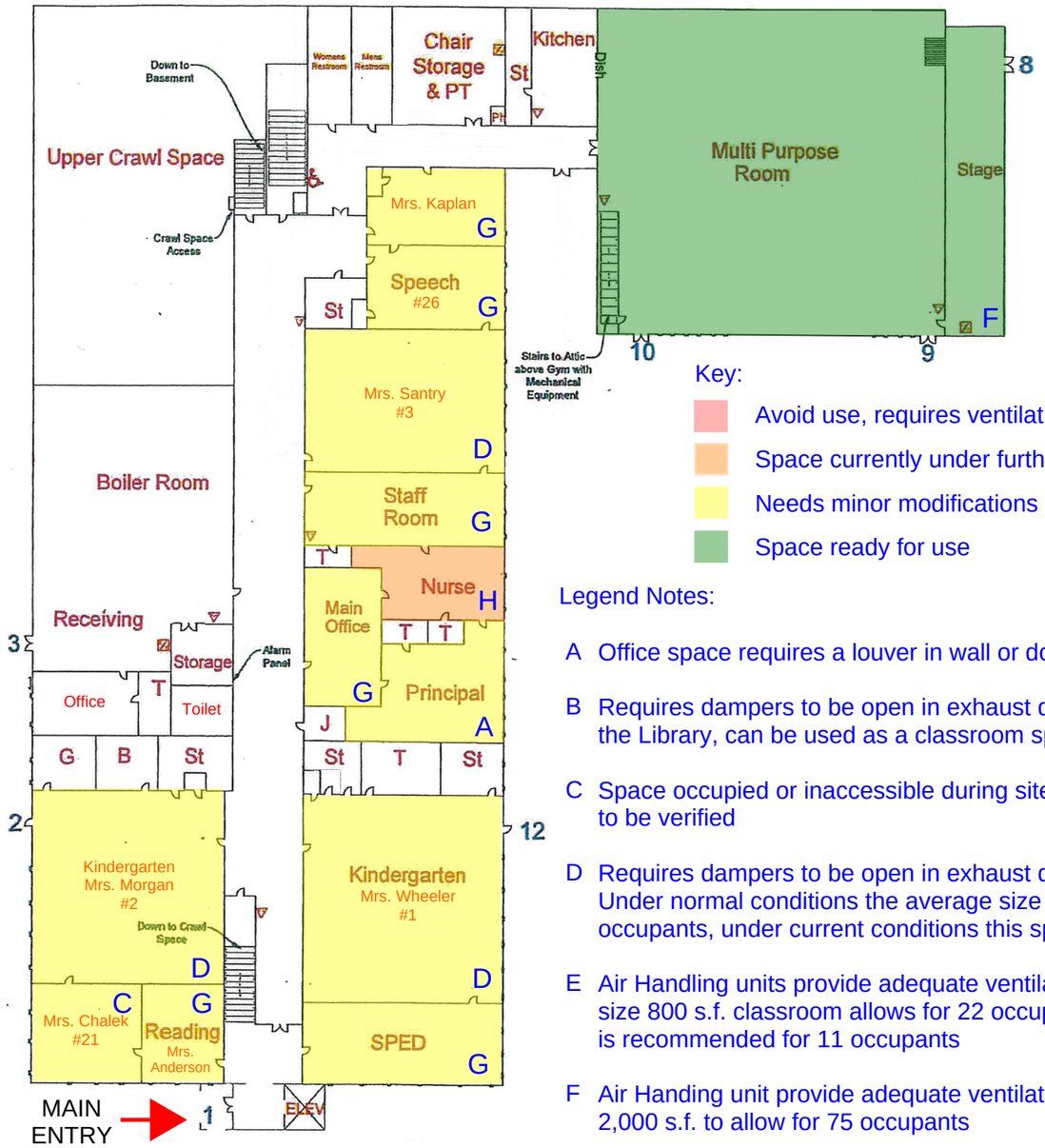
08/21/2020

STANLEY ELEMENTARY SCHOOL

EXISTING FLOOR PLANS

LAVALLEE | BRENSINGER ARCHITECTS

FIRST FLOOR:



Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Legend Notes:

A Office space requires a louver in wall or door to transfer air

B Requires dampers to be open in exhaust ducts then ventilation will be adequate in the Library, can be used as a classroom space (see note D)

C Space occupied or inaccessible during site visit and not entered, ventilation should to be verified

D Requires dampers to be open in exhaust ducts then ventilation will be adequate. Under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

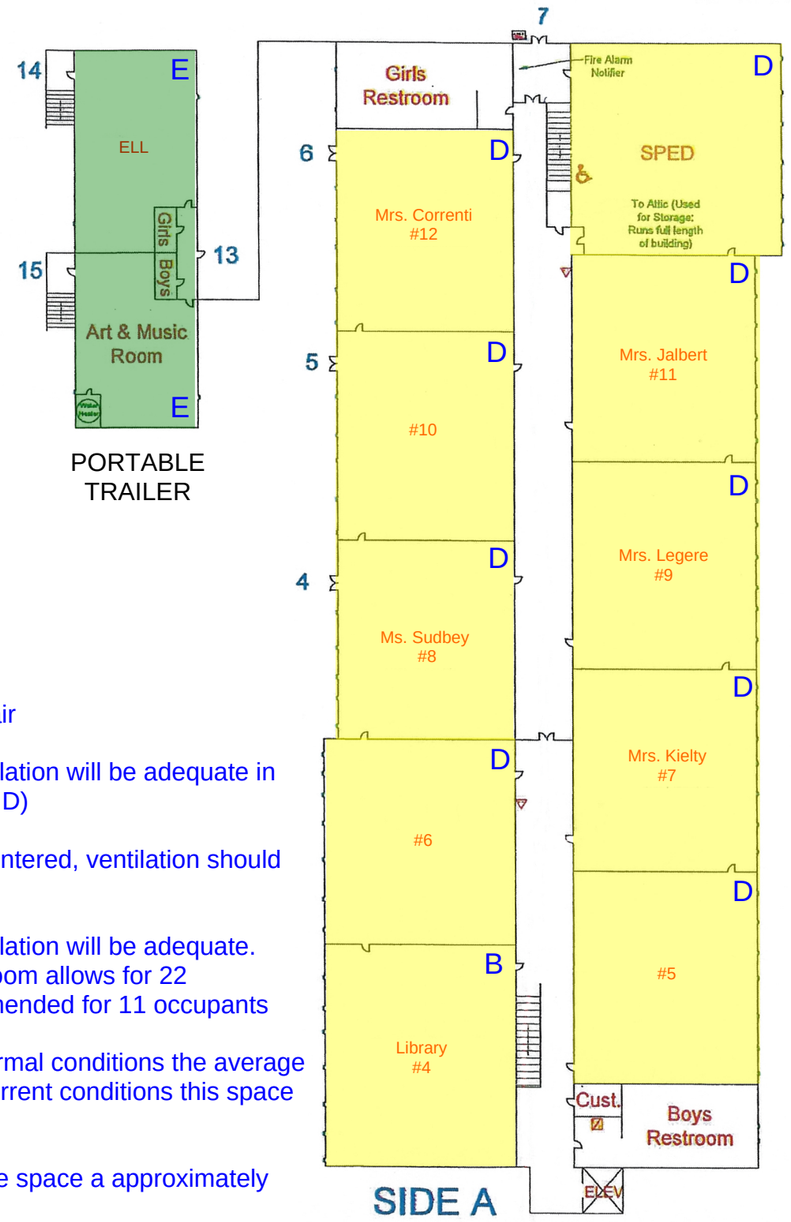
E Air Handling units provide adequate ventilation, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit provide adequate ventilation for multi-use space a approximately 2,000 s.f. to allow for 75 occupants

G Requires dampers to be open in exhaust ducts then ventilation will be adequate

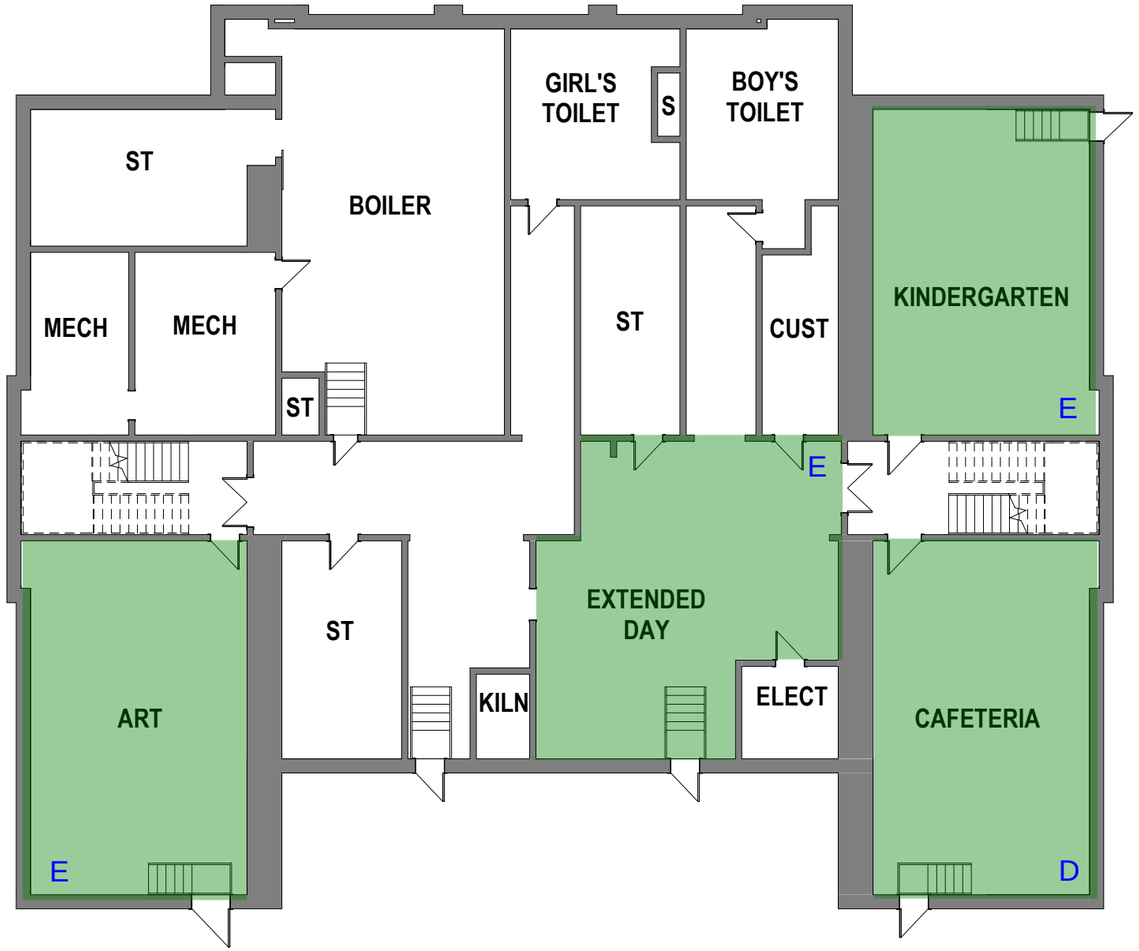
H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

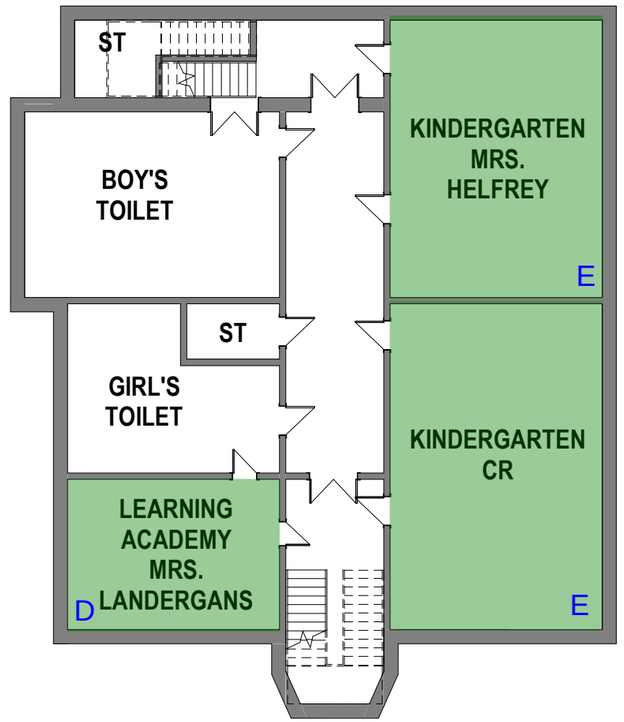
SECOND FLOOR:



TOWN OF SWAMPSCOTT

08/21/2020





Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Legend Notes:

A No unit ventilator, confirm exhaust

B Ventilation is adequate for library use, can be used as a classroom space

C Space occupied or inaccessible during site visit and not entered, ventilation should to be verified

D Unit Ventilator provides adequate ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit and wall mounted exhaust provide adequate ventilation for multi-use space

G Office space has adequate exhaust

H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

TOWN OF SWAMPSCOTT

HADLEY ELEMENTARY SCHOOL

EXISTING CONDITIONS - BASEMENT

N

08/21/2020

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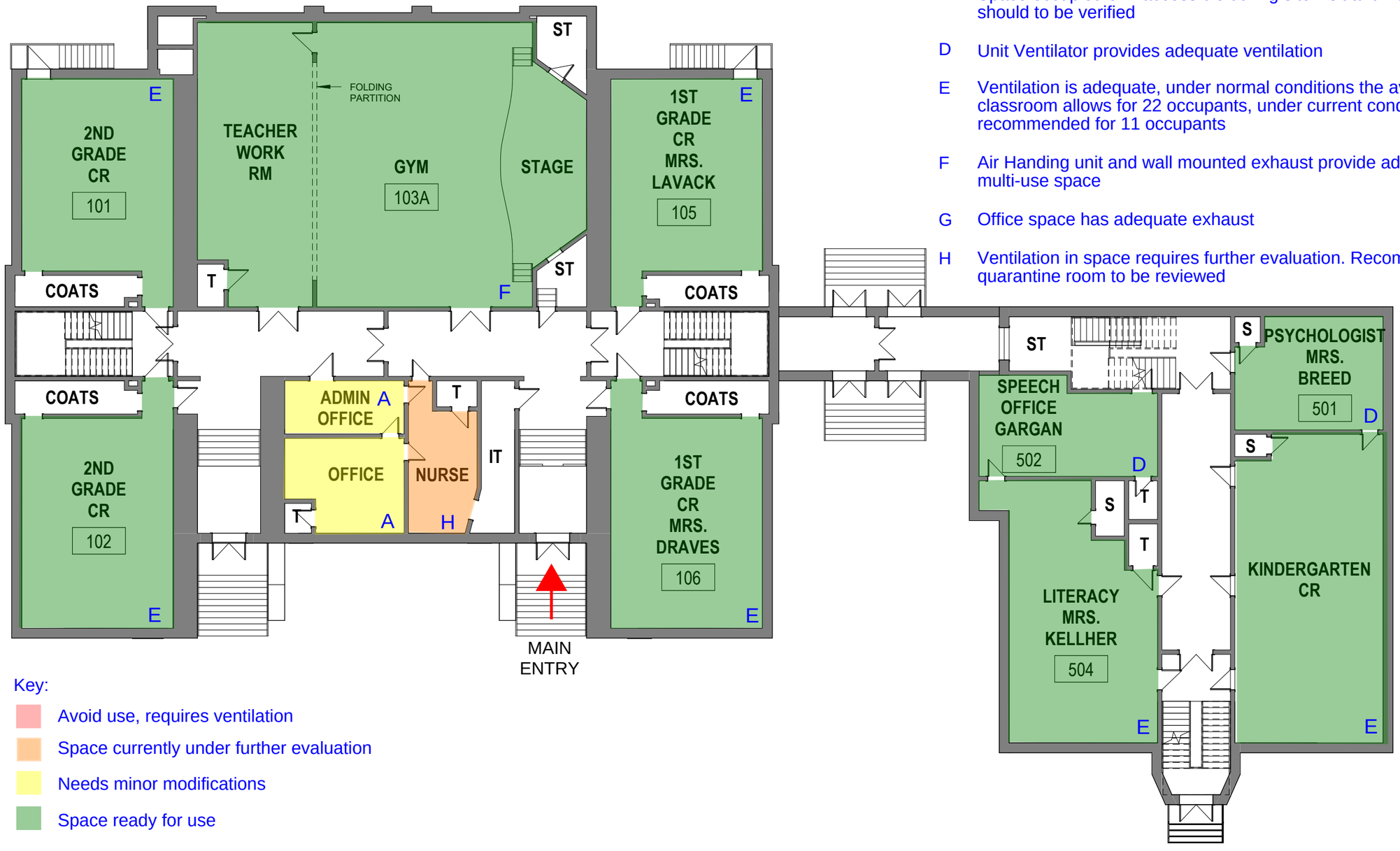


Legend Notes:

A No unit ventilator, confirm exhaust

B Ventilation is adequate for library use, can be used as a classroom space

C Space occupied or inaccessible during site visit and not entered, ventilation should to be verified

D Unit Ventilator provides adequate ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit and wall mounted exhaust provide adequate ventilation for multi-use space

G Office space has adequate exhaust

H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

TOWN OF SWAMPSCOTT

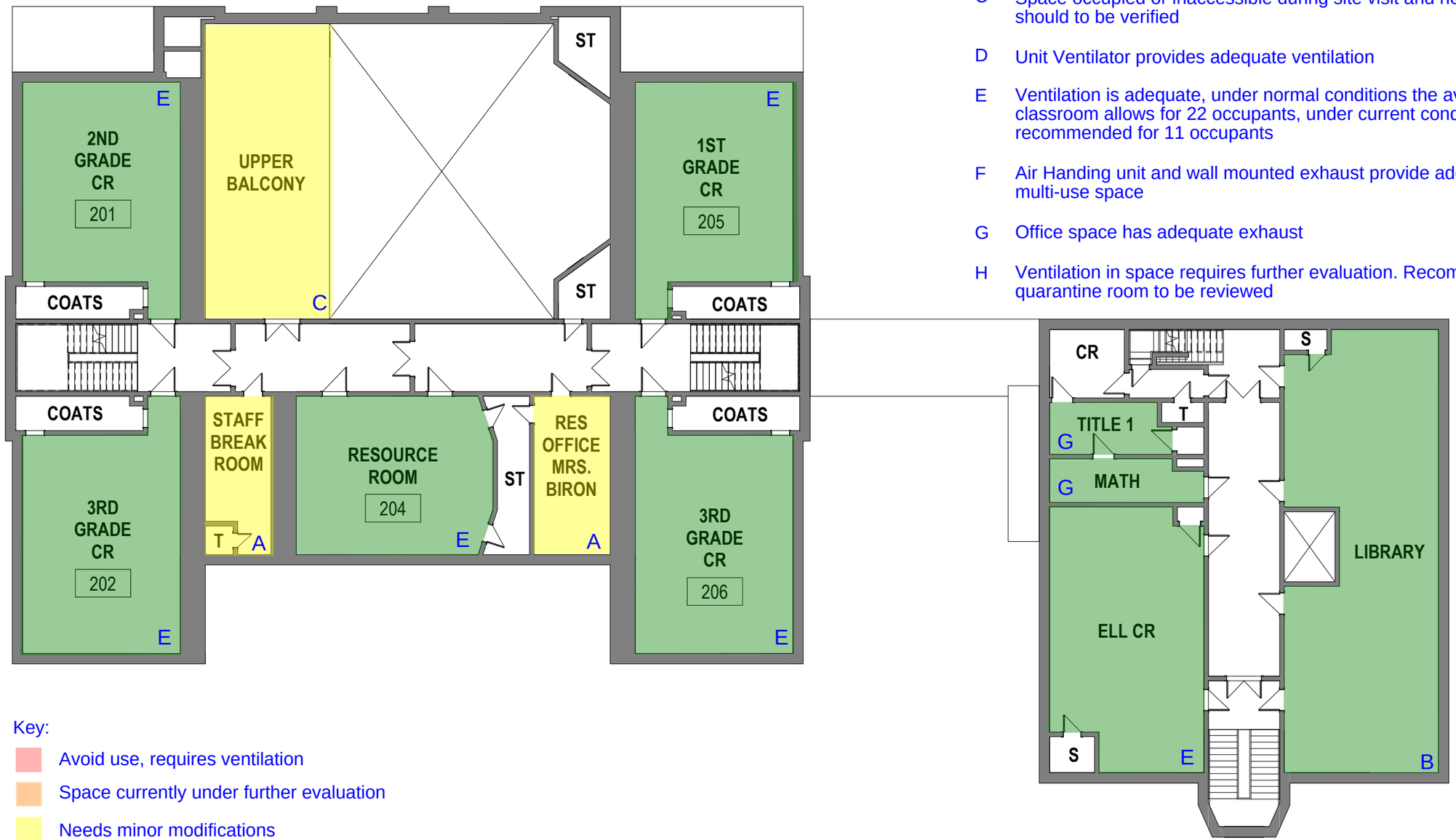
HADLEY ELEMENTARY SCHOOL

EXISTING CONDITIONS - LEVEL 1

N

08/21/2020

LAVALLEE | BRENSINGER ARCHITECTS



Legend Notes:

A No unit ventilator, confirm exhaust

B Ventilation is adequate for library use, can be used as a classroom space

C Space occupied or inaccessible during site visit and not entered, ventilation should to be verified

D Unit Ventilator provides adequate ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit and wall mounted exhaust provide adequate ventilation for multi-use space

G Office space has adequate exhaust

H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

TOWN OF SWAMPSCOTT

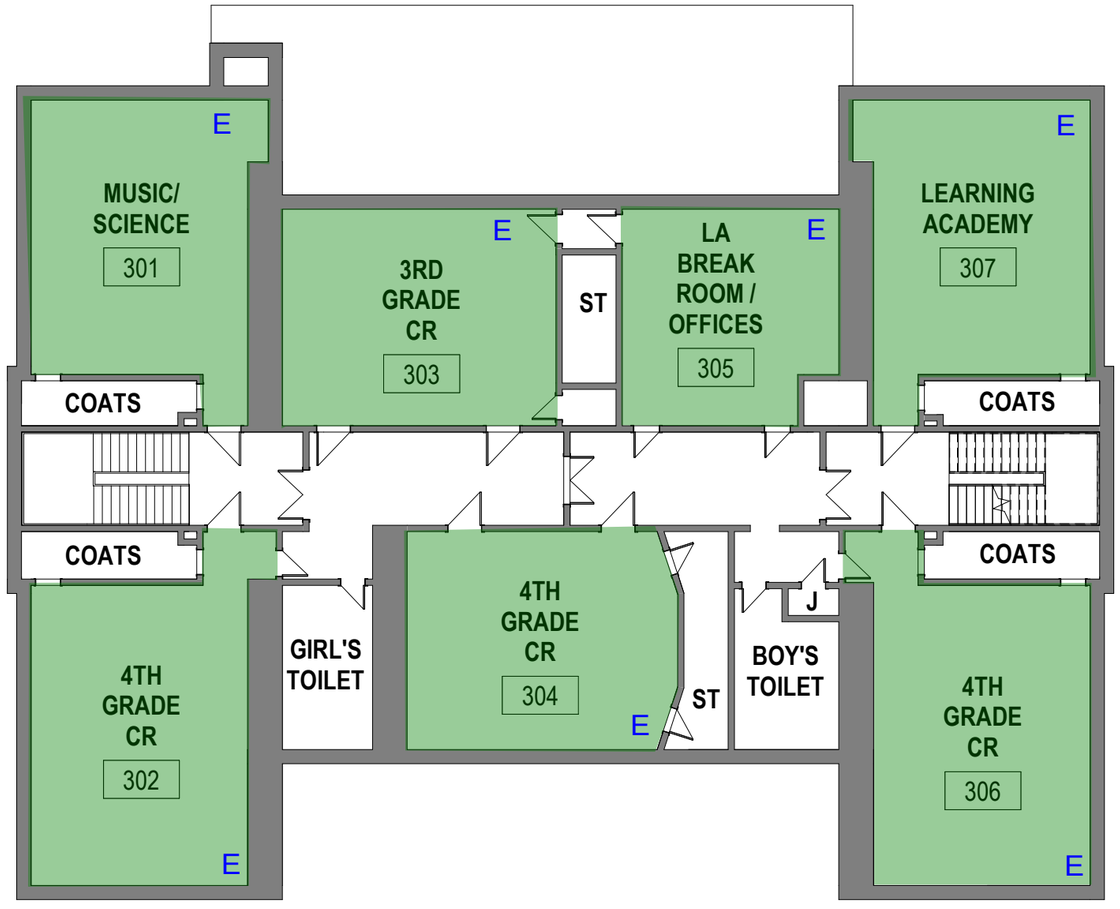
HADLEY ELEMENTARY SCHOOL

EXISTING CONDITIONS - LEVEL 2

N

08/21/2020

LAVALLEE | BRENSINGER ARCHITECTS



Key:

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- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Legend Notes:

A No unit ventilator, confirm exhaust

B Ventilation is adequate for library use, can be used as a classroom space

C Space occupied or inaccessible during site visit and not entered, ventilation should to be verified

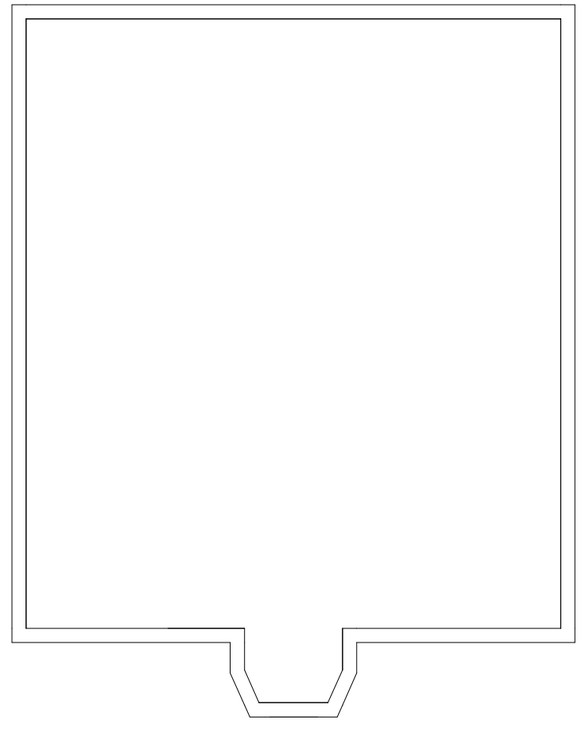
D Unit Ventilator provides adequate ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Air Handing unit and wall mounted exhaust provide adequate ventilation for multi-use space

G Office space has adequate exhaust

H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed



TOWN OF SWAMPSCOTT

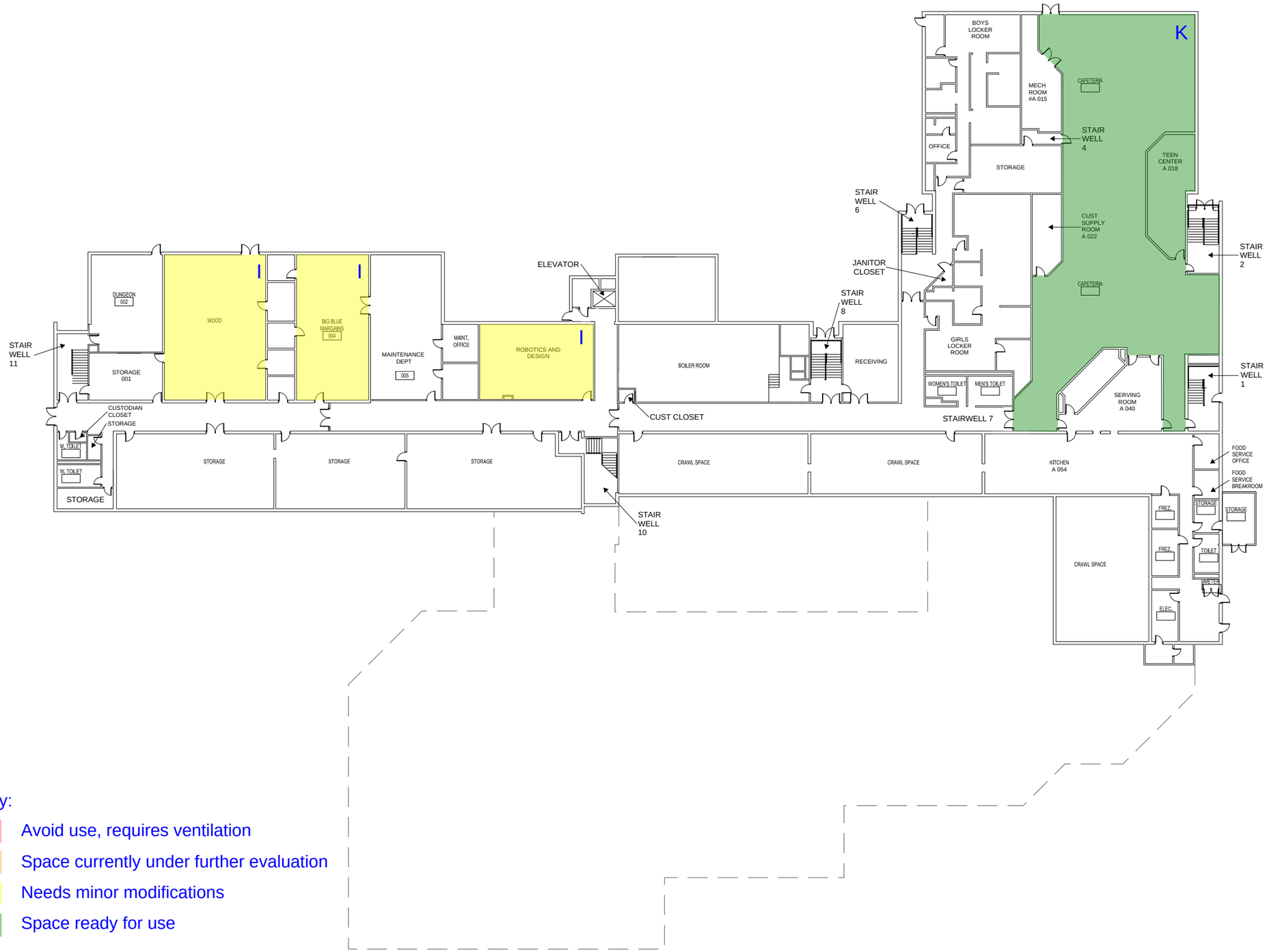
HADLEY ELEMENTARY SCHOOL

EXISTING CONDITIONS - LEVEL 3

N

08/21/2020

LAVALLEE | BRENSINGER ARCHITECTS



Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Legend Notes:

A Unit ventilator broken and no exhaust (exhaust louver is inside of office space)

B Air handling units need to be serviced for adequate ventilation

C Exhaust fans need repair, demand control vent needs to be disable and unit vent damper actuator needs to be repaired

D Space requires louver in wall or door to transfer air for exhaust and/or ventilation

E Ventilation is adequate, under normal conditions the average size 800 s.f. classroom allows for 22 occupants, under current conditions this space is recommended for 11 occupants

F Office space has adequate exhaust

G Ventilation is adequate in science labs, under normal conditions the average size 1200 s.f. classroom allows for 24 occupants with fixed lab benches, under current conditions this space is recommended for 12 occupants

H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

I Unit ventilator and exhaust is loud and needs servicing; acoustics in this space will be poor for teaching

J Air handling unit is gym provides adequate ventilation for the function of the space

K Air handling unit and unit ventilators in cafeteria provides adequate ventilation for function of the space

L Verify ventilation, transfer grilles may be required between rooms.

A-100 GROUND FLOOR PLAN

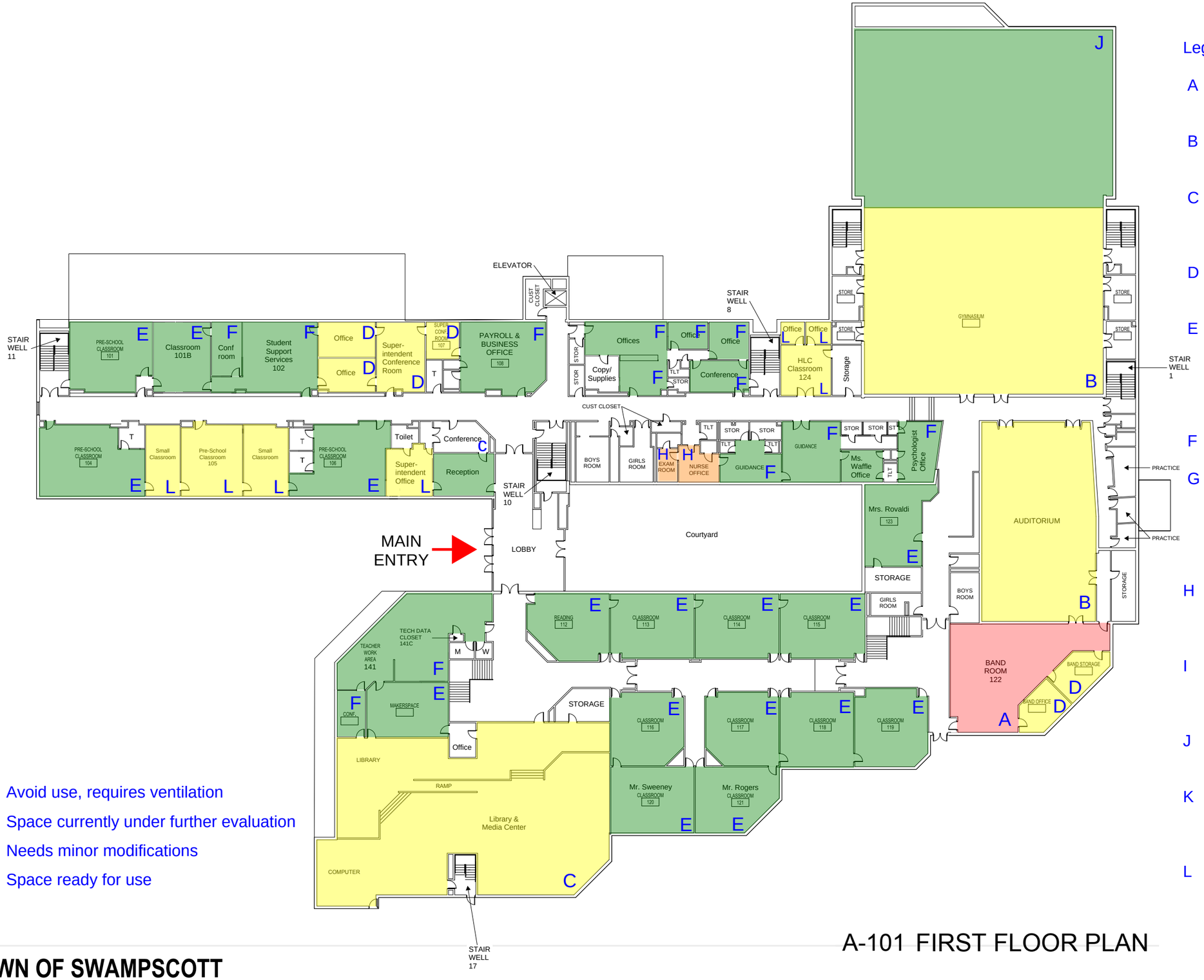
TOWN OF SWAMPSCOTT

SWAMPSCOTT MIDDLE SCHOOL

EXISTING FLOOR PLANS

08/21/2020

LAVALLEE | BRENSINGER ARCHITECTS



Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Legend Notes:

A Unit ventilator broken and no exhaust (exhaust louver is inside of office space)

B Air handling units need to be serviced for adequate ventilation

C Exhaust fans need repair, demand control vent needs to be disable and unit vent damper actuator needs to be repaired

D Space requires louver in wall or door to transfer air for exhaust and/or ventilation

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F Office space has adequate exhaust

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H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

I Unit ventilator and exhaust is loud and needs servicing; acoustics in this space will be poor for teaching

J Air handling unit is gym provides adequate ventilation for the function of the space

K Air handling unit and unit ventilators in cafeteria provides adequate ventilation for function of the space

L Verify ventilation, transfer grilles may be required between rooms.

A-101 FIRST FLOOR PLAN

TOWN OF SWAMPSCOTT

08/21/2020

LAVALLEE | BRENSINGER ARCHITECTS

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Legend Notes:

A Unit ventilator broken and no exhaust (exhaust louver is inside of office space)

B Air handling units need to be serviced for adequate ventilation

C Exhaust fans need repair, demand control vent needs to be disable and unit vent damper actuator needs to be repaired

D Space requires louver in wall or door to transfer air for exhaust and/or ventilation

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H Ventilation in space requires further evaluation. Recommendations for quarantine room to be reviewed

I Unit ventilator and exhaust is loud and needs servicing; acoustics in this space will be poor for teaching

J Air handling unit is gym provides adequate ventilation for the function of the space

K Air handling unit and unit ventilators in cafeteria provides adequate ventilation for function of the space

L Verify ventilation, transfer grilles may be required between rooms.

A-102 SECOND FLOOR PLAN

TOWN OF SWAMPSCOTT

SWAMPSCOTT MIDDLE SCHOOL

EXISTING FLOOR PLANS

08/21/2020

LAVALLEE | BRENSINGER ARCHITECTS

FIRST FLOOR:

Key:

- Avoid use, requires ventilation
- Space currently under further evaluation
- Needs minor modifications
- Space ready for use

Notes:

A Air Handling units provide ventilation and exhaust to all classrooms, offices and specialty spaces. Verify that demand control has been deactivated during this time

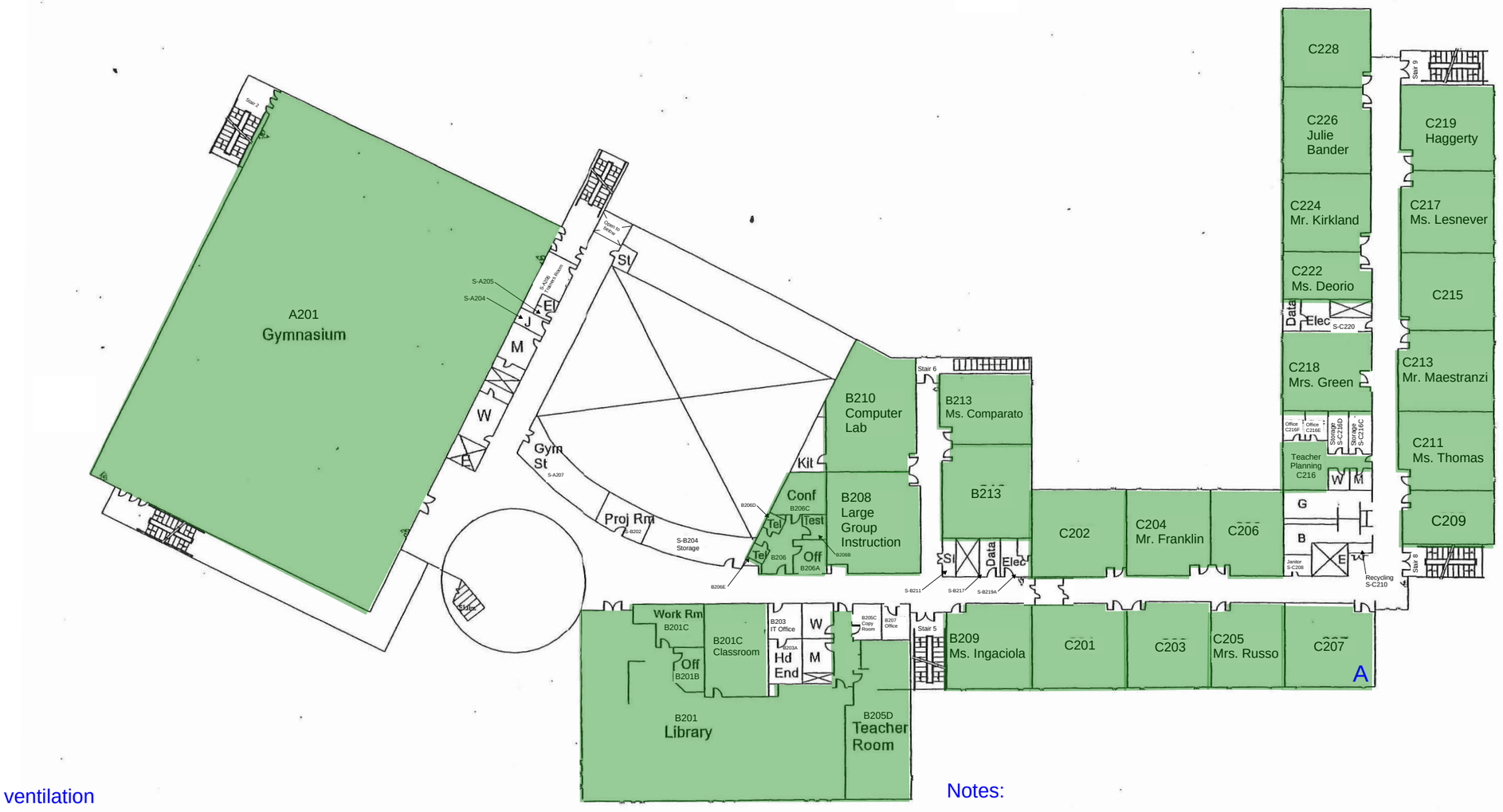
B Nurse's suite requires further evaluation. Recommendations for quarantine room to be reviewed

TOWN OF SWAMPSCOTT

08/21/2020

SWAMPSCOTT HIGH SCHOOL | EXISTING FLOOR PLANS | LAVALLEE | BRENSINGER ARCHITECTS

SECOND FLOOR:



Key:

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- Space ready for use

Notes:

A Air Handling units provide ventilation and exhaust to all classrooms, offices and specialty spaces. Verify that demand control has been deactivated during this time

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TOWN OF SWAMPSCOTT

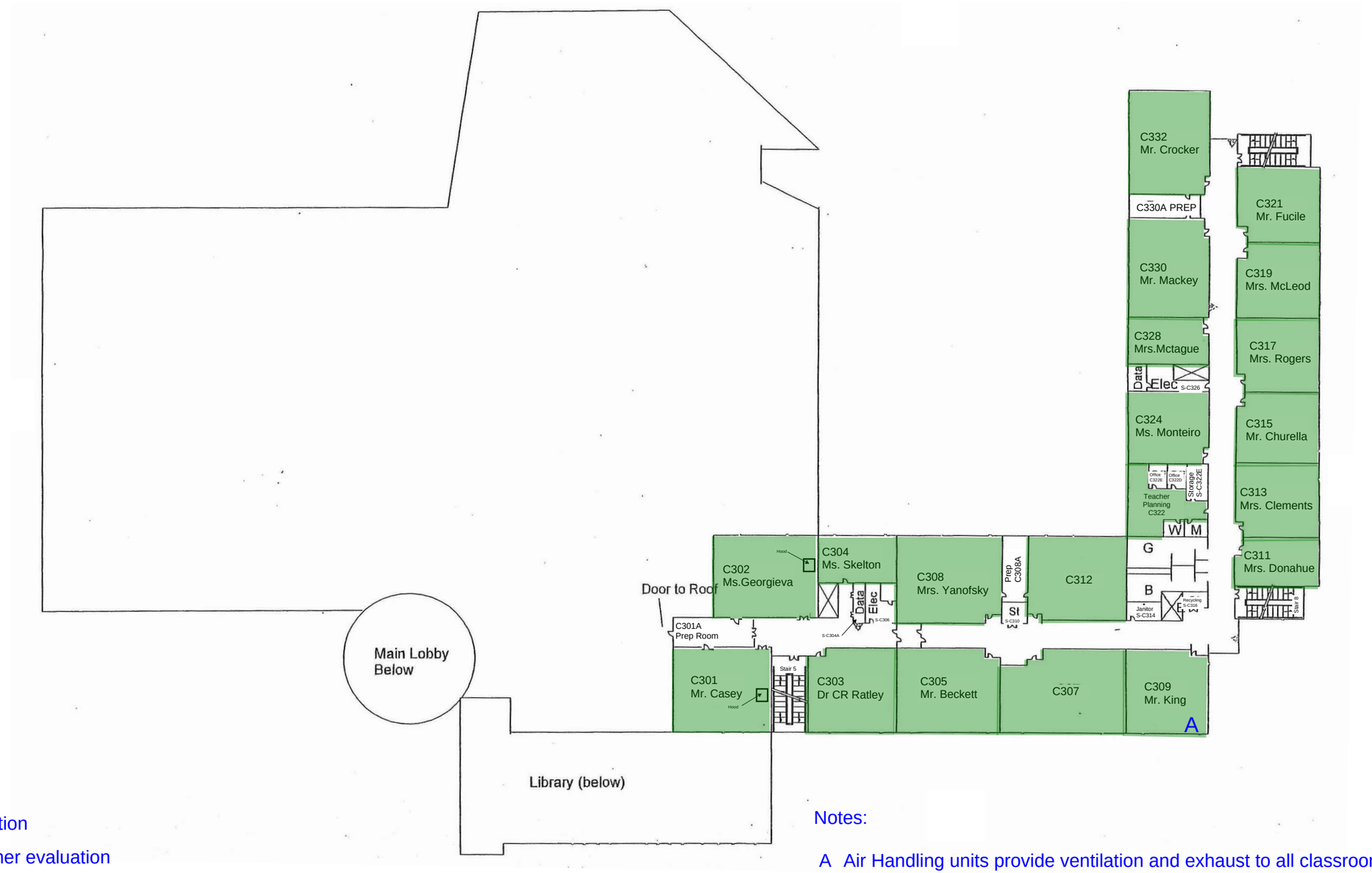
08/21/2020

SWAMPSCOTT HIGH SCHOOL

EXISTING FLOOR PLANS

LAVALLEE | BRENSINGER ARCHITECTS

THIRD FLOOR:



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- Space ready for use

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TOWN OF SWAMPSCOTT

08/21/2020

SWAMPSCOTT HIGH SCHOOL | EXISTING FLOOR PLANS | LAVALLEE BRENSINGER ARCHITECTS

Existing Conditions

Classroom and Office Ventilation Systems

General Description & Operation

Stanley Elementary School: Old school building's heating and ventilation systems are comprised of heating only unit ventilators and radiators with no mechanical exhaust fans. Unit ventilators provide outside air intake at exterior wall louver and include, heating coil, outside air damper, and air filter. Exhaust system was designed to be natural ventilation with exhaust air rising through ductwork to masonry chimney and cupola.

New school building's heating and ventilation systems are comprised of heating only unit ventilators and (4) four roof mounted exhaust fans ducted to each classroom. Unit ventilators provide outside air intake at exterior wall louver and include, heating coil, outside air damper, and air filter.

Unit ventilators and thermostats are pneumatic with air compressor system providing 8-15 psi to units. Pneumatic system has summer / winter switch which allows for outdoor air to be provided through unit ventilators in summer without heating.

Picture 1 - Typical Classroom Unit Ventilator

Picture 2 – Roof Top Exhaust Fans

Clarke Elementary School: Classroom heating and ventilation systems are comprised of heating only unit ventilators and (2) two ducted exhaust fans mounted in attic. Unit ventilators provide outside air intake at exterior wall louver and include heating coil, outside air damper, air filter.

Unit ventilators and thermostats are pneumatic with compressor system providing 8-15 psi to units. Exhaust fan systems have been retrofitted with electronic motorized dampers and controls that open and close based on time of day. Further (3) night thermostats are used to control setback temperature throughout the building. Pneumatic system has

summer / winter switch which allows for outdoor air to be provided through unit ventilators in summer without heating.

(2) two modular classrooms or "portables" are heated, cooled, and ventilated by (2) two rooftop units. Supply and exhaust air is ducted to space and delivered through duct mounted supply diffusers.

Hadley Elementary School: Main building's heating and ventilation systems are comprised of heating only unit ventilators and (7) seven ducted exhaust fans mounted on roof. Unit ventilators provide outside air intake at exterior wall louver and include heating coil, outside air damper, and air filter.

Annex building heat and ventilation systems are comprised of heating only unit ventilators and (6) six ducted exhaust fans mounted on roof. Unit ventilators provide outside air intake at exterior wall louver and include heating coil, outside air damper, and MERV 8 filter.

Unit ventilators and thermostats are pneumatic with compressor system providing 8-15 psi to units. Pneumatic system has summer / winter switch which allows for outdoor air to be provided through unit ventilators in summer without heating.

Swampscott Middle School: Shaw Wing (original school) heating and ventilation systems are comprised of heating only unit ventilators and roof mounted exhaust fans ducted to each classroom.

Roger Wing (addition) heating and ventilation systems are comprised of heating only unit ventilators and roof mounted exhaust fans ducted to each classroom. This wing had some renovations done in the 90's and (5) five unit ventilators were added with face and bypass dampers to protect against freezing in Science classroom wing.

Unit ventilators and thermostats are mostly pneumatic throughout with compressor system providing 8-24 psi to units depending on area of school. Pneumatic system has summer / winter switch which allows for outdoor air to be provided through unit ventilators in summer without heating and thermostat control to unit.

Some electronic controls have been added to the building operations. Library system is running on demand control ventilation with motorized actuators controlling unit ventilator outside air damper position based on room CO2 level. Further the hot water heating system is operating with a supply temperature reset based on outside air temperature.

Swampscott High School: Building was built in 2008 and has the most up to date systems. Eleven rooftop air handling units provide heating, cooling and ventilation to all spaces. (1) One energy recovery unit provides heating, cooling and ventilation to the locker room area.

Typical classroom systems are ducted supply and return with series fan powered variable air volume box. Supplemental heating is provided by perimeter radiant ceiling panels.

A building automation system is installed and controls all air handling units, exhaust fans, thermostats, set points and schedules.

Picture 3 – Roof Top Air Handling Unit

Auditorium, Gymnasium, Cafeteria, and Library Ventilation System

General Description & Operation

Stanley Elementary School: Library and auditorium systems are comprised of (4) heating only unit ventilators at perimeter and (2) ducted vertical fan coil heating only units with high room supply grille and low return under stage. Fan coil units were not well maintained and current operation status is unknown.

Gymnasium has an approximately 3,000 cfm air handling unit located in mechanical room that provides heating and ventilation to the space from overhead supply diffusers and low wall return grilles.

Clarke Elementary School: Library has heating only unit ventilators similar to classrooms.

Multi-purpose gym and stage room has (4) four 1,200 cfm unit ventilators that provide heating and ventilation to space. An air handling unit located in attic mechanical room

provides heating and ventilation to the kitchen area with separate exhaust fan located in mechanical room also.

Hadley Elementary School: Gym and auditorium space is heated by steam unit heaters at perimeter along with air side supply system with high room supply grilles on each side of stage. Exhaust ductwork is run under stage and up to roof top exhaust fan.

Swampscott Middle School: (2) air handling units located in mechanical rooms on each side of gymnasium provide heating and ventilation to the original gym space. Units include hot water heating coil, return damper, outside air damper and pneumatic controls. Gym addition heating and ventilation is provided by a single air handling unit located behind gym area in separate mechanical space. (4) four roof top exhaust fans provide exhaust to the space.

An air handling unit located in the gym mechanical room provides heating and ventilation to the Auditorium space. Unit include hot water heating coil, return damper, outside air damper and pneumatic controls (2) two roof top exhaust fans provide exhaust to the space.

Swampscott High School: Gym is heated and ventilated by roof top units 5 and 6. Air is distributed by ducted supply registers in the open ceiling. Return air is through (xx) low registers on the perimeter of the room.

Cafeteria air systems are provided by roof top unit 8. Unit provides heating, cooling and ventilation to space by ducted supply and return to ceiling diffusers and grilles. Fin tube radiation provides heating at exterior walls.

Auditorium air systems are provided by roof top unit 3. Unit provides heating, cooling and ventilation to space by ducted supply and return to ceiling diffusers and grilles.

Analysis

Classroom and Office Ventilation Systems

Outside Air Ventilation Rate

Stanley Elementary School: No drawings or documentation were provided for existing classroom unit ventilators. Based on size of unit air discharge and average velocity measurement, classroom unit ventilators supply approximately 1,000 cfm of mixed outside air and recirculated air to classroom for heating and ventilation. Outside air component of supply air is estimated at 300 cfm per room based on experience with similar equipment.

At 300 cfm outside air a typical 800 square foot classroom exceeds minimum ventilation requirements for 11 occupants and meets ventilation requirements for up to 20 occupants.

Clarke Elementary School: No drawings or documentation were provided for existing classroom unit ventilators. Based on size of unit air discharge and average velocity measurement, classroom unit ventilators supply approximately 1,000 cfm of mixed outside

air and recirculated air to classroom for heating and ventilation. Outside air component of supply air is estimated at 300 cfm per room based on experience with similar equipment.

At 300 cfm outside air a typical 800 square foot classroom exceeds minimum ventilation requirements for 11 occupants and meets ventilation requirements for up to 20 occupants.

While heating and ventilation supply air was currently working properly no exhaust flow could be established at registers through existing building exhaust system. Upon further inspection a programmable timer system and electronic motorized dampers system has been retrofitted on the building exhaust. When placed in override position the dampers did not open still. This system needs further troubleshooting to verify operation and does not meet minimum code requirements at time of visit.

Hadley Elementary School: No drawings or documentation were provided for existing classroom unit ventilators. Based on size of unit air discharge and average velocity measurement, classroom unit ventilators supply approximately 1,200 cfm of mixed outside air and recirculated air to classroom for heating and ventilation. Outside air component of supply air is estimated at 400 cfm per room based on experience with similar equipment.

At 400 cfm outside air a typical 800 square foot classroom exceeds minimum ventilation requirements for 9 occupants and meets ventilation requirements for up to 23 occupants.

Swampscott Middle School: No drawings or documentation were provided for existing classroom unit ventilators. Based on size of unit air discharge and average velocity measurement, classroom unit ventilators supply approximately 1,000 cfm of mixed outside air and recirculated air to classroom for heating and ventilation. Outside air component of supply air is estimated at 300 cfm per room based on experience with similar equipment.

At 300 cfm outside air a typical 800 square foot classroom exceeds minimum ventilation requirements for 11 occupants and meets ventilation requirements for up to 20 occupants.

Swampscott High School: RTU-1 and 2 are identical units and provide heating, cooling, and ventilation to the classroom areas. Units provides 83 tons of cooling at 33,000 cfm supply air and 14,850 cfm outside air each. This unit meets code requirements for the space as designed.

Auditorium, Gymnasium, Cafeteria, & Library Ventilation Systems

Outside Air Ventilation Rates

Stanley Elementary School: No drawings or documentation were provided for Auditorium, Gym and Cafeteria systems.

Based on size of supply air grille and average velocity, the library heating and ventilation units provide 1,250 cfm each of mixed outside air and recirculated air to the space for heating and ventilation. Outside air component of supply air is estimated at 380 cfm per

unit based on experience with similar equipment. Total library outside air of 760 cfm and area of 3,130 square feet meets minimum ventilation requirements for up to 75 occupants.

Based on size of air handling unit ductwork and average velocity, the gym and cafeteria heating and ventilation unit provides approximately 3,000 cfm of mixed outside air and recirculated air to the space for heating and ventilation. Outside air component of supply air is estimated at 1,000 cfm per unit based on experience with similar equipment. Gym area outside air of 1,000 cfm and area of 2,200 square feet meets minimum ventilation requirements for up to 70 occupants.

Clarke Elementary School: No drawings or documentation were provided for Multi-purpose gym and cafeteria room.

Based on size of supply air grille and average velocity the (4) unit ventilators provide 1,250 cfm each of mixed outside air and recirculated air to the space for heating and ventilation. Outside air component of supply air is estimated at 375 cfm per unit based on experience with similar equipment. Total library outside air of 1,500 cfm and area of 2,000 square feet meets minimum ventilation requirements for up to 75 occupants.

Hadley Elementary School: No drawings or documentation were provided for Multi-purpose gym and cafeteria room.

Based on size of supply air grille and average velocity the (2) concealed unit ventilators provide 1,250 cfm each of mixed outside air and recirculated air to the space for heating and ventilation. Outside air component of supply air is estimated at 375 cfm per unit based on experience with similar equipment. Total library outside air of 1,500 cfm and area of 2,200 square feet meets minimum ventilation requirements for up to 75 occupants.

Swampscott Middle School: No drawings or documentation were provided for Cafeteria unit ventilators and air handling units. Based on size of unit air discharge and average velocity measurement, air handling unit 5 provides 5,000 cfm of mixed outside air and recirculated air to the cafeteria for heating and ventilation. Outside air component of supply air is estimated at 1,000 cfm per room based on experience with similar equipment.

Further the cafeteria has (2) two unit ventilators on the exterior wall that provide approximately 1,000 cfm total air flow and 300 cfm outside air at each unit based on experience with similar equipment.

Total cafeteria outside air of 1,600 cfm and area of 6,740 square feet meets minimum ventilation requirements for up to 51 occupants.

Swampscott High School: Drawings, schedules, and access to building automation system were provided for all spaces in high school building.

RTU-3 provides heating, cooling, and ventilation to the Auditorium. Unit provides 28.75 tons of cooling at 11,500 cfm supply air and 1,000 – 6,500 cfm outside air. This unit meets minimum code requirements for the space as designed.

RTU-4 provides heating, cooling, and ventilation to the Library. Unit provides 27.5 tons of cooling at 11,000 cfm supply air and 2,160 cfm outside air. This unit meets minimum code requirements for the space as designed.

RTU-5 provides heating, cooling, and ventilation to the Art and Music rooms. Unit provides 32.5 tons of cooling at 13,000 cfm supply air and 5,850 cfm outside air. This unit meets minimum code requirements for the space as designed.

RTU-6 and 7 provides heating and ventilation to the Gym. Each unit provides 20,000 cfm supply air and 2,000-7,000 cfm outside air. These units meet minimum code requirements for the space as designed.

RTU-8 provides heating, cooling, and ventilation to the Cafeteria. Unit provides 35 tons of cooling at 14,000 cfm supply air and 1,400 – 4,000 cfm outside air. This unit meets minimum code requirements for the space as designed.

RTU-9 provides heating, cooling, and ventilation to the Administration areas. Unit provides 16 tons of cooling at 6,500 cfm supply air and 2,300 cfm outside air. This unit meets minimum code requirements for the space as designed.

RTU-10 provides heating, cooling, and ventilation to the TV studio. Unit provides 6 tons of cooling at 2,500 cfm supply air and 750 cfm outside air. This unit meets minimum code requirements for the space as designed.

RTU-11 provides heating, cooling, and ventilation to the TV studio. Unit provides 6 tons of cooling at 2,500 cfm supply air and 750 cfm outside air. This unit meets minimum code requirements for the space as designed.

ERU-1 provides heating and ventilation to the Locker room areas and includes energy recovery wheel to temper air entering in all seasons. Unit provides 5,500 cfm of outside air to space. This unit meets minimum code requirements for the space as designed.

Options & Recommendations

Stanley Elementary School:

Short Term Recommendations -

- Clean all unit ventilators and replace filter.
- Verify outside airflow from unit ventilator is operational and meets original design intent.
- Run multispeed unit ventilators at highest speed to allow for maximum airflow.
- Inspect, verify, and repair as needed all pneumatic controls, unit ventilator dampers, and thermostats throughout building.

- During cooling season operate pneumatic controls in summer mode and verify that unit ventilator outside air dampers are fully open.

- During heating season operate pneumatic controls in winter mode and verify that unit ventilator outside air dampers are fully open. **CAUTION: If system is not operating correctly a fully open unit ventilator outside air damper could lead to coil freezing and damage to unit and interior space. Facilities should carefully check damper for proper operation in freezing temperatures.**

- Turn off any pneumatic system timer controls to allow for building to run for a minimum of 2 hours before the start of school and 2 hours after school ends for building flush out.

Long Term Recommendations -

- Provide code compliant exhaust system for original school building area.

Clarke Elementary School:

Short Term Recommendations -

- Clean all unit ventilators and replace filter.

- Verify outside airflow from unit ventilator is operational and meets original design intent.

- Run multispeed unit ventilators at highest speed to allow for maximum airflow.

- Inspect, verify, and repair as needed all pneumatic controls, unit ventilator dampers, and thermostats throughout building.

- During cooling season operate pneumatic controls in summer mode and verify that unit ventilator outside air dampers are fully open.

- During heating season operate pneumatic controls in winter mode and verify that unit ventilator outside air dampers are fully open. **CAUTION: If system is not operating correctly a fully open unit ventilator outside air damper could lead to coil freezing and damage to unit and interior space. Facilities should carefully check damper for proper operation in freezing temperatures.**

- Turn off any pneumatic system timer controls to allow for building to run for a minimum of 2 hours before the start of school and 2 hours after school ends for building flush out.

- Contract building controls company to troubleshoot operation with automated building exhaust damper system. Repair system or disconnect motors and manually open dampers for short term use.

Hadley Elementary School:

Short Term Recommendations -

- Clean all unit ventilators and replace filter.
- Verify outside airflow from unit ventilator is operational and meets original design intent.
- Run multispeed unit ventilators at highest speed to allow for maximum airflow.
- Inspect, verify, and repair as needed all pneumatic controls, unit ventilator dampers, and thermostats throughout building.
- During cooling season operate pneumatic controls in summer mode and verify that unit ventilator outside air dampers are fully open.
- During heating season operate pneumatic controls in winter mode and verify that unit ventilator outside air dampers are fully open. **CAUTION: If system is not operating correctly a fully open unit ventilator outside air damper could lead to coil freezing and damage to unit and interior space. Facilities should carefully check damper for proper operation in freezing temperatures.**
- Turn off any pneumatic system timer controls to allow for building to run for a minimum of 2 hours before the start of school and 2 hours after school ends for building flush out.

Swampscott Middle School:

Short Term Recommendations -

- Clean all unit ventilators and replace filter.
- Repair or replace library roof top exhaust fan.
- Repair disconnected motorized damper linkage in library unit ventilators.
- Repair broken unit ventilator in band room 122.
- Verify outside airflow from unit ventilator is operational and meets original design intent.

- Run multispeed unit ventilators at highest speed to allow for maximum airflow.

- Inspect, verify, and repair as needed all pneumatic controls, unit ventilator dampers, and thermostats throughout building.

- During cooling season operate pneumatic controls in summer mode and verify that unit ventilator outside air dampers are fully open.

- During heating season operate pneumatic controls in winter mode and verify that unit ventilator outside air dampers are fully open. **CAUTION: If system is not operating correctly a fully open unit ventilator outside air damper could lead to coil freezing and damage to unit and interior space. Facilities should carefully check damper for proper operation in freezing temperatures.**

- Turn off any pneumatic system timer controls to allow for building to run for a minimum of 2 hours before the start of school and 2 hours after school ends for building flush out.

- Turn off demand control ventilation in library areas.

- Superintendents of Schools Office, Superintendents Conference Room, Preschool 105, Room 216, and Principals Office do not currently meet code requirements for either outdoor air supply or exhaust depending on space. Transfer grilles need to be added between partitioned areas in order to allow for proper airflow and exhaust.

Swampscott High School:

Short Term Recommendations -

- Replace all filters in roof top air handling equipment with minimum MERV 13 rated filters as capacity allows.

- Update building automation system schedule for all air handling units to allow for unit to run in occupied mode for a minimum of 2 hours before the start of school and 2 hours after school ends for building flush out.

- Turn off demand control ventilation in all areas.

Medium Term Recommendations -

- Implement minimum outside air value reset to allow for increased outside air rate as temperature decreases based on air handling unit heating and cooling coil capacity.