



INDOOR AIR QUALITY

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Fall 2019 School Environmental Health & Safety Workshops

Washington State Department of Health School Environmental Health & Safety Program

Our Mission

To protect and improve the
Environmental Health and Safety
condition of schools in Washington state.



Indoor Air Quality Principles

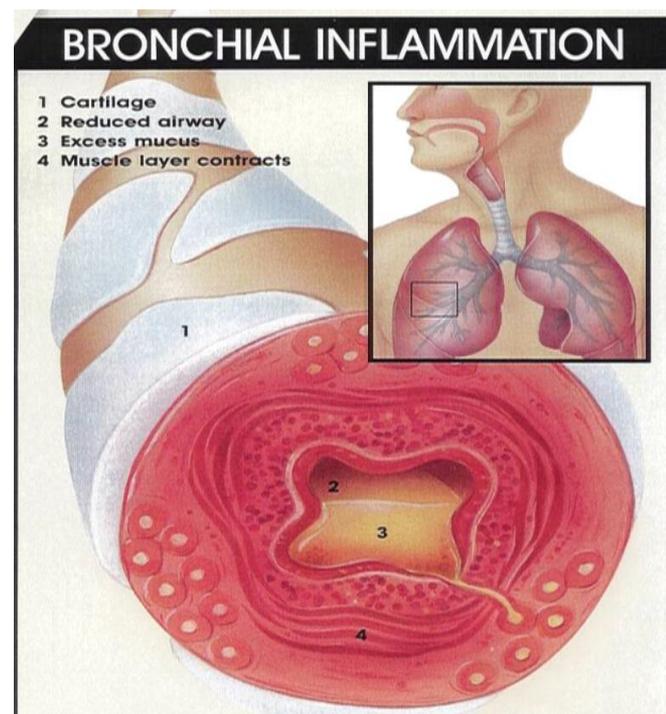
- Source control
- Ventilation
- “If there is a pile of manure in the room, do not try to remove the odor by ventilation. Remove the pile of manure.”

Max Joseph Von Pettenkofer, 1818-1901



Control Asthma Triggers

- Door mats
- Avoid clutter / cleanable surfaces
- Limit hanging items/ T-bar clips
- Vinyl/leather furniture
- Animals
- Food storage
- Water based/low VOC markers
- No fragranced products
- No chemicals from home
- Premixed clay
- Carpet cleaning
- Wash stuffed toys in hot water every 2 weeks



Perfumed, Fragranced, & Scented

- **Added fragrances can trigger asthma attacks, allergies, sensitization.**
 - People on the autism spectrum particularly impacted.
- **Eye, skin, and respiratory irritation.**
- **“Fragrance” – a thousand components.**
 - Limonene, pinenes, acetone, ethanol, camphor, benzyl alcohol, ethyl acetate, limonene, **benzene**, **formaldehyde**, 1,4-dioxane, methylene chloride, acetaldehyde, synthetic musks, **phthalates**, etc.
- **A primary source of IA and OA pollutants.**
- **Look for “fragrance-free,” not “unscented”.**
- **New Fragrance-Free Toolkit from UCLA**
<https://csw.ucla.edu/about/fragrance-free/>



Research Study

Fragranced consumer products: exposures and effects from emissions, Anne Steinemann

Air Qual Atmos Health, 20 October 2016

- 35% of population reported health problems
 - Half disabled
- 15% have lost workdays or a job due to exposure in the workplace
- 20% would leave quickly if fragranced products
- 50%+ would prefer fragrance-free public places – hotels, airlines, healthcare, work
- 53% support fragrance-free workplace policies
 - 20% opposed
- 18% unable/reluctant to use public toilets due to scented sprays
- 14% unable/reluctant to wash hands with fragranced soap

Essential Oils / Natural Air Fresheners

- All air fresheners tested – even those advertised as “natural,” “green,” “organic,” or with essential oils – emitted chemicals classified as toxic or hazardous, including some with no safe exposure level.

Hidden Hazards in Air Fresheners and Deodorizers

<http://www.drsteinemann.com/Resources/Air%20Freshener%20Fact%20Sheet.pdf>

- Persistent exposure to lavender products is associated with premature breast development in girls, according to new research by NIEHS scientists.
 - The findings also reveal that chemicals in lavender oil and tea tree oil are potential endocrine disruptors...

https://factor.niehs.nih.gov/2019/9/feature/3-feature-lavender/index.htm?utm_source=efactor-newsletter&utm_medium=email&utm_campaign=efactor-newsletter-2019-September

- **Not okay in schools/public places**
- **Sensitization reactions/asthma**
- **Respiratory, eye, skin irritation, headaches**
- **No diffusers, plug-ins, Sensei, candles, etc.**
- **Particulates/oils spread throughout room**

American Lung Association **Sample Fragrance-Free School Policy**

<http://www.healthyschools.org/documents/fragrance-free-policy-sample-updated.pdf>



Healthy Air for Healthy Schools

Use Only:

- Approved chemicals, cleaners, or disinfectants provided by the school or district. Never bring in products from home.
- Fragrance-free soap and water or fragrance-free baby wipes to clean surfaces. Disinfection is for trained custodians with approved effective products.
- Pens, markers, and board cleaners that are water-based, unscented, crayon, or low-odor.
- Spray paints and spray glues where there is mechanical exhaust ventilation.

Avoid Products That Reduce Air Quality — Do Not Use:

- Room deodorizing sprays, plug-ins, scented candle warmers, scented reeds, candles, incense, essential oils, or potpourris.
- Air-cleaning devices that generate ozone or are called "ionizers" – ozone is a respiratory irritant.
- Perfumes, colognes, body sprays and other strongly scented personal care products.
- Permanent, solvent-based, or scented pens, markers, and board cleaners.
- Disinfectant wipes.
- Urinal cakes.
- Rubber cement or spray adhesives with hexane or toluene.



Using classroom products that are free of airborne irritants means healthy indoor air quality!

- > Eliminate unnecessary chemicals.
- > Reduce asthma and headaches.
- > Increase attendance and performance!

Learn more at www.doh.wa.gov/schoolenvironment



DOH 333-243 August 2019

For people with disabilities, this document is available on request in other formats.

Call 1-800-525-0127 (TDD/TTY call 711).

Makerspaces

What requires local exhaust ventilation?

What other safety requirements?

WAC 246-360-080/110/120/140

- **3D Printers**
- **Laser Engravers**
- Hot Wheels
- LEGO WeDo coding sets
- **Paints**
- **Glue/Hot Glue**
- **Clay/Glazes/Kilns**
- Printers
- Cardboard Cutters
- Sewing Machines
- Circular Knitting looms
- Blenders & Cooking Supplies



Adequate mechanical ventilation must be provided whenever kilns, paints, glues or other vaporous materials are being used. All sources producing air contaminants of public health importance shall be controlled by the provision and maintenance of a local mechanical exhaust ventilation system.

Healthy Air Quality in Schools - Tips for Administrators, Custodians, and Teachers



Healthy Air Quality in Schools

Achieving healthy air quality in schools takes administrators, custodians, and teachers working together. Good ventilation and source control of pollutants means healthy indoor air quality.

General Tips

- Teachers and staff need to know who to contact for indoor air quality concerns in the school.
- There should be a written school or district indoor environmental quality plan that includes indoor air quality and integrated pest management.
- Notify school or district indoor air quality contact or maintenance staff if you detect odors or dust from locations such as shops, copy rooms, science labs, laminators, locker rooms, graphic arts, custodial supply rooms, storage areas, combustion equipment, kitchens, or bus exhaust. Document your concerns.
- Immediately report any water leaks, water stains, damp materials, or unusual odors (such as musty or moldy smells) to maintenance staff.
- Maintenance staff should respond to water leaks and moisture problems within 24 hours.
- Relative humidity levels between 30 and 50 percent are better for health. Low relative humidity leads to dry eyes and respiratory irritation. High relative humidity allows dust mites to grow and promotes condensation.
- Dispose of food wastes promptly in covered containers.

Ventilation

- Operate the ventilation system continually when the school is in use, including during custodial work. Supply at least 15 cubic feet per minute per person of fresh outside air whenever the school is in use. See [WSU Energy Program's Good Ventilation is Essential for a Healthy and Efficient Building \(PDF\)](http://www.energy.wsu.edu/Portals/0/Documents/Good_Ventilation_is_Essential.pdf). (www.energy.wsu.edu/Portals/0/Documents/Good_Ventilation_is_Essential.pdf).
- An occupied room is considered to be receiving the minimum amount of fresh air when indoor carbon dioxide (CO₂) levels are approximately 700 parts per million (ppm) over outside ambient CO₂ levels. See [WSU Energy Program's Measuring Carbon Dioxide Inside Buildings \(PDF\)](http://www.energy.wsu.edu/Portals/0/Documents/Measuring_CO2_Inside_Buildings-Jan2013.pdf). (www.energy.wsu.edu/Portals/0/Documents/Measuring_CO2_Inside_Buildings-Jan2013.pdf).
- Maintain three feet of clearance around unit ventilators and do not put items on top of them to block airflow.
- Change ventilation filters regularly. Use the highest rated, deepest pleat filters the system can accommodate.
- Check to make sure that supply air diffusers, exhaust, and return grills are not blocked. They should be clean and dry.
- Don't turn off unit ventilators – ask maintenance staff to repair noisy units, control temperatures, and control drafts.
- Monitor windows – they should not show condensation except on the very coldest of days.
- Don't allow vehicle idling on school property.
- Maintenance staff should follow integrated pest management strategies. Don't use pesticides in the building.

Control Asthma Triggers

Reduce Animal Allergens, including Dust Mites

- Animals shouldn't be classroom residents and should only come to school for educational purposes.
- Use integrated pest management practices to prevent cockroach and rodent infestations.
- Store food in tightly sealed containers.
- Seal all cracks and crevices.
- Grate all foundation and roof ventilation.
- Use barriers to discourage birds roosting.
- Wash stuffed animals and blankets in hot water every two weeks, or remove them.

Control Dust

- All outside doors should have large entry mat barriers (walk-off mats) outside and just inside the door. The mats should provide at least four to seven footfalls.
- Maintain cleanable surfaces and avoid clutter. Put loose items into plastic boxes with lids that can be wet-wiped.
- Damp-wipe surfaces weekly with a micro-fiber cloth.
- Don't hang items from the ceiling T-bars without special clips to prevent fraying fiberglass. Remove or clean items when dusty.
- Discourage clutter by removing as many unnecessary dust-collecting items as possible.
- Use pre-mixed and pre-wetted clay art supplies whenever possible to reduce dusts.
- Replace fabric upholstered furniture with furniture easily dusted.
- Remove area rugs that cannot be regularly cleaned and that trap dirt and moisture.

Reduce Chemicals

- Don't use permanent, solvent-based or scented pens, markers, and board cleaners. Use water-based, unscented, crayon-based, or low-odor items.
- Don't use room deodorizing sprays, plug-ins, scented candle warmers, scented reeds, candles, incense, therapeutic oils, or potpourris.
- Don't use urinal cakes in bathrooms.
- Avoid spray adhesives, contact cement, and volatile paints. If spray adhesives are necessary, use hexane and toluene-free products. Wear solvent-resistant gloves. Spray in an area with local exhaust ventilation and away from children. See [King County's Selecting Safer Art Adhesives](http://www.kingcounty.gov/Portals/0/Documents/Art/Art_Adhesives.pdf) (www.hazwastehelp.org/publications/publications_detail.aspx?DocID=z%2F70%2F2BLUUM%3d).
- Don't bring chemicals, cleaners, or disinfectants from home. Use only those provided by the school or district.
- Never use air-cleaning devices that generate ozone. Ozone is a respiratory irritant.
- Discourage the use of perfumes, colognes, body sprays and other strongly scented personal care products.
- Hazardous chemicals in laboratories, chemical storages, shops, art rooms, and any other areas need to be properly stored and managed to prevent air contamination.

Carpet Care

- Whenever possible, don't allow food or beverages in classrooms. If possible, vacuum daily (when children are not present). Use a vacuum with a HEPA (high efficiency particulate air) filter – or use HEPA vacuum bags. Having both is even better.
- Avoid use of area rugs. They can trap moisture and dirt under them. Clean carpets thoroughly with truck-mounted hot water and steam extraction once or twice per year.
 - Spot treat carpet as needed first.
 - Use the minimum amount necessary of low-odor and low-sudsing carpet shampoo.
 - All shampoo and cleaner needs to be thoroughly extracted until the water runs clean.
 - Carpet should dry thoroughly within 24 to 48 hours after cleaning.

Resources

- [School Environmental Health and Safety, Department of Health](http://www.doh.wa.gov/schoolenvironment) (www.doh.wa.gov/schoolenvironment)
- [School Indoor Air Quality Best Management Practices Manual, 2003 \(PDF\)](http://www.doh.wa.gov/Documents/Pubs/333-044.pdf) (www.doh.wa.gov/Documents/Pubs/333-044.pdf)
- [Integrated Pest Management for Schools, WSU](http://schoolipm.wsu.edu/) (<http://schoolipm.wsu.edu/>)
- [Creating Healthy Indoor Environments in Schools, EPA](http://www.epa.gov/iaq/schools/index.html) (www.epa.gov/iaq/schools/index.html)
- [Taking Asthma Care To School, Washington Asthma Initiative \(PDF\)](http://www.waasthma.org/wp-content/uploads/2014/05/AMES2014Final.pdf) (<http://www.waasthma.org/wp-content/uploads/2014/05/AMES2014Final.pdf>)
- [Art Hazards, King County Local Hazardous Waste Management Program](http://www.hazwastehelp.org/ChemToxPesticides/artchemicals.aspx) (<http://www.hazwastehelp.org/ChemToxPesticides/artchemicals.aspx>)

IAQ Research

Reported ventilation and CO2 data strongly indicate that ventilation is inadequate in many classrooms, possibly leading to health symptoms. Adequate ventilation should be a major focus of design or remediation efforts.

*Indoor air quality, ventilation and health symptoms in schools:
An analysis of existing information* (Daisey, JM, Angell, WJ, Apte, MG, Indoor Air
2003;13;53-64.

There is evidence that low ventilation rates and other building characteristics can lead to increased incidence of respiratory diseases caused by viruses (Brundage et al., 1988; Fisk, 2001).

Outside Air

- Increased Ventilation – Increased Achievement
- Work performance may be improved from a few percent to possibly as much as 10% by providing superior indoor environmental quality (IEQ).
- The economic benefits of the work performance improvements will often far outweigh the costs of providing better IEQ.

Lawrence Berkeley National Laboratories

<https://www.iaqscience.lbl.gov/performance-summary>

Ventilation and School Performance

Increases in classroom ventilation rates up to approximately **20 cfm per student** are associated with improvements in student performance of a few to several percent, with the magnitude of improvement depending on the initial ventilation rate.

Increases of ventilation rates up to approximately **15 cfm per student** are associated with a higher proportion of students passing standardized reading and math tests.

[Lawrence Berkeley National Labs Indoor Air Quality Scientific Finding Resource Bank
https://www.iaqscience.lbl.gov/performance-summary](https://www.iaqscience.lbl.gov/performance-summary)

Carbon Dioxide and Performance

- Is CO₂ an Indoor Pollutant? Direct Effects of Low-to-Moderate CO₂ Concentrations on Human Decision-Making Performance

<https://ehp.niehs.nih.gov/doi/10.1289/ehp.1104789>

Satish, et al. EHP September 2012

- Relative to 600 ppm, at 1,000 ppm CO₂, moderate and statistically significant **decrements** occurred in six of nine scales of decision-making performance. At 2,500 ppm, large and statistically significant reductions occurred in seven scales of decision-making performance
- Epidemiologic and intervention research has shown that higher levels of CO₂ within the range found in normal indoor settings are associated with perceptions of poor air quality, increased prevalence of acute health symptoms (e.g., headache, mucosal irritation), slower work performance, and increased absence. (Erdmann and Apte 2004; Federspiel et al. 2004; Milton et al. 2000; Seppanen et al. 1999; Shendell et al. 2004; Wargocki et al. 2000).

Filtration

- ASHRAE Filter Rating of MERV 8-**13**
 - prefilter
- Deepest pleat possible – less resistance
- Tight fit
- Change as needed (3 months)
- Not just to protect the unit – **Filter the outside air!**
- Reduce classroom clutter/furnishings
- Entry mats – cleaned regularly
- Vacuums with HEPA filters

Ventilation in the Codes

- 2015 International Mechanical Code (WAC 51-52)
- IMC ventilation requirements are based on ASHRAE 62.1
- **Codes are minimum.**
- Classrooms/computer labs: **10 cfm/person + 0.12 x ft²**
 - Default: 15 cfm/person
- Science, art, wood/metal shops: **10 cfm/person + 0.18 x ft²**
 - Default: 17 cfm/person for science labs,
19 cfm/person for art and wood/metal shops.
 - Air from these rooms may not be recirculated to other parts of the building.

WAC 246-366-080 Ventilation.

(1) All rooms used by students or staff shall be kept reasonably free of all objectionable odor, excessive heat or condensation.

(2) All sources producing air contaminants of public health importance shall be controlled by the provision and maintenance of local mechanical exhaust ventilation systems as approved by the health officer.

Codes – Natural Ventilation

WAC 51-11C – 2015 International Energy Conservation Code

C403.6 Dedicated outdoor air systems (DOAS). (This section is **Optional through 6/30/2017; it becomes Prescriptive as of 7/1/2017**). For office, retail, **education**, libraries and fire stations, outdoor air shall be provided to each occupied space by a **dedicated outdoor air system (DOAS) which delivers 100 percent outdoor air without requiring operation of the heating and cooling system fans for ventilation air delivery.**

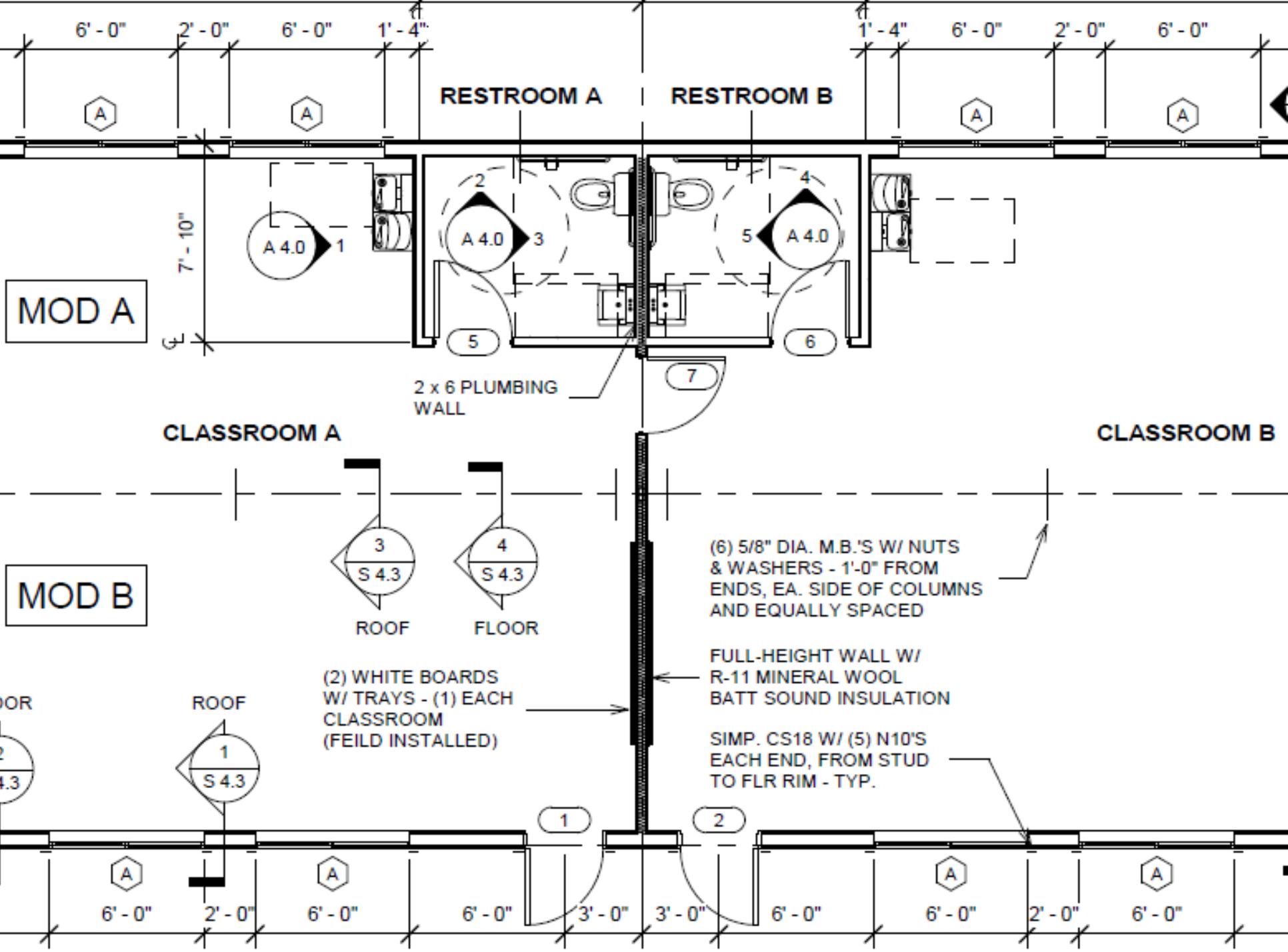
Exceptions:

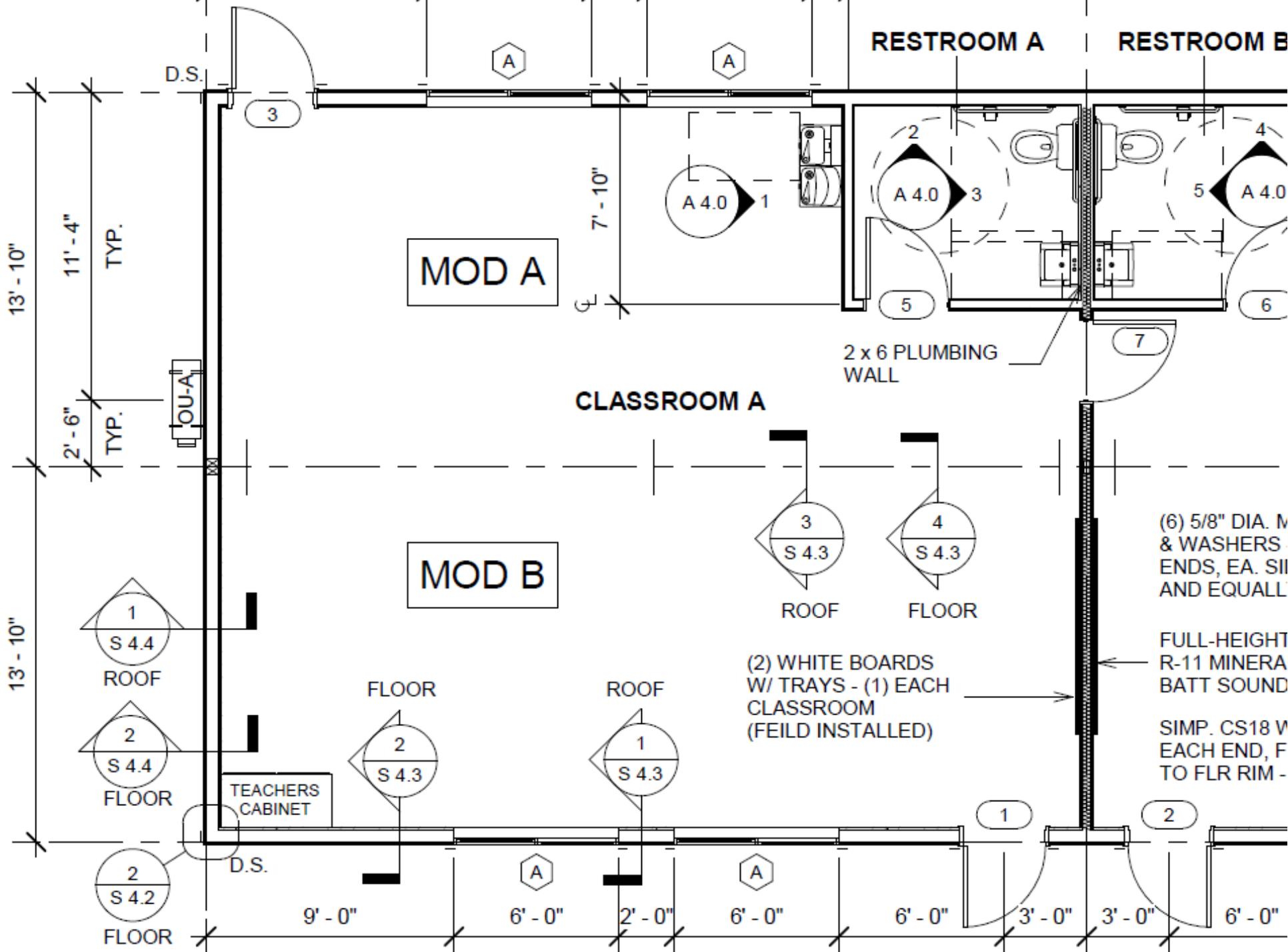
Occupied spaces that are not ventilated by a mechanical ventilation system and are only ventilated by a natural ventilation system per Section 402 of the *International Mechanical Code*.

WAC 51-52 – 2015 International Mechanical Code

402.1 Natural ventilation. *Natural ventilation* of an occupied space shall be through windows, doors, louvers or other openings to the outdoors. The operating mechanism for such openings shall be provided with ready access so that the openings are readily controllable by the building occupants.

402.2 Ventilation area required. The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.





Portable Plans

PER WSEC C402.5.1.2 BUILDING TEST. THE COMPLETED BUILDING SHALL BE TESTED AND AIR LEAKAGE RATE OF THE BUILDING ENVELOPE SHALL NOT EXCEED 0.40 CFM/SQ. FT. AT A PRESSURE DIFFERENTIAL OF 0.3 INCHES OF WATER GAUGE IN ACCORDANCE WITH ASTM E 779 OR AN EQUIVALENT METHOD APPROVED BY THE CODE OFFICIAL.

THE AIR BARRIER SHALL BE CONTINUOUS FOR THE THERMAL ENVELOPE & ACROSS THE JOINTS & ASSEMBLIES. JOINTS & SEAMS SHALL BE SEALED, INCLUDING SEALING TRANSITIONS IN PLACES & CHANGES IN MATERIALS. PENETRATIONS OF THE AIR BARRIER & PATHS OF AIR LEAKAGE SHALL BE CAULKED, GASKETED, OR OTHERWISE SEALED IN A MANNER COMPATIBLE WITH THE CONSTRUCTION MATERIALS & LOCATION

11. THIS PROJECT PROVIDES TWO ADDITIONAL EFFICIENCY PACKAGE OPTIONS PER 2015 WSEC, SECTION C406.

A. ENERGY ADD OPTION #1 IS C406.1 (ITEM #2); C406.3 REDUCED LIGHTING POWER DENSITY. INSTALLED LIGHTING WATTAGE IS LESS THAN 75% OF ALLOWED INTERIOR LIGHTING WATTAGE WSEC C405.4.2(1) OR C404.4.2(2)

B. ENERGY ADD OPTION #2 IS C406.1 (ITEM #3); C406.4 ENHANCED LIGHTING CONTROLS. NO LESS THAN 90% OF ALL INTERIOR LIGHTING IS CONTROLLED WITH CONTINUOUS DIMMING ALONG WITH EXCEPTION #3 OF WSEC 406.4

12. THIS PROJECT MEETS DEDICATED OUTDOOR AIR SYSTEM REQUIREMENTS PER WSEC C403.6, EXCEPTION #1, NATURAL VENTILATION AREAS AT WINDOWS IS GREATER THAN 4% OF FLOOR AREA (SEE NATURAL VENTILATION SCHEDULE MO.1)

WINDOW SCHEDULE

Mark	Count	Width	Height	Type	Frame	Glass	SHGC	U-VAL	Air Leakage
A	8	6' - 0"	4' - 0"	XO	VINYL	DUAL / LOW E / ARGON / SOLAR TINT / TMP	0.30	0.3	.18 CFM/SF

LIGHTING PLAN NOTES

1. THIS BUILDING PROVIDES LIGHTING "ADDITIONAL EFFICIENCY PACKAGE OPTIONS" PER C406.3 & C406.4
2. LIGHT LEVELS TO MEET WAC 246-366A-115 TABLE 2
3. OCCUPANCY SENSOR(S) IN EACH ROOM WILL BE WIRED TO CONTROL ALL LIGHT FIXTURES IN THAT ROOM.

MECHANICAL NOTES

1. MECHANICAL UNIT:
SEE 'HVAC SYSTEM SCHEDULE'
2. EXHAUST FAN:
EF-1: PANASONIC FV-08VQ5 (80 CFM)
DAMPER: FAMCO ADC4120 MOTORIZED DAMPER
3. CONTROLS:
THERMOSTAT:
WIRELESS PROGRAMMABLE CONTROLLER
DAIKIN BRC1E73
4. DUCTWORK:
NONE
5. VOLUME DAMPERS:
6. NOISE LIMITS:
DESIGN MECHANICAL EQUIPMENT TO MEET NC-35
NOISE CRITERION AND MECHANICAL BACKGROUND
NOISE AT OR BELOW 45 DBA.
LOCATE BUILDINGS AWAY FROM NOISE AND
POLLUTION SOURCES.
7. DEDICATED OUTDOOR AIR SYSTEM (DOAS - WSEC C403.6)
 1. THIS PROJECT MEETS DEDICATED OUTSIDE AIR
SYSTEM REQUIREMENTS PER WSEC C403.6,
EXCEPTION #1. NATURAL VENTILATION AREAS AT
WINDOWS IS GREATER THAN 4% OF FLOOR AREA AT
REQUIRED AREAS.
 2. (ERV) EQUIPMENT NOT REQUIRED ON THIS PROJECT.
REQUIRED AREAS ARE PROVIDED WITH NATURAL
VENTILATION

Plans – Continued

OUTSIDE AIR CALCULATION

MECHANICAL UNIT A :

CLASSROOM	(27 OCC)(10 CFM)	= 270
AREA FACTOR	(764 SF)(.12 CFM)	= 92
RESTROOM	(1 FIXT)(70 CFM)	= 70
TOTAL		= 432 CFM

MINIMUM OUTSIDE AIR FOR
UNOCCUPIED BUILDING = 92 CFM

MECHANICAL UNIT B :

CLASSROOM	(27 OCC)(10 CFM)	= 270
AREA FACTOR	(764 SF)(.12 CFM)	= 92
RESTROOM	(1 FIXT)(70 CFM)	= 70
TOTAL		= 432 CFM

MINIMUM OUTSIDE AIR FOR
UNOCCUPIED BUILDING = 92 CFM

NATURAL VENTILATION SUMMARY

Name	Area	4% Of Floor Area	Window Cir. Opening
CLASSROOM A	764 SF	30.57 SF	41.4
CLASSROOM B	764 SF	30.57 SF	41.4

Ventilation and Portables

- OA needs to be continuous in portables.
- The 6'x4' windows will need to be open all the way constantly to properly ventilate.
- Heating and cooling with the windows open?
- If windows are closed because of heat, cold, wind, rain, pollen, or air pollution then CO₂, chemicals, and body odors will rapidly build up.
- Well insulated and sealed for energy efficiency with large, energy efficient, low-E, tinted windows.
- The bathroom exhaust fans designed to only operate with the light is on and the bathroom occupied.
- The OA calculation for the design was based on an occupancy of 27 on each side.

DOAS vs. Natural Ventilation

The original proponent of the DOAS provision stated that in their opinion natural ventilation is a great option for many spaces when outdoor conditions are suitable, but is not a good idea as the sole source of ventilation particularly for **high occupant density spaces**.

They recommend a hybrid approach with a DOAS sized for the full ventilation load and operable windows with HVAC system lock-out controls when the windows are opened, as the most energy efficient solution.

L&I: ~25% of the permitted portable buildings required to have DOAS are installing them. The remaining 75% are going with either all natural ventilation or partial ventilation through the HVAC system and the remaining balance via natural ventilation.

In a recent instance the portable classroom manufacturer offered to include with their building a DOAS or operable windows sized for ventilation, and the school district chose operable windows.

Tool Lending Library

Smart Buildings Center, NW Energy Efficiency Council (NEEC)

<https://www.smartbuildingscenter.org/tool-library/>

Lending “library” of diagnostic tools.

CO, CO₂, data loggers, power meters, lighting loggers, infrared cameras, liquid and air flow measurement devices, etc.

Free of charge. Shipping or pick up Tues-Thurs 9-4.

Guidance on how to use/interpret data.

Library of videos and application notes.

Tool-library@smartbuildingscenter.org

206-538-0685

You can subscribe for updates.



THANK YOU!

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Resources available:

www.doh.wa.gov/schoolenvironment

Join my list serve for timely information!

