



# YUKON WILDFIRE SMOKE RESPONSE GUIDELINES FOR PROTECTING PUBLIC HEALTH

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## **Glossary of Terms**

**At Risk:** refers to individuals who has been identified as having a medical condition that, when affected by specified external stressors, can have their health status compromised.

## **1. BACKGROUND**

Wildfires in Canada are expected to increase in size, severity and duration (Elliott, 2014). Climate change, reduced snowfall, low water levels, increasing summer temperatures and more lightning storms are all contributing to unfavorable conditions in the North and across Canada (Ecology North, 2017). Over a 56-year period (from 1950 to 2006) there were 6,294 fires and 8,148,354 hectares burned in Yukon (Government of Yukon, 2011). This has the potential to grow, as the average annual fires and area burned may double by 2069 due to climate change impacts (McCoy & Burn, 2005). In addition smoke from wildfires can affect communities that are hundreds of kilometers from the source of the fire, thereby increasing the potential of wildfire smoke events in Yukon (Barn et al., 2016).

Smoke from wildfires poses a health risk to the public (Elliott, 2014). While some communities in Yukon do have existing emergency measures plans which may include forest fire response elements, there is no plan in place on how to mitigate and prevent exposure to wildfire smoke for the general public. It is prudent to both advise the public of the potential health risk as well as provide resources on how the population can manage their individual health. The decision to order an evacuation or partial evacuation of a community should be considered a last resort measure, as there are less intrusive protective health measures that can be taken first. Evacuation can have a significant psycho-social impact to evacuees and may create additional stressors when individuals are away from support systems and resources (Elliott, 2014).

Furthermore wildfire smoke can have impacts on health care facilities by increasing patient loads, to mitigate this stress on the health system well-planned communications and prevention strategies may reduce this potential burden.

Comprehensive emergency management in Canada includes four inter-related components including prevention and mitigation, preparedness, response and recovery. The guidelines will primarily focus on preparedness and response with respect to wildfire smoke events.

### **1.1 OBJECTIVE**

This document provides planning considerations to assist decision makers in taking measures to protect public health and well-being during a wildfire smoke event including the movement of populations at risk, and to assist health agencies in communicating health risks and strategies to protect people from wildfire smoke. Decision makers may include local government in communities, personnel involved in emergency planning, First Nation governments and the health emergency management committee (HEMC).

### **1.2 SCOPE**

- Wildfire smoke and health effects background
- Roles & responsibilities for preparedness and planning
- Air quality assessment of smoke conditions

- Evidence-based recommendations for measures to reduce health effects

### **1.3 SMOKE FROM WILDFIRES**

#### **1.3.1 Wildfire Smoke**

Wildfire smoke is an annual event throughout Yukon caused by wildland fires that are either attributed to lightning strikes or human causes (Government of Yukon, 2011). Additionally wildfires from jurisdictions outside of Yukon may impact the air quality experienced locally.

#### **1.3.2 Smoke Composition**

The composition of wildfire smoke is dependent on multiple factors such as the type of vegetation burned and other weather-related factors (Ministry of Health, Province of BC, 2012). Wildfire smoke is comprised of particles and gasses. Gasses in wildfire smoke include carbon monoxide, nitrogen oxides, and volatile organic compounds. Some of the compounds in wildfire smoke are known to be carcinogenic, such as polycyclic aromatic hydrocarbons (PAHs), benzene and free radicals. In addition there are secondary pollutants that are produced by wildfire smoke (Elliott, 2014). The concentration and composition of wildfire smoke is highly variable and can change from each fire and as the smoke plume ages (Elliott, 2014).

#### **1.3.3 Air Quality**

Air quality is defined as the state of the air around us (BC Air Quality, 2017). Poor air quality is caused by pollutants, such as those found in wildfire smoke that increase in concentration and pose a danger to human health and/or the surrounding environment.

Individual reaction to air pollutants varies. Health effects due to air quality are determined by exposure length, quantity of air breathed, personal health status and the concentration of pollutants in the air (Government of NWT, 2016).

The Air Quality Health Index (AQHI) is an information tool available to the public from Environment Canada & Climate Change that assists Canadians in protecting their health from the potential effects of poor air quality (Government of Yukon, 2017). This tool is only available in Whitehorse and does provide updates on local air-quality on a 24-hour averaging period (Government of Yukon, 2017). For more information on the AQHI and how it is calculated is available at: [http://www.env.gov.yk.ca/air-water-waste/air\\_emissions\\_regs.php](http://www.env.gov.yk.ca/air-water-waste/air_emissions_regs.php)

For the remainder of the Yukon where AQHI is not available, it is possible to estimate the AQHI by the observed visibility as seen in **Table 2 on page 15** of this document.

#### **1.3.4 Particulates**

Sources of airborne particulate in both urban and rural settings include:

- Motor vehicle exhaust
- Wood burning stoves and fireplaces

- Dust from construction, landfills and agriculture
- Wildland fires and brush or waste burning
- Industrial emission sources
- Wind-blown dust
- Volcanoes
- Some pollen

### **1.3.5 Health Effects of Wildland Fire Smoke**

Evidence for wildfire smoke effects is limited, as the differences between wildfire smoke effects on health compared to other sources of air pollution are still not well understood (Elliott, 2014). Wildfire smoke typically has finer Particulate Matter (PM) than urban air pollution, and also to contain a different mix of organic gasses (Elliott, 2014).

Demonstrated health effects from wildfire smoke are limited based on current scientific literature, however there are associations that have been demonstrated such as asthma and COPD exacerbations, bronchitis, pneumonia, all-cause mortality, cardiovascular outcomes, adverse birth outcomes, childhood respiratory disease and anxiety (Elliott, 2014). In addition symptoms such as: eye irritation, sore throat, wheeze and cough have been noted (Elliott, 2014). Additional long term health effects are not known such as lung cancer, atherosclerosis and chronic disease (Elliott, 2014). Furthermore health risks can be exacerbated by heat waves especially for vulnerable populations (Elliott, 2014).

### **1.3.6 Populations at Risk and Requiring Special Care**

There are a number of factors that cause certain populations to be more susceptible to the effects of air pollution (Elliott, 2014). These factors include age, gender, genetics and pre-existing conditions (Elliott, 2014).

#### **Populations at Risk Due to Susceptibility to Smoke:**

- Pregnant women and unborn children
- Infants and young children
- Adults 65 and over
- Populations with pre-existing respiratory disease
- Populations with pre-existing cardiovascular disease
- Populations with chronic inflammatory diseases (e.g., diabetes, obesity)

**Source:** Elliott, C.T. (2014) Guidance for BC Public Health Decision Makers During Wildfire Smoke Events

## **Special Care during any Emergency is required for the Following Populations:**

- Any condition medical or social in nature and include individuals whose activities of daily living (ADLs) or health care needs require specified support in the pre-emergency environment, and in an emergency response environment those care needs cannot be maintained.
- People requiring any special care and supportive care (ex: wheelchair, stretcher, institutionalized residents, on dialysis, home care).
- People with mobility issues.
- Language, social and economic isolation.

## **2. Roles & Responsibilities**

### **2.1 FEDERAL GOVERNMENT**

#### **2.1.1 Public Health Agency of Canada (PHAC)**

In a national health emergency or disaster, the Office of Emergency Response Services (OERS) is responsible for supporting emergency health and social services in the provinces, territories or abroad. It manages the National Emergency Strategic Stockpile (NESS), which includes medical, pharmaceutical and related emergency supplies. OERS also administers the Quarantine Act with quarantine officers' at large international airports across the country.

PHAC has a mobile clinic that can be deployed in the event of a local emergency, which is coordinated locally through Emergency Health Services (EHS).

#### **2.1.2 Environment and Climate Change Canada**

Environment Canada issues longer term weather forecasts which are important for heat considerations during a smoke event. In addition they issue public weather alerts for all communities in the Yukon, including air quality alerts due to wildfire smoke. However, these are area forecasts and are not specific to Yukon communities.

In addition Environment and Climate Change Canada issues twice-daily smoke predictions (FireWork) that show where smoke from fires in Canada and the United States is expected to spread over the next 48 hours (available April 1 to October 31 only). FireWork does not predict the burn path of a wildfire.

### **2.2 GOVERNMENT OF YUKON**

#### **2.2.1 Community Services, Emergency Measures Organization (EMO)**

The Government of Yukon, through the Emergency Measures Organization (EMO), is responsible for coordinating the territory's prevention/mitigation, preparedness, response and recovery, (not necessarily "major" it is any event that requires coordination major emergencies and disasters (Government of Yukon, 2014).

### **2.2.2 Wildland Fire Management**

The Yukon Wildland Fire Management Program is responsible for managing Yukon wildfires and enforcing the Government of Yukon's Forest Protection Act.

The Fire Management Program works to prevent personal injury and loss of life, and to minimize social and economic disruption resulting from wildfires.

- Prepare people, equipment and aircraft to manage wildfires.
- Monitor weather and fuel conditions; detect, assess and manage wildland fires on a priority basis as determined by zonation policy.
- Communication responsibility to the community about fires.
- Contact EMO or local municipality to advise alert or evacuation.
- Provide guidance on wildfire smoke as required.

### **2.2.3 Community Nursing**

Community Nursing provides Primary Health Care which is carried out by a system of health facilities that are designed to meet the health needs of the community in which they are situated. There are 11 primary health care centres, and three public health units, in Yukon.

Community Nursing, as a Branch of Health and Social Services Department (HSS), will work in collaboration with service providers across HSS, and others as applicable, to support emergency preparedness messaging, and to work with at risk individuals as able to assist these individuals and their families/caregivers to develop personal emergency plans. Community Nursing provides 24 hour emergency services in 11 communities, which may include medical evacuation from a community.

### **2.2.4 Emergency Social Services (ESS)**

Emergency Social Services(ESS) is responsible for providing short-term assistance to Yukoners who are forced to leave their homes due to emergencies including fires, floods, earthquakes and smoke when regular operation of community social services are unable to support the emergency situation. Emergency Social Services (ESS) will:

- Coordinate or provide for the non-medical survival needs of persons affected by an emergency; and
- Coordinate or provide public reception centres and registration and inquiry services, emergency lodging, feeding, clothing and personal services which encompasses counseling, financial assistance, coordination of alternate shelter for domestic pets, and the care of persons with special requirements and in special care facilities.

### **2.2.5 Emergency Health Services (EHS) will:**

- Coordinate or provide for the immediate medical and public health needs of individuals and communities.
- Communicate information, advice and direction related to health emergencies including areas such as water quality, sanitation, safe food handling, institutional hygiene, waste disposal and wildfire smoke
- In consultation with the Chief Medical Officer of Health (CMOH), health officers protect the health of the public through enforcement of various acts.

### **2.2.6 Regional Social Services**

#### **Community Social Worker:**

This term identifies the Regional Social Worker or Community Social Services Worker, who is an employee of Regional Services Branch, H&SS and fulfills the role of Social Worker and is the Emergency Social Services lead at the community level.

### **2.2.7 Health Emergency Management Committee (HEMC)**

The HEMC is an advisory body reporting to the Deputy Minister of Health and Social Services. It provides recommendations for preparedness and response activities within the Department of Health and Social Services and according to national standards and principles.

### **2.2.8 Chief Medical Health Officer**

The office of the Yukon Chief Medical Officer of Health is responsible for the Department of Health and Social Services' legislated responsibility to protect and promote the public's health in a variety of areas including Emergency Preparedness and Response. They provide 24-hour public health coverage in the Yukon and are responsible for ensuring the requirements of the [Public Health and Safety Act](#) are met.

They provide medical guidance, expertise and leadership by contributing science based risk assessment and helping communicate with the public about health risks. During a wildfire smoke event, they may be asked for an opinion about the health threat due to wildfire smoke and interventions for consideration through activation of the Health Emergency Management Committee (HEMC).

### **2.2.9 Environment Yukon**

The Government of Yukon, in partnership with the Government of Canada and the Yukon Lung Association, implemented the AQHI for Whitehorse in June 2016. The AQHI relates air quality to human health, using a simple 10 point scale. The higher the number, the higher the health risk. The AQHI uses data gathered from an air quality monitoring station located in downtown

Whitehorse, operated by the Department of Environment. Health messaging delivered through this program corresponds with the actual air quality level.

The Department of Environment is also responsible for setting standards for ambient air quality, including standards addressing acute vs chronic exposure to particulate matter. Further, the Department has the authority to issue permits under the Air Emissions Regulations, to regulate specific source emissions.

## **2.3 HEALTH FACILITY**

Health care is provided across a number of settings in Yukon which includes community health centres in 11 Yukon communities outside of Whitehorse.

### **2.3.1 Yukon Hospital Corporation (YHC)**

The YHC is the main provider of acute care services in Whitehorse, Dawson City & Watson Lake hospitals. The YHC works collaboratively with the government on all evacuation plans.

### **2.3.2 Continuing Care**

Continuing Care is a division of Health and Social Services. Continuing Care provides Residential, Home Care and Regional Therapy services for the citizens of the Yukon Territory.

There are five continuing care facilities in the Yukon. Birch Lodge, Copper Ridge Place, Thomson Centre and Macaulay Lodge are located in Whitehorse and McDonald Lodge provides services in Dawson City.

## **2.4 MUNICIPAL GOVERNMENT**

### **2.4.1 Municipalities**

The elected councils Municipalities are the local authority within their municipal boundaries for the purposes of the *Municipal Act*.

Municipal governments are required to have emergency plans in place. They are also responsible for implementing emergency plans and procedures that will protect the general public and minimize property and environmental damage and loss during emergencies. The *Municipal Act* authorizes the Mayor or designed official to declare a state of emergency in the municipality. For emergencies that take place on in unincorporated communities, the Government of Yukon is the local authority.

## **3. RESOURCES FOR DECISION MAKING & ACTION**

### **3.1 ASSESSMENT OF SMOKE CONDITIONS**

It is recommended that each community designate an individual (s) to assess potential health risks from wildfire smoke in order to determine the best protective health measure. It is

important to have a minimum of two designates to ensure availability in the event of wildfire smoke in the associated community.

In order to make an informed decision regarding the course of action air quality should be assessed, estimated duration of the smoke and the potential health effects reviewed (Government of NWT, 2016). Local support services should also be reviewed such as the availability of health care and cleaner air shelters for the public (Government of NWT, 2016).

## **3.2 AIR QUALITY**

In order for health professionals to make timely decisions that protect public health it is crucial to get information on air quality as quickly as possible. There are a number of methods that are in place to assist with determining air quality at any locations in the Yukon. Each method has advantages depending on the location, time of day and access to technology (Government of NWT, 2016).

### **3.2.1 Air Quality Health Index (AQHI)**

The AQHI, is a health risk communication tool that is currently available for Whitehorse only. The National Air Pollution Station (NAPS) measures real-time PM2.5 concentrations at a location in downtown Whitehorse. Pollutants that are measured include ground-level ozone, particulate matter and nitrogen dioxide (Government of Canada, 2016). The AQHI does account for wildfire smoke but does not discriminate between it and any other sources of PM2.5. AQHI data is collected by Environment and Climate Change Canada and projects the air quality for the current day as well as the next day (Environment Yukon, 2016). The AQHI uses a scale from 1 to 10+, the higher the number, the increased health risk (Environment Yukon, 2016). An example of the AQHI is shown in Figure 1.

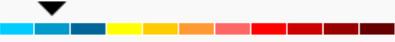
There are corresponding health messages associated with each level of risk as seen in Table 1 below.

An AQHI Canada App is available for download for your Android or iPhone or iPad to access hourly AQHI readings and daily updates for Whitehorse and other Canadian communities.

Figure 1

## Whitehorse - Air Quality Health Index

Current	<a href="#">Past 24 hr</a>
Not Available	

Forecast Maximums	<a href="#">Next 18 hr</a>   <a href="#">Health Message</a>
Issued at: 6:00 AM PST Wednesday 18 January 2017	
Wednesday	2 - Low Risk 
Wednesday night	2 - Low Risk 
Thursday	2 - Low Risk 

### Who is at risk?

People with heart and lung conditions are most affected by air pollution.

To find out if you are at risk, consult [the health guide](#), or your physician.

Visit the [national AQHI Web site](#) to learn more about the AQHI.

### Did you know...?

You can play a part in reducing air pollution. 1 car in 5 travels less than 1 kilometre: an average person can walk 1 kilometre in 10 minutes.

Source: Government of Canada (2017). Retrieved from [http://weather.gc.ca/airquality/healthmessage\\_e.html](http://weather.gc.ca/airquality/healthmessage_e.html)

**Table 1**

**Air Quality Health Index Messages**

This table is a summary of air quality health messages by category			
Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population*	General Population
Low Risk	1-3	<b>Enjoy</b> your usual outdoor activities.	<b>Ideal</b> air quality for outdoor activities.
Moderate Risk	4-6	<b>Consider reducing</b> or rescheduling strenuous activities outdoors if you are experiencing symptoms.	<b>No need to modify</b> your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High Risk	7-10	<b>Reduce</b> or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	<b>Consider reducing</b> or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High Risk	Above 10	<b>Avoid</b> strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	<b>Reduce</b> or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

Source: Government of Canada (2017). Retrieved from [http://weather.gc.ca/airquality/healthmessage\\_e.html](http://weather.gc.ca/airquality/healthmessage_e.html)

**3.2.2 Special Air Quality Statements**

Public weather alerts are issued by Environment Canada for all communities in the Yukon. The alerts can be found [here](#) and include important information such as air quality, health messaging and the estimated duration of the event. The objective of the statement is to

highlight significant events such as widespread wildfire smoke. These statements are issued through broadcast media and available on mobile devices, which may limit the audience that receives them and can disadvantage vulnerable populations. To issue an air quality advisory due to wildfire smoke in Yukon, Environment Canada can be contacted directly via internal phone number or e-mail and are available 24/7. These air quality statements are sent in both official languages.

### 3.2.3 Visibility Index (Landmark)

This method of estimating air quality can be valuable in areas that do not have continuous monitors as the concentration of smoke can vary significantly depending on the area (Government of NWT, 2016). In addition in the communities that do not have AQHI it is a convenient tool to assess smoke levels and the corresponding health risk for the community. Landmarks are established that have known distances and a trained observer can estimate the level of particulate matter concentration in the air (Government of NWT, 2016). It is prudent to identify these landmarks prior to a wildfire smoke event in order to be adequately prepared (Government of NWT, 2016). The advantage of this tool is its simplicity which allows for quick assessment of the public health risk in order for decisions to be made by key participants in the emergency response plan (Government of NWT, 2016).

**Table 2: Estimating Particulate Matter Concentrations from Visibility Assessment**

Air Quality Category	Equivalent approx. PM2.5 1-3 hour average in µg/m3	Visibility in Km
Good	0-40	15 kms and up
Moderate/Unhealthy for Sensitive Groups	41-175	5-14 kms
Unhealthy	176-300	2.5-4 kms
Very Unhealthy	301-500	1.5-2 kms
Hazardous	Over 500	Less than 1km

Adapted from Wildfire Smoke: a guide for public health officials: <https://www.arb.ca.gov/smp/progdev/pubeduc/wfgv8.pdf>

### 3.3 HEALTH EFFECTS OF SMOKE

In order to make an informed decisions regarding protective health measures for the public and at-risk populations the following needs to be assessed air quality, health effects and the duration of wildfire smoke (Government of NWT, 2016). Available resources such as residential health facilities, health providers and access to cleaner air shelters needs to be determined when deciding on an appropriate intervention for reducing the exposure to wildfire smoke (Government of NWT, 2016).

There are secondary health effects that may occur due to interventions that may be recommended such as staying indoors in warmer months. This may cause exposure to heat which involves additional measures to manage this exposure including appropriate hydration

(Government of NWT, 2016). For further recommendations on heat illness, visit Health Canada's [website](#).

For populations at risk the availability of portable air filters might be considered for distribution for those that may have financial barriers to access.

### **3.4 DURATION OF SMOKE FORECAST**

The duration that the public has been exposed to wildfire smoke is pertinent to help support decision-making on how to inform the public and determine what actions need to be taken to protect public health (Government of NWT, 2016). Weather forecasts are used to predict how long wildfire smoke is expected to remain in an area and whether the exposure is continuous or sporadic (Government of NWT, 2016).

#### **Canada's Wildfire Smoke Prediction System (FireWork)**

FireWork is an air quality prediction system that indicates how smoke from wildfires is expected to move across North America over the next 48 hours. The system runs twice daily, morning and evening.

The FireWork system makes it possible to include the effects of wildfire smoke in forecasts of air quality by estimating the amount of pollution that will be added to the air. These smoke forecast maps show how the air quality in your community may be affected by wildfire smoke. Environment and Climate Change Canada will also issue air quality alerts when smoke concentrations are expected to be high.

The FireWork forecast maps indicate anticipated air quality conditions and not the current air quality.

FireWork has seasonal operational status and 24/7 operational support from April 1 to October 31. Essential FireWork products are available to the public via the WeatherOffice web page: [https://weather.gc.ca/firework/index\\_e.html](https://weather.gc.ca/firework/index_e.html)

#### **FireSmoke Canada**

Uses the BlueSky system and provides forecasts out to 48 hours during the fire season. It is a partnership of 11 agencies and is operated by UBC. It is a software framework developed by U.S. Forest Service (Larkin et al. 2008) that includes data and models of fuel consumption, emissions, fire, weather and dispersion.

More information can be found [here](#).

## **The Air Quality Health Index (AQHI)**

The AQHI, which is currently only available for Whitehorse, is health risk communication tool which forecasts health risks due to air quality for the current day and following day. The AQHI uses a scale from 1 to 10+, the higher the number, the increased health risk (Environment Yukon, 2016). It also provides corresponding health messages with actions on how protect yourself when the air quality is diminished (Government of Canada, 2016). In order to access this information access to the internet either through a computer or mobile device is required.

## **4. RECOMMENDATIONS**

### **4.1 INTERVENTIONS FOR CONSIDERATION TO PROTECT THE PUBLIC DURING WILDFIRE SMOKE EVENTS**

There are a number of interventions that can be considered to protect the public during a wildfire smoke event. The goal of these interventions is to minimize the exposure to wildfire smoke. Since wildfire smoke events are variable, it is difficult to prescribe an intervention based on the level of particulate matter as multiple factors such as transportation and community resources should be considered.

The decision on evacuation is extremely complex and has the potential to cause harm due to the interruption of normal activities, social and economic factors and health care services (Elliott, 2014). In addition it may exacerbate mental illness and increase mortality rates among those living in continuing care facilities (Elliott, 2014). Therefore the decision to evacuate must be carefully considered with other contextual factors and may be considered after other interventions have been ineffective.

## Box 1. Interventions for Consideration to Protect the Public during Wildfire Smoke Events

Communications advising people to:

- **stay indoors:** reduce time spent outdoors in order to protect health
- **reduce outdoor physical activity:** decrease physical exertion outdoors in order to protect health
- **Recommend patients update their own asthma/COPD action plans:** ensure that plans for self-management of asthma/COPD are in place, up-to-date, and adequate supplies (e.g., medication) is available

**Use a home clean air shelter:** spend time in a room in your home with cleaner air to reduce smoke exposure. Use a portable air cleaner if possible.

**Cancelling outdoor events:** Decision that group activities that occur outside will not take place. Such activities include school activities (e.g., recess, outdoor classes and events), sporting events (e.g., tournaments, practices) and mass gatherings (e.g., arts and cultural events, athletic events).

**Providing community clean air shelter(s):** Spend time in a community based facility such as a community building or school that has cleaner air than outdoor air.

**Augmenting air filtration in institutions:** The use of in-duct or portable filtration to improve air quality and protect people in institutional settings including hospitals, nursing homes, long term care facilities, day cares, schools, and other institutions.

**Evacuating:** The urgent removal of individuals from a community in order to protect them from exposure to wildfire smoke. This may be voluntary or mandatory and can start out as voluntary and progress into a mandatory order. This may include a segment of the population only, e.g. populations at risk.

### 4.2 COMMUNITY VS. HOME CLEAN AIR SHELTERS

To determine whether a Community Cleaner Air Shelter (CCAS) is recommended versus a home clean air shelter the following should be considered:

- Travelling distance of residents to a CCAS, and the level of exposure in transit
- Mobility of residents, especially for families with small children and the elderly
- Additional stress for individuals to try and access a CCAS
- Benefits of potentially more effective filtration intermittently at CCASs versus less effective ongoing filtering in HCAs for longer periods of time

- Communication strategies for encouraging community members to go to CCASs if recommended and stay if extended stays are required. If smoke events are prolonged HCASs might be more appropriate than long stays at CCASs.

## 5. RECOVERY

### 5.1 ASSESSMENT/EVALUATION

Once the smoke emergency is over it is important to review the experience to determine lessons learned for continuous improvement. This assessment should be planned and scheduled with all appropriate participants to ensure that it is executed.

The Health Emergency Management Committee will:

- Reviewing emergency management documents/issues going forward to senior managers.
- Recommend corrective actions from a strategic and/or technical points of view.

*Key questions to consider:*

- What worked well? Why?
- What did not work well? Why?
- What can be improved for future wildfire smoke events?
- Are there any additional tools/resources that might be helpful in the future?
- Were there any infrastructure issues?

*Community Evaluation Indicators:*

- Emergency response plans are up to date and include wildfire smoke
- A list of at-risk populations in the community has been created and/or updated
- Clean air shelters in the community have been identified and communicated to the public
- Community landmarks have been identified to be used for visibility index and person (s) responsible for emergency response has been notified

Transportation requirements to community cleaner air shelter and for evacuation for at-risk members of the community have been planned in advance

*Individual Evaluation Indicators:*

- Do community members know what a clean air shelter?
- Have at-risk populations created a clean air shelter at home? Or are at-risk populations aware of cleaner air shelters in the community?
- Do individuals with asthma, COPD or another chronic illness have a wildfire smoke action plan?

## 5. REFERENCES

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## APPENDIX A: CREATING A CLEANER AIR SHELTER IN THE COMMUNITY

Table 1 reviews criteria for selecting a cleaner air shelter in the community for protection against airborne smoke. The entire building can serve as protection, however a room within a building may provide a higher level of protection if it is less subject to air infiltration.

**Table 1: Criteria for Selecting a Cleaner Air Shelter**

Criteria	Description
Accessibility	The shelter must be easily reached quickly and accessible to persons with mobility, cognitive and other impairments.
Size	Identify facilities that can comfortably occupy large groups such as schools, shops and large commercial buildings. Preferably buildings with central air conditioning and filtration.
Tightness	Newer buildings are preferable to older ones as they are usually better sealed from outdoor air. There should be a low rate of air exchange from the outdoors, with minimal doors and windows present.
Heating Ventilating and Air Conditioning (HVAC)	The shelter should be isolated or capable of being isolated rapidly from the HVAC system of the building so smoke does not enter the shelter. Assure that the facility can handle the increased cooling load due to high occupancy. Ductless mini split-type air-conditioner, fully enclosed air-handling unit (only if the unit and its ducts are fully within the cleaner air shelter) can be used. Conventional air conditioning systems must not be operated in the protective mode because the fans introduce outside air.
Ventilation	For Class 1 shelters, 15 cfm per person is the desired ventilation rate; however, the minimum ventilation rate is 5 cfm per person if that rate is adequate for pressurization. Class 3 and unventilated Class 2 Safe Rooms are suitable only for short-duration use, not only because the low ventilation rate when occupied can cause carbon dioxide levels to rise, but also because protection diminishes as the time of exposure to the hazard increases.
Water and Toilets	Drinking water and a toilet should be available to occupants of a clean air shelter. Use of canned/bottled water and portable toilets may be required.
Communications	A radio should be available to receive emergency instructions for termination of sheltering. A telephone or cell phone can be used for communication as well.

Power	Electrical power and lighting are required. Class 1 and Class 2 cleaner air shelters require power for the air-filtration units. If power is lost in a Class 1 or Class 2 shelter, it will continue to protect at the level of a Class 2 shelter as long as the room remains sealed. A backup generator is another useful resource if available.
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## Identification

Shelter Class	Description	Protection	Cost	Advantage	Limitations
Class 1 Ventilated and pressurized with filter air	Air is drawn from outside the room, filtered and discharged inside the room at a rate sufficient to produce an internal pressure. The clean air shelter is ventilated with filtered air and the internal pressure produced with filtered air prevents infiltration of outside air.	HIGH	HIGH	Protection has no time limits; Eliminates accumulation of carbon dioxide (CO <sub>2</sub> )	It provides no protection against some toxic chemicals of high vapour pressure
Class 2 Filtration with little or no pressurization	Includes air filtration, but with little or no internal pressure. Without positive pressure, the cleaner air shelter does not prevent the infiltration of contaminated air. <b>Class 2 unventilated:</b> air is drawn from inside the cleaner air shelter, filtered, and discharged inside it. <b>Class 2 ventilated:</b> air is drawn from outside but at a flow rate too small to create a measurable differential pressure.	MED	MED	Protective against all gases	Protection diminishes with duration of exposure (and against non-filterable gases)

Class 3 Unventilated , no filtration	Protection comes from clean air retained within a tight enclosure	LOW	LOW	Protective against all agents; no air-filtering capability and is unventilated	Protection diminishes with time of exposure ; CO2 build-up may limit time in the shelter.
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Table 2 and Table 3 describe ventilated and unventilated shelters and categories them into 3 classes of shelters. Table 3 provides a description and overview of the costs and benefits of the different categories of shelters.

**Table 2 Ventilated and Unventilated Shelters**

Shelter Type	Description	Advantage	Disadvantage
Ventilated Shelter	Can be designed to provide filtered and conditioned fresh air.	May provide filtered and conditioned fresh air. Can be used for a longer period of time.	May be more difficult to find a building with this capability.
Unventilated Shelter	Tightly sealed room or building.	Any room or building can be turned into an unventilated shelter.	Cannot be occupied for long periods of time. Shelters always have some form of leakage paths.

**Table 3 Categories of Shelters: Class 1, 2, 3**

**High-efficiency air filtration**

High-efficiency air filtration can augment a cleaner air shelter. Filtration may remove air-borne contaminants as air circulates within the room. Filtration systems draw outside air in, therefore the level of protection received is equivalent to the efficiency of the filter. Increasing the efficiency of the filter will add stress to the system because of the added pressure needed to force the air through the new filter. All filters have limited service life. Upgrades may be required to provide adequate electrical power, fan capacity, or structural support to handle the added airflow resistance of HEPA filtration (Dix-Cooper, 2014).

Commercial filter units that are designed for indoor air quality can be used in an unventilated Class 2 Cleaner air shelter. There are many different models available from several manufacturers; however, the filtering performance varies over a wide range. The HEPA filter

element provides protection against liquid and solid aerosols such as those found in smoke, while the adsorber element protects against gases and vapours.

### **Preparation**

After the room or location for the cleaner air shelter has been decided based on the criteria listed in Tables 1-3 above, the first decision is to determine the class of cleaner air shelter. Details for preparation and maintenance for the three classes of cleaner air shelters are presented below.

#### **Class 3 Cleaner air shelter**

- Can be permanent or temporary

### **Checklist for preparing both Class 2 and 3 Cleaner air shelters**

**Ceiling/Floor:** This is where most leakage occurs. Important to temporarily seal baseboards by removing them and apply foam sealant in the gap at the floor-wall juncture. Electric baseboards could be temporarily removed as well and seal the wiring penetrations and the gap at the floor-to-wall juncture.

**Pipes/Conduits/Cables:**

Seal penetrations using caulk, foam sealants, or duct seal by placing weather-stripping.

**Doors:**

During the event, door sweeps or duct tape can be used to seal the gap beneath the door temporarily.

**Windows:**

If older windows, reduce leakage by measures such as taping plastic sheeting over them.

**Electrical outlets and switches**

Expanding foam can be used or ready-made outlet sealers can be used to seal gaps behind switches and outlets.

**Ducts for supply, return, and exhaust:**

Temporarily closing the ducts to the clean air by placing duct tape or contact paper over the supply, return, and exhaust grilles. Automatic dampers or hinged covers can be custom-made of sheet metal or wood, to be attached above or beside the opening for all applications except the door periphery.

**Fans:**

Some shelter systems have been designed with the capability of automatically deactivating all fans in the building with a single switch. The low-cost alternative to automatic fan shutoff is to record on a checklist the location of switches for all fans in the building.

**Air Conditioning:**

Cover window-type or through-the-wall air conditioner with plastic sheeting and tape over the inside of the window and/or air conditioner

### **Maintenance for a Class 3 Cleaner air shelter**

The Class 3 cleaner air shelter has no air filtration equipment and, therefore, requires little or no routine maintenance. It has no mechanical equipment unless there are dampers for isolating the air conditioner. Maintenance requirements are limited to periodically checking supplies for deterioration or loss.

## **Class 2 Cleaner air shelter**

**The design details listed above also apply to Class 2 cleaner air shelters (ventilated and unventilated)**

### **Unventilated Class 2 Cleaner air shelter**

- The improvement from a Class 3 shelter is determined by the flow rate and efficiency of the particulate filter for aerosols and the efficiency of the absorber for gases and vapors.
- There are 4 types: free-standing table top unit, free-standing floor unit, ceiling-mounted unit, and duct-mounted unit.
- Level of protection is determined by clean-air delivery rate of the filter unit and the tightness of the enclosure
- If a high-efficiency filter unit is used, the clean-air delivery rate approaches the actual flow rate of the unit
- Floor/table model filter units and ceiling-mounted models should be placed in the center of the room
- Remove any obstructions to the airflow in and out of the units
- Ducts cannot be outside the envelope formed by the walls, ceiling, and floor. Duct-mounted models must confirm to the following requirements:
  - The filter unit must have both an adsorber containing activated carbon and a particulate filter. The adsorber must have at least one pound of activated carbon for each 20 cfm of flow rate. For example, a 200-cfm unit requires at least 10 pounds of carbon adsorbent.
  - The particulate filter must have an efficiency of at least 99 per cent against one-micron particulate.
  - The unit(s) must provide a total clean-air delivery rate of at least one cfm per square foot of floor area.
  - The adsorber must have the capability for chemisorption (removal of gases that are not removed by physical adsorption).

### **Ventilated Class 2 Cleaner air shelter**

- A shelter is classified as a Class 2 if the filter unit is undersized resulting in lower protection factors

### **Maintenance for a Class 2 Cleaner air shelter**

- The filter unit used in a Class 2 cleaner air shelter is an indoor air quality filter unit and, as such, it can be used routinely to improve the air quality in the spaces in or around the designated cleaner air shelter.
- A spare filter set, both adsorber and HEPA filter, should be stored in a sealed bag in the clean air shelter along with instructions and any tools needed for changing the filter quickly in an emergency.

## **Class 1 Cleaner air shelter**

- Designing and installing a ventilated cleaner air shelter is much more complex than an unventilated cleaner air shelter, particularly with regard to the filter unit. Pressurization requires introducing air from outside the protective enclosure; therefore, the removal efficiency of the filters is more critical in determining the protection provided.
- The system must employ ultra-high efficiency filters, and it must allow no air to bypass the filter as it is forced into the safe room. Operating procedures for Class 1 cleaner air shelters are similar to those of Classes 2 and 3. The system is turned on immediately upon receipt of a warning. Tape, plastic, and carbon dioxide detectors are not necessary in the Class 1 cleaner air shelter.

### **Selecting a Filter Unit for a Class 1 Cleaner air shelter**

Generally, filter units available commercially are not designed to standards that ensure protection against highly toxic chemical, biological, and radiological materials. The ideal requirement is a certified filter unit that has both a HEPA filter and an ultra-high-efficiency gas absorber in series. To protect against very fine particulate, a Class 1 system requires ultra high-efficiency filtration, at least 99.999 percent removal in a single pass. HEPA filters, which are defined as having at least 99.97 percent efficiency against the most penetrating particulate size (about 0.3 micron), have efficiencies greater than 99.999 percent against aerosols of 1 to 10 micron size.

### **Sizing the Filter Unit for Pressurization**

If a filter unit is undersized (provides inadequate flow for pressurization), the result is substantially lower protection factors and the system becomes a ventilated Class 2 cleaner air shelter. Filter unit(s) must be sized to provide makeup air at a flow rate sufficient to produce a pressure of at least 0.1 inch water gauge (iwg) in the shelter. The airflow rate needed to achieve this pressure in a cleaner air shelter varies with the size and construction of the cleaner air shelter. For cleaner air shelters of frame construction and standard ceiling height, most can be pressurized to 0.1 iwg with airflow in the range of 0.5 to 1 cfm per square foot.

### **Maintenance for a Class 1 Cleaner air shelter**

Maintenance of the Class 1 cleaner air shelter consists primarily of serviceability checks and replacing filters. Serviceability checks should be performed about every two months by turning the system on and checking for the following while it is operating:

#### **Checklist for maintenance of a Class 1 Cleaner air shelter**

- System pressure: The system pressure is indicated by a gauge typically mounted on the control panel, with the correct operating range marked on the gauge.

- Isolation dampers: Correct damper positioning is indicated by damper status lights on the control panel.
- Relief damper: It should be visually inspected while the system is operating. A properly functioning relief damper should be open when the cleaner air shelter is pressurized, and it should close immediately when a door is opened into the cleaner air shelter, releasing pressure.
- HEPA filter resistance: The differential pressure across the HEPA filter is measured by a gauge mounted on the filter unit with taps on either side of the HEPA filter. If the pressure across the filter is greater than specified (approximately 3 iwg or higher), it is an indication that the HEPA filter has become loaded with dust and its higher resistance is reducing the flow rate of the filter unit. If such is the case, the HEPA filter should be changed.
- Cooling system: If the cleaner air shelter supply air is cooled and heated, the temperature of the air flowing from the supply register should be checked with a thermometer during serviceability checks.
- Door latches: All doors into the cleaner air shelter should be adjusted to latch automatically with the force of the door closer. For cleaner air shelters with multiple doors, leakage past unlatched doors can cause internal pressure to fall below the specified operating range.
- Weather stripping: The weather stripping on each door on the boundary of the cleaner air shelter should be visually inspected to ensure it has not been removed or damaged through wear and tear. For wipe seals at the bottom of the door, the alignment and height of the seal above the floor should be inspected and adjusted as necessary.
- Filters: Routine maintenance includes replacing filters. If a canister-type filter is used, it is replaced as a unit at its expiration date. For other types of filter units, three types of filters are replaced: the pre-filter, HEPA filter, and carbon adsorber. Ideally, with only intermittent operation, all three types of filters should be replaced at the same time, every three to four years. This period is defined mainly by the service life of the adsorber. A spare filter set should be stored in a sealed bag in the clean air shelter along with instructions and any tools needed for changing the filter quickly in an emergency.