Kentucky's
Voluntary Smoke Management Plan

March 2022

A cooperative effort by members of the

Kentucky Prescribed Fire Council

The Kentucky Prescribed Fire Council consists of state and federal agencies, conservation organizations, universities, contractors, and private individuals who promote the safe and beneficial use of controlled burning as a land management tool. Memberships are open to anyone interested in using fire to manage land in the Commonwealth of Kentucky. For more information about membership, please visit: https://www.kyfire.org/

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Introduction:
Why Have a Voluntary Smoke Management Plan?

The Kentucky Prescribed Fire Council (KPFC) promotes the safe and beneficial use of prescribed fire within the Commonwealth. The application of prescribed fire reduces the risks of catastrophic wildfires, while also maintaining healthy forests and fire-dependent ecosystems. The Council also works to promote the use of smoke management techniques to maintain good air quality, protect public health, and ensure compliance with National Ambient Air Quality Standards.

The US Environmental Protection Agency (EPA) allows certain data collected at ambient air monitoring stations to be excluded from comparisons against National Ambient Air Quality Standards (NAAQS) when the data have been influenced by what is called an "**Exceptional Event**." Exceptional Events include natural events such as wildfires and dust storms, as well as certain human-caused events such as firework displays, industrial accidents, and prescribed fires. In order to exclude data impacted by prescribed fires, the EPA requires that states prepare robust demonstration packages, which show that each particular fire met all the criteria set forth by the 2016 Exceptional Events Rule. In order to meet these criteria, the state must either:

- certify to the EPA Administrator that it has adopted and is implementing a **"Certified" Smoke Management Program (CSMP)**; or,
- demonstrate that the burn manager employed appropriate **Basic Smoke Management Practices (BSMPs)**.

"Certification" of a SMP requires that a state or local agency certify in a letter to EPA Regional Administrator (or delegated EPA-official) that it is adopting and implementing a CSMP, which generally includes the following elements:

- **Authorization to Burn:** Includes a defined process for authorizing or granting approval to use prescribed fire on wildland by a designated central authority. Such a process could include the use of burn permits that includes considerations of air quality impacts.
- **Minimization of Pollutant Emissions:** Encourages wildland owners/managers to consider alternate treatments to fire and/or to follow emission reduction techniques.
- **Smoke Management Components of Burn Plans:** Includes the components of burn plans that describe the actions that will be taken to minimize fire emissions, the approaches to be used to evaluate smoke dispersion, the methods of public notification, the actions that will be taken to reduce public smoke-exposure, and any methods of air quality monitoring.
- **Public Education and Awareness:** Establishes the criteria for issuing public health

advisories, when necessary.

- **Program Evaluation:** Provides for periodic review of the SMP's effectiveness by various stakeholders.

Under the Exceptional Events Rule, this document does not meet the criteria necessary to be classified as fully adopted, implemented, and certified. Instead, this **Voluntary Smoke Management Plan (VSMP) seeks to encourage prescribed fire practitioners to use Basic Smoke Management Practices during every prescribed fire used in the State, regardless of whether that prescribed fire is being set on wildland, private lands, or agricultural lands.** The use of a Voluntary Smoke Management Plan that relies upon BSMPs has several advantages:

1) Reduces the likeliness that smoke from prescribed fire will cause an exceedance or violation of a NAAQS; thus reduces the necessity of a fully adopted, implemented, and certified SMP.
2) Serves as a template for testing a Smoke Management Program, should a certified SMP be needed at a later date.
3) Provides a voluntary method of reporting prescribed fire; thus, increasing the likeliness that a particular prescribe fire could be correlated with an exceedance or violation of the NAAQS.
4) Provides prescribed fire practitioners with flexible recommendations, as opposed to strict regulatory requirements, for managing and minimizing smoke impacts.
5) Provides air quality professionals with guidance on Exceptional Event demonstrations.
6) Provides a document that caters to people with varying professional and educational backgrounds.
7) Does not require the programmatic support or funding necessary to implement a certified smoke management program.

Additionally, Exceptional Event demonstrations that rely upon BSMPs require interagency collaboration. Air-agencies, federal land managers (FLMs), and other entities, must periodically collaborate with burn managers operating within the jurisdiction of the state to discuss and document the process by which they will work together to protect public health and manage air quality impacts while conducting prescribed fires on wildland. EPA does not define the mechanisms of these efforts, which may consist of either an informal agreement or a formal document, such as a memorandum.

This Voluntary Smoke Management Plan (VSMP) represents an informal agreement between members of the Kentucky Prescribed Fire Council and a commitment to protect and expand the use of prescribed fire in the state, as well as to limit impacts of smoke on public health. The guidelines contained in this document are intended to aide all practitioners in these endeavors and are intended to supplement any existing agency-specific smoke management plan.

Chapter 1.0:
Overview of Prescribed Fire

History of Natural and Human-Caused Fire

Fire is a form of land disturbance that influences the condition and distribution of ecological communities through direct and indirect impacts to plants, animals, and physical features of the landscape. Both naturally-occurring and human-caused fire have been and continue to be important in shaping and changing the ecosystems of Kentucky, the surrounding Central Hardwood/Eastern Deciduous Forest region, North America, and worldwide (Keeley et al. 2009). Throughout history, humans have used fire to meet land management goals, whether for hunting and gathering, agriculture, timber production, ecosystem restoration, habitat improvement, or other purposes.

Prior to European settlement, approximately 95% of Kentucky was covered by a vast expanse of forest. This ancient forest was a product of a humid continental climate that favored tree growth, as well as a fire regime that was influenced by both native peoples and lighting strikes. Embedded within the pre-settlement forest were open grasslands and park-like savannas and woodlands, which were created and maintained by a combination of fire, grazing of large mammals like bison and elk, and

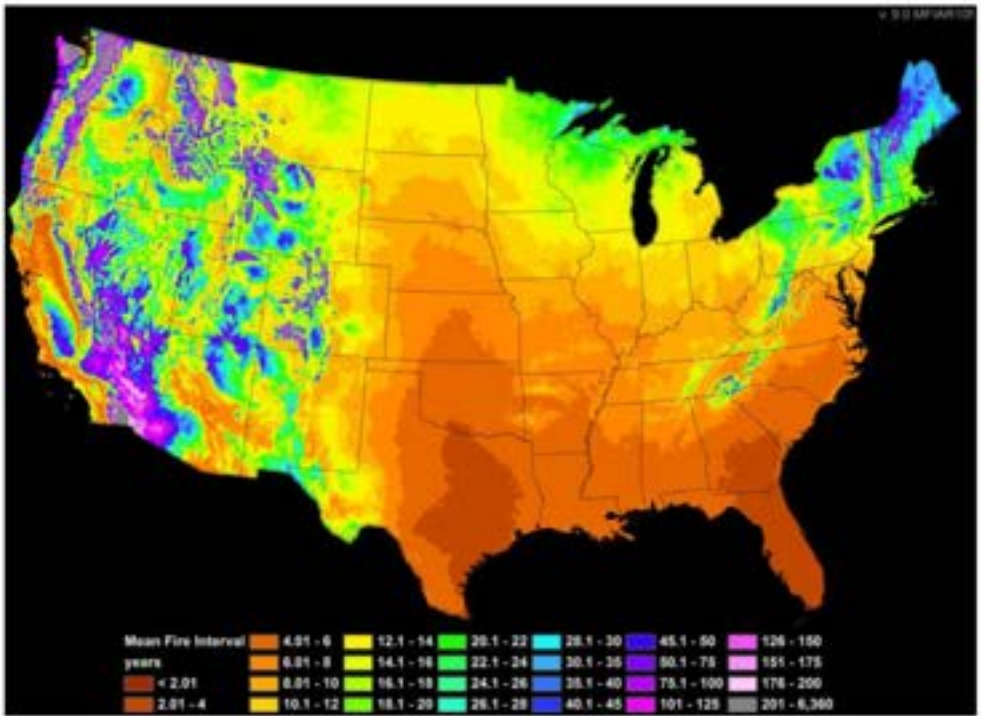


Image: Historic (1650–1850 CE) Mean Fire Interval (MFI) estimates, in years, for the presence of fire in all or part of an average 1.2 km^2 area, based upon the Physical Chemistry of Fire Frequency Model (PC2FM).

Source: *Guyette, Richard P.; Stambaugh, Michael C.; Dey, Daniel C.; Muzika, Rose-Marie. 2012. Predicting fire frequency with chemistry and climate. Ecosystems. 15: 322-335.*

climate fluctuations.

Unfortunately, for most of the 20th century the United States focused on suppressing all fires. The goal was to protect valuable timber resources and rural communities, but the policy had devastating effects on wildland ecology. For thousands of years, fire helped to return nutrients to the soil, encourage the growth of fire-resilient ecosystems, and promoted the growth of the many plant species reliant upon fire for germination, establishment, or reproduction. In the absence of a natural fire regime, forests have become uncharacteristically dense, often comprised of smaller trees, which are forced to compete for scarce resources. These weakened ecosystems are more susceptible to the effects of catastrophic wildfire, as well as disease and insect damage (Berry 2007). Regardless, many Americans were instilled with the idea that fire was unequivocally "bad." .

During the 1960s, scientific research increasingly began to demonstrate the positive role fire played in wildland ecology. Combined with a greater sense of environmental awareness within the general public, American policy slowly shifted from fire-phobic to more fire-friendly through the remainder of the century.

Today, fire is recognized as an integral component in the health and biodiversity of many natural habitats, and that the plants and animals within these ecosystems have evolved to be adapted to, or reliant upon, natural fire. Wildfires, whenever possible, are frequently allowed to burn instead of being extinguished. Land-management agencies often try to replicate historic and natural fire regimes through the use of **prescribed fire.** A prescribed fire is a fire that is intentionally ignited and controlled in order to achieve specific goals. Prescribed fires are planned to occur according to a set of predetermined conditions, also called "prescriptions."

In Kentucky, prescribed fire is used as a land management method by many state and federal agencies, nongovernmental organizations, private landowners, farmers, right-of-way managers, agroforestry businesses and others on private, public, and commercial lands. Most of these prescribed fires are implemented in grasslands, but a substantial acreage of prescribed fire also occurs in forestland.

Image: Members of the Kentucky Prescribed Fire Council conduct a demonstration burn. September 2014.

Conservation agencies – like the Office of Kentucky

Nature Preserves (OKNP), the Kentucky Department of Fish and Wildlife Resources (KDFWR), the U.S. Fish and Wildlife Service (FWS), and the U.S. Forest Service (FS) – and organizations like The Nature Conservancy (TNC) and the National Wild Turkey Federation (NWTF) – use prescribed fire to restore rare plant communities or maintain prairie and woodland wildlife habitats. While these agencies, organizations, and citizens have differing goals for fire-use, they share a common interest in ensuring the careful application of prescribed fire through extensive, systematic training of personnel and strict adherence to prescribed burn plans that dictate several parameters necessary for burning to occur; examples include weather conditions, vegetation conditions, site preparation activities, and personnel needed to conduct the burn, among several others.

The Kentucky Prescribed Fire Council promotes the safe and beneficial use of controlled fire as a land management tool within the Commonwealth. Some of the recognized benefits of prescribed fire include:

- Reduces the risk of catastrophic wildfires
- Promotes native and rare plant and animal species
- Controls unwanted vegetation, including invasive species
- Enhances wildlife habitats

A well-structured prescribed fire management regime promotes the decrease of high-density, catastrophic wildfires while simultaneously improving overall forest health. Fire management has the ability to identify and achieve numerous objectives within one solution. Prescribed fire gives professionals and practitioners more control in the protection of residents through better management of water systems, healthier air quality, and wildfire risk reduction.

Benefits of Prescribed Fire: Reduction of Catastrophic Wildfires

The unplanned, reckless occurrence of fire, whether from arson or careless brush burning, is a public safety threat and may be detrimental to natural resources conservation and management, particularly timber. Unfortunately, unplanned wildfires are all too common across Kentucky every year. The Kentucky Division of Forestry (KDF) is the state agency tasked with enforcing laws related to burning. In the fiscal year 2019, KDF reported 707 fires covering 9,904 acres. From 2010-2019, arson was responsible for 64.9% of Kentucky's wildfires, with escaped debris fires accounting for 22.3%.

Prescribed fire reduces the amount of fuels available for catastrophic wildfires; therefore, reducing the frequency of catastrophic fires, as well as the severity of such fires. This also contributes to wildfire risk reduction in wildland-urban interface areas. Additionally, prescribed fire helps to control the emission of smoke from wildland fires. While all fire produces smoke, whether from a prescribed fire

or a wildfire, the use of prescribed fire allows practitioners to control when those emissions are released and under what conditions. Reduction of particulate matter and harmful compounds results in safer and healthier communities.

Benefits of Prescribed Fire: Promotion of Native and Rare Species

Kentucky's forests are experiencing a shift in the dominant tree species, which can cause negative impacts on wildlife ecosystems. Historically, fire tolerant tree species such as oaks, hickories, and yellow pines prevailed over maples, white pines, hemlock, and other fire intolerant tree species. Fire tolerant, shade-sensitive trees provide much of the mast that many wildlife species depend on for survival. Past overemphasis on fire suppression cultivated more dense forests, resulting in a denser, closed canopy, an ideal environment for shade loving species to thrive and overpower oaks that need sunlight for seed generation. Dwindling oak numbers also threatens Kentucky's timber industry, a critical component for Kentucky's economic health. Proper prescribed fire usage supports the re-creation of more open, prosperous oak forests that allows sunlight to reach the forest floor, encouraging native wildlife diversity and survival.

A number of rare invertebrates, from butterflies and moths to leafhoppers require grassland vegetation to survive. Encroachment of woody stems reduces growth of host plants and limits the invertebrates' dispersal into suitable habitat. Prescribed fire maintains open distributional pathways as well as sustains vegetation to support invertebrate population numbers. Prescribed fire units must be carefully designed to ensure survival of many invertebrates due to their typically limited ability to disperse great distances.

Benefits of Prescribed Fire: Control of Unwanted Species

The Kentucky Exotic Pest Plant Council lists 145 plant species that are considered to be severe or significant threats to Kentucky's native biota. Their presence can affect not only the survival and viability of plant and animal populations, but also forest structure, succession, soil chemistry, water quality, even the stability of soils. Their impact may be lessened through active management using a variety of control and containment strategies.

Although herbicides and mechanical methods are more widely used to manage invasive plants, prescribed fire may also be useful in some circumstances. Some species' abundance may be reduced by fire, if it is properly timed and repeated at appropriate intervals. Other species may not be set back at all or may even increase. Using fire to remove a dense litter layer prior to herbicide treatment can enhance coverage and improve results. Prior to implementing prescribed fire as a management tool, land-managers and owners should conduct an invasive species inventory to identify

those that may increase with use, prior to conducting a burn. Beyond harmful invasive species, prescribed fire can be used to control trees-species that aren't commercially valuable.

Benefits of Prescribed Fire: Enhances Natural Habitats

Fire management enhances the habitats and resource availability of many native plant and animal species. Game species in particular benefit from fire-treated environments, such as white-tailed deer, eastern wild turkey, and quail. Prescribed fire can potentially produce a rich ecosystem that provides adequate protection and food resources, while also sustaining recreational and economical hunting activities. In turn, prescribed fire usage can also decrease problematic insect species that threaten habitats and forest conditions. For example, the invasive gypsy moth feeds on valuable oak stands. Meanwhile, the emerald ash borer kills numerous ash trees, reducing habitat resources and increasing dead fuel loads.

References:

Alison Berry. Forest Policy Up in Smoke: Fire Suppression in the United States. Property and Environment Research Center. September 2007. https://www.perc.org/2007/09/17/forest-policy-up-in-smoke/

Kentucky Invasive Plant Council. Website. https://www.se-eppc.org/ky/

Keeley et al. Ecological Foundations for Fire Management in North American Forest and Shrubland Ecosystems. US Forest Service. March 2009. https://www.fs.fed.us/pnw/pubs/pnw_gtr779.pdf

Kentucky Prescribed Fire Council. Kentucky Basic Controlled Burn Workshop: Student Manual. 2012.

Fill et al. Quail, Turkey, and Deer: Fire Effects and Management Recommendations. Southern Fire Exchange. https://southernfireexchange.org/wp-content/uploads/2018-8.pdf.

Chapter 2.0:

Kentucky Regulation of Prescribed Fire

Under Kentucky law, burning is regulated by several Kentucky Revised Statues (KRS), including some related to forests and others related to outdoor air quality. Given the prevalence of forest cover across the Kentucky landscape, most prescribed fires pose the potential to impact or involve forests, and require careful consideration in the prescribed burn planning process. Thus, prescribed fire most often falls under the jurisdiction of the KDF, the agency responsible for fighting wildland fires on private lands and enforcing forest burn laws. Kentucky regulations that govern burning, as well as links to access these regulations, are listed below:

- 401 KAR 63:005. Open burning.
  https://apps.legislature.ky.gov/law/kar/401/063/005.pdf
- 149.370 Acts creating fire hazards in forests prohibited.
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1892
- 149.375 Setting fire on own land regulated.
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1893
- 149.380 Setting fire on land owned by another, prohibited
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1894
- 149.390 Fires to capture or destroy game prohibited
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1896
- 149.400 Fire hazard seasons -- Fires prohibited -- Exceptions.
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1898
- 149.401 City or county ordinance banning open burning during fire hazard periods.
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1899
- 149.405 Entry in forest lands during drought -- Emergency proclamation --Notice.
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1900
- 149.430 Liability of violator for state and private damages -- Disposition of damages
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1905
- 149.175 Exemption from chapter's requirements for persons certified by the Kentucky prescribed Fire Council's Burn Boss Program -- Exceptions
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=44971
- 149.991 Penalties for violation of KRS 149.360 to 149.430
  https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=1925

The most prominent of these regulations are summarized below; however, it is the responsibility of the practitioner to know and understand all laws, state and local, which may impact their ability to burn.

KRS 149.400: ***Fire hazard seasons – Fires prohibited – Exceptions***

This statute specifies **two forest fire hazard seasons**: **February 15th through April 30th, and October 1st through December 15th** (Subsection (1)). During fire hazard seasons, it is illegal to burn within one hundred fifty feet (150') of any woodland or brushland, except between the hours of 6:00 p.m. and 6:00 a.m. local time, or when the ground is covered with snow. Subsection (2) exempts burning plant beds, and Subsection (3) exempts qualified employees of railroad, utility, or pipeline companies in connection with the construction, operation, or maintenance of rights-of-way. Subsection (4) is perhaps most relevant to the majority of prescribed burning that occurs in Kentucky; it exempts qualified employees of state government agencies to burn, on state-owned or managed land or on private lands under a written agreement with the landowner, for the specific purposes of wildlife or plant habitat improvement, ecological site restoration, site preparation for natural or artificial regeneration, or fuel reduction. Nongovernmental organizations like The Nature Conservancy (TNC) and other governmental agencies (such as the U. S. Forest Service) may apply to KDF for written approval to set fires under subsection (4). Persons who set such fires (burn crew leaders, known as a "burn boss") must notify the local KDF office at least twenty-four (24) hours in advance and obtain KDF approval.

KRS 149.375: Setting fire on own land regulated

This statute makes it illegal for any person, their employee, or their lessee to set fire within or adjacent to timberland they own or lease, unless the person carefully clears around the flammable material as necessary to prevent the escape or spread of fire to other lands. All fires must be attended until extinguished.

149.380: Setting fire on land owned by another, prohibited

This statute prohibits any person from burning on timberland they do not own, lease, or control It also specifies that willfully, maliciously, or wantonly allowing a fire to escape from one's own land onto the land or property of another is illegal. To willfully, maliciously, or wantonly set, throw or place any device, instrument or paraphernalia in or adjacent to any timberland with intent to burn timberland is also illegal.

149.430: Liability of violator for state and private damages -- Disposition of damages

This statute states any person who initiates a forest fire, originating as a result of violating KRS149.360 to 149.430, will be liable for all suppression costs incurred by the state and county. Such person(s) will additionally be accountable to all persons suffering from damages of personal property incurred from the fire or the act of fire suppression.

149.991: Penalties for violation of KRS 149.360 to 149.430

This statute states the possible punitive fines and imprisonment for any violation of KRS 149.360 to 149.430. For violation of KRS 149.380 specifically, the possible fine ranges from $1,000 to $10,000, and/or up to five years imprisonment. For violation of KRS 149.360 to KRS 149.430 (excluding 149.380) the possible fine ranges from $100 to $500 and/or up to six months imprisonment.

149.175: Exemption from chapter's requirements for persons certified by the Kentucky prescribed Fire Council's Burn Boss Program -- Exceptions

The Division of Forestry may exempt any person certified by the Kentucky Prescribed Fire Council's Burn Boss Program from the requirements of this chapter, given that any fire set is in accordance with KRS 149.375 and shall not be conducted under a local burn ban or under a red flag warning day. Persons exempted under this section shall give notification of a prescribed burn to the Division of Forestry at least twenty-four (24) hours prior to the burn, and notify adjacent landowners and local emergency dispatch the day of the burn.

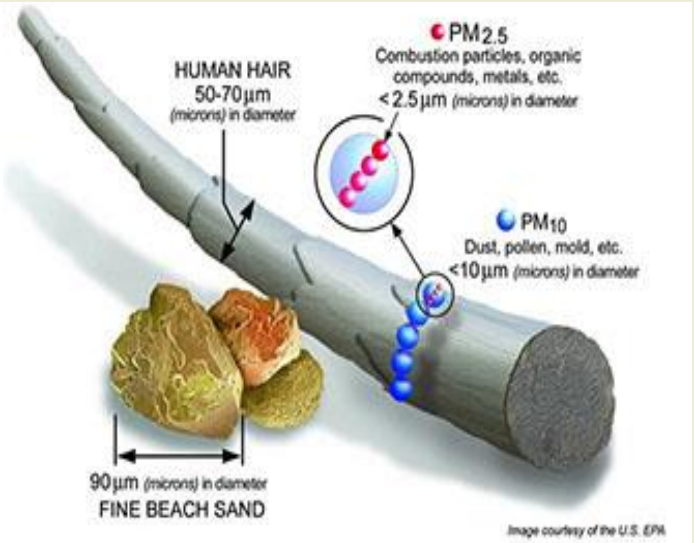
References:

Kentucky General Assembly. Website. https://legislature.ky.gov/Pages/index.aspx

Chapter 3.0:
Wildland Fire and Human Health

While wildland fire has a range of ecological benefits, the smoke from wildland fires can have a number of detrimental impacts on the health of both the general public and prescribed fire practitioners. Symptoms from smoke inhalation can include chest tightness, shortness of breath, wheezing, coughing, respiratory tract and eye burning, chest pain, dizziness or lightheadedness, and more. Asthma may be aggravated by smoke-inhalation. The EPA's AirNow website has multiple sources regarding effects on public health from fires at https://www.airnow.gov/air-quality-and-health/fires-and-your-health/

Particulate Matter Size Illustration



Source: *http://www.lung.org/about-us/blog/2016/01/how-wildfires-affect-health.html*

Wildland Fire Smoke Composition

Smoke is a complex mixture of carbon dioxide, water vapor, carbon monoxide, particulate matter, organic compounds, nitrogen oxides, and thousands of other trace minerals. The composition of smoke depends on multiple factors, including how efficiently a fuel burns, the fuel type and moisture content, the fire temperature, and numerous weather-related influences.

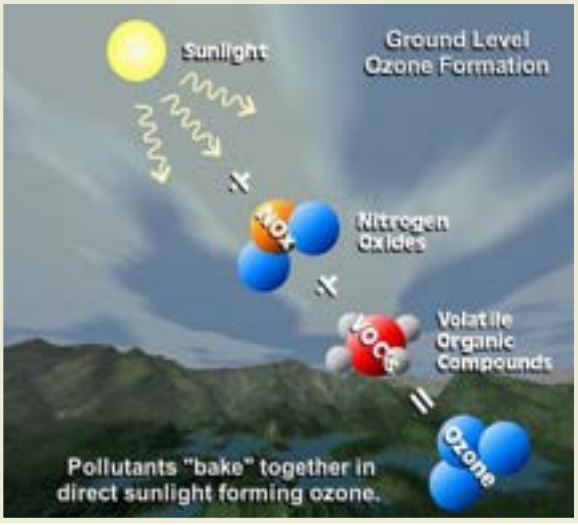
Particulate matter (PM) is the principal pollutant of concern from wildfire smoke for the relatively short-term exposures often experienced by the public. The size of the particles affects their potential to cause health effects. Particles larger than 10 micrometers do not usually reach the lungs, but can irritate the eyes, nose, and throat. However smaller particles, with diameters less than or equal to 10 micrometers ($\mathbf{PM_{10}}$), can be inhaled deep into the lungs. Particulate matter with diameters less than 2.5 micrometers ($\mathbf{PM_{2.5}}$) can be inhaled into the deepest recesses of the lungs resulting in even greater damage.

Another pollutant of concern during smoke events is **carbon monoxide (CO)**, which is a colorless, odorless gas produced by incomplete combustion of wood or other organic materials. Carbon

monoxide levels are highest during the smoldering stages of a fire, especially in very close proximity to the fire. Inhaling CO reduces oxygen delivery to the body's organs and tissues and can lead to headaches, nausea, vomiting, and dizziness. If CO levels are high enough, a person may become unconscious or die. Exposure to moderate and high levels of CO over long periods of time has also been linked with increased risk of heart disease. People who survive severe CO poisoning may suffer long-term health problems.

Finally, the presence of smoke can lead to the formation of **ground-level ozone (O_3)**, which is the primary component of smog. Ground-level ozone is different from the stratospheric ozone that comprises the Earth's protective ozone layer. Ground-level ozone isn't emitted directly from a fire, but rather forms secondarily from chemical reactions between the pollutants that are emitted: **oxides of nitrogen (NO_x)** and **volatile organic compounds (VOCs)**. Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and airway inflammation. It also can reduce lung function, harm lung tissue, and aggravate asthma.

Ground-Level Ozone Formation



Source: ***https://aura.gsfc.nasa.gov/images/features/ground_ozone.jpg***

Smoke Exposure and Sensitive Populations

Certain people are more at likely to experience the effects of wildland fire smoke, including:

- **persons with heart or lung diseases-** heart failure, angina, ischemic heart disease, chronic obstructive pulmonary disease, emphysema or asthma.
- **older adults**- more likely to have heart or lung disease than younger people.
- **children, including teenagers-** respiratory systems are still developing; tend to breathe more air (and air pollution) per pound of body weight than adults; more likely to be active outdoors; more likely to have asthma.
- **Diabetics-** more likely to have underlying cardiovascular disease.
- **pregnant women-** potential health effects on both the mother and her unborn fetus.
- **smokers, including former smokers-** lung-health has already been compromised. Smokers may be conditioned to smoke and may be less likely to notice detrimental effects.

When planning for prescribed fire, potential impacts from smoke on these sensitive populations near the burn site should be considered.

Smoke Exposure at the Fireline

Personnel working near the fireline, including firefighters and prescribed fire practitioners, are also susceptible to both long-term and short-term effects of smoke exposure. Many fireline personnel tolerate, or even accept, the negative effects of smoke as an "occupational hazard"; some personnel even avoid the use of available **personal protective equipment (PPE)**. Similar to smokers, prescribed fire practitioners may become conditioned to the short-term effects of smoke inhalation, while still experiencing long-term health impacts. While outside the scope of this document, fireline personnel are encouraged to take every opportunity to protect their health. For more information regarding PPE, smoke exposure, and fireline safety, the following resources are recommended:

- USDA. *Wildland Firefighter Smoke Exposure*. Published October 2013. https://www.fs.fed.us/t-d/pubs/pdfpubs/pdf13511803/pdf13511803dpi100.pdf
- Noble Research Institute. *Tools of the Trade– Basic Requirements for Prescribed Burns.* Published March 2008. https://www.noble.org/news/publications/ag-news-and-views/2008/march/tools-of-the-trade---basic-requirements-for-prescribed-burns/

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American Lung Association. How Wildfires Affect Our Health. EACH Breath Blog Article.. January 2016. https://www.lung.org/blog/how-wildfires-affect-health

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USEPA, AirNow. How Smoke from Fires Can Affect Your Health. January 2017. https://www.airnow.gov/air-quality-and-health/how-smoke-from-fires-can-affect-your-health/

USEPA, USDOI, USDA. Wildland Fires and Air Quality. January 2016. https://www.epa.gov/sites/default/files/2016-04/documents/2016_04_04_joint_wildland_fire_air_quality_messages.epa_usda_doi.final_.pdf

Chapter 4.0:
Overview of Ambient Air Quality

National Ambient Air Quality Standards

The federal Clean Air Act (42 U.S.C. 7401-7671), as amended by the U.S. Congress in 1970, 1977, and 1990, directs the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards defining maximum allowable ambient (outdoor) concentrations for criteria pollutants, which are considered harmful to human health and the environment. Known as **National Ambient Air Quality Standards** or "**NAAQS**," these standards establish limits for each of the criteria pollutants. Through the Clean Air Act, the EPA has established federal standards for the following six **criteria pollutants**:

- Carbon Monoxide (CO)
- Ozone (O_3)
- Nitrogen Dioxide (NO_2)
- Sulfur Dioxide (SO_2)
- Lead (Pb)
- Particulate Matter (PM)

Particulate matter is further defined by particle size with specific NAAQS established for PM_{10}, which consists of particles less than 10 microns (also referred to as micrometers), and $PM_{2.5}$, which consists of particles less than 2.5 microns in size. The table at the end of this chapter lists the level of each NAAQS, as established at the time of this plan's publication.

There are two standard goal levels for each of the criteria pollutants. The **Primary Standard** is designed to protect the public health. The **Secondary Standard** is designed to protect public welfare. Welfare includes damage to plants and animals, impairment of visibility, and property damage. A criteria pollutant may have more than one primary and/or secondary standard in order to represent both short-term and long-term impacts.

It is important to note that the EPA is required under the Clean Air Act to review, and if necessary, revise NAAQS at least every five years. As such, the specific thresholds listed in this table will change over time. Updated NAAQS can be viewed at https://www.epa.gov/criteria-air-pollutants/naaqs-table

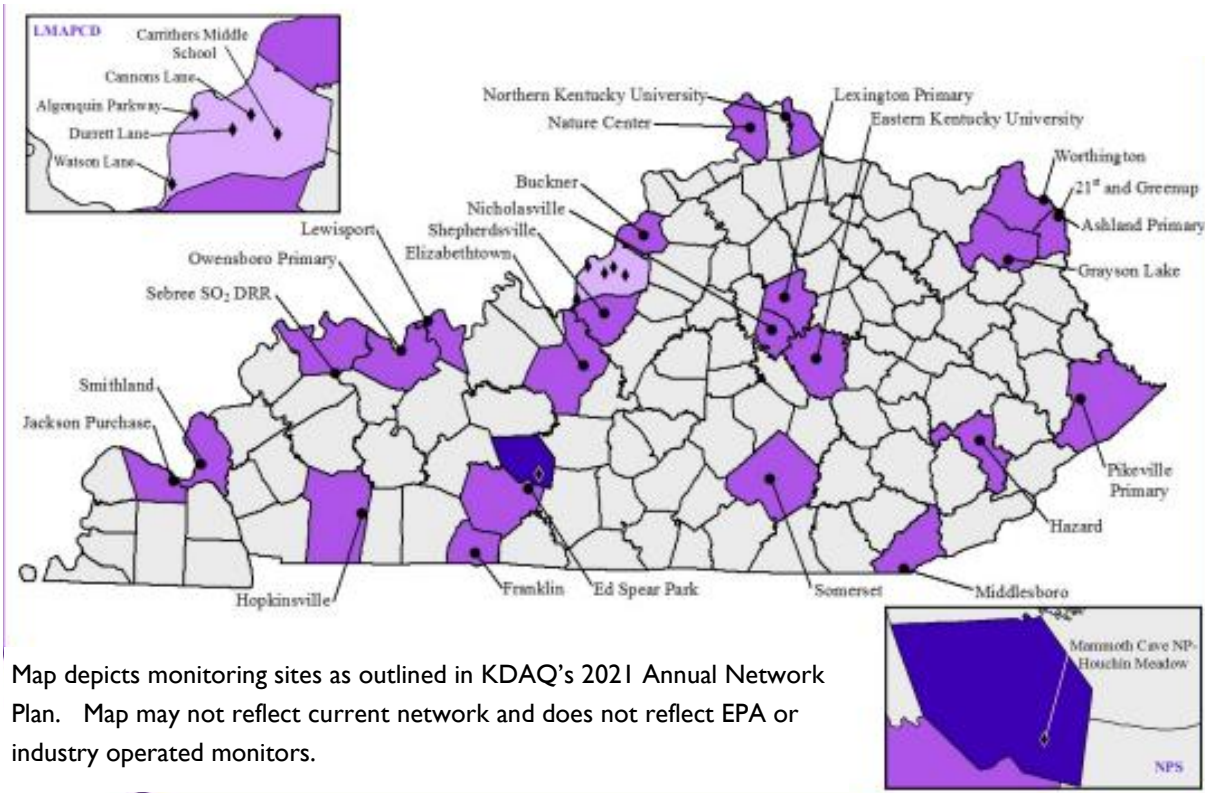
Source: *https://www.kyfire.org/gallery*

Kentucky's Ambient Air Monitoring Network

States are required to operate an ambient air monitoring network, the data from which is compared to the NAAQS to determine if the an area is meeting those standards. Each year, the Kentucky Division for Air Quality (KDAQ) is required to submit an Annual Ambient Air Monitoring Network Plan to the EPA, which documents the location of ambient air monitors in the state-operated network. The Annual Network Plan can be accessed at the Kentucky Division for Air Quality's website at https://eec.ky.gov/Environmental-Protection/Air/Pages/Division-Reports.aspx

Smoke from prescribed fire can impact monitors and can cause an area to exceed NAAQS. Practitioners should avoid impacting all known ambient air monitors. However, it must be noted that ambient air monitoring networks are dynamic; thus, **the actual sites and monitors in operation at any given time may differ from the network presented in the Annual Network Plan.** Additionally, other monitoring organizations, such as the EPA, NPS, or industry, may operate monitors not reflected in the plan. Practitioners can help avoid impacts on both known and unknown monitors by following **Basic Smoke Management Practices (BSMPs)**. More information on BSMPs can be found in Chapters 6-12.

2021 Kentucky Ambient Air Monitoring Network Map



Map depicts monitoring sites as outlined in KDAQ's 2021 Annual Network Plan. Map may not reflect current network and does not reflect EPA or industry operated monitors.

Source: *https://eec.ky.gov/Environmental-Protection/Air/Pages/Division-Reports.aspx*

Criteria Pollutant Non-Attainment Areas

Ambient air monitoring data is compared against NAAQS in order demonstrate an area's compliance with, or progress made toward meeting the standard for each criteria pollutant. An area with monitoring data in violation of a particular NAAQS may be **designated** by the EPA as being in "Non-Attainment". Areas that meet the NAAQS or do not have any monitoring data are designated as "Attainment/Unclassifiable." Former non-attainment areas are known as "Maintenance Areas." Current attainment designations for Kentucky can be found on the EPA's Green Book webpage at https://www.epa.gov/green-book

Beyond the implications on public health, a non-attainment designation can have detrimental economic consequences for an area. Areas may experience impacts on economic development and investment due to enhanced regulatory oversight and restrictive permitting. Additionally, areas may lose the funds associated with federal highway and transportation projects.

It's important to remember that an area could be violating a NAAQS, but may have yet to be designated as a non-attainment area by the EPA. It's also critical to remember that smoke could impact an ambient air monitor causing a current attainment area to violate a NAAQS. While this may seem daunting, practitioners may be able avoid impacts on area designations by following this VSMP and by practicing the recommended BSMPs.

Kentucky Non-Attainment Areas (March 2022)

Kentucky County	Standard Violated		Area Name
Boone	*8-Hr Ozone (2015)*	*	Cincinnati-Middleton, OH-KY-IN
Bullitt	*8-Hr Ozone (2015)*		Louisville-Jefferson County, KY-IN
Campbell	*8-Hr Ozone (2015)*	*	Cincinnati, OH-KY-IN
Henderson	*Sulfur Dioxide (2010)*	*	Henderson-Webster Counties, KY
Jefferson	*8-Hr Ozone (2015)*		Louisville-Jefferson County, KY-IN
Kenton	*8-Hr Ozone (2015)*	*	Cincinnati-Middleton, OH-KY-IN
Oldham	*8-Hr Ozone (2015)*		Cincinnati-Middleton, OH-KY-IN
Webster	*Sulfur Dioxide (2010)*	*	Henderson-Webster Counties, KY

**Designation only applies to part of the county*

State Implementation Plan

The **State Implementation Plan (SIP)** is a state-specific plan to ensure attainment and maintenance of the various National Ambient Air Quality Standards within a state or region. Each state is required to develop and implement a SIP. SIPs are dynamic and constantly evolve to meet objectives. If a state does not enforce it's SIP-approved regulations, the EPA may take enforcement action against the state and implement a Federal Implementation Plan (FIP).

A SIP isn't one single document, but rather a collection of all documents used to achieve the objective. A SIP typically includes an ambient air monitoring program, extensive analysis of air quality, various types of modeling, attainment demonstrations, mechanisms of enforcement, and regulations. A state SIP will include reporting to an **emission inventory** of the pollutants discharged into the atmosphere annually. A SIP may include a Smoke Management Plan, so long as that plan meets certain minimum regulatory requirements.

A SIP applies not only to the actions of state, tribal, and local government, but also to federal agencies . Under the "**General Conformity**" rule, the CAA ensures that the actions taken by federal agencies will not interfere with a state's plans to attain and maintain any NAAQS.

National Emissions Inventory

State, local, and tribal level emission inventories are combined with various other data-sources in order to compile the EPA's **National Emissions Inventory (NEI)**. Emissions reported to the NEI for wildfires or prescribed fires are classified as originating from "event" sources. The NEI does not classify fires originating on agricultural lands as "event" sources, but rather as "nonpoint" sources. However, the sum of the emissions from wildfire, prescribed fire, and agricultural fires is used to generate the **National Fire Emissions Inventory (NFEI)**.

State and local air agencies are not required to report fire-related emissions to the NEI. Instead, the NEI uses emissions that are reported, even if those records are not complete, and combines those datasets with data obtained from other sources, including satellite remote sensing. This combined dataset is used to model and estimate fire-emissions for each state. The Kentucky Division for Air Quality does not currently report smoke emissions to the NEI, as such, the state relies upon the estimated data. However, federal land managers do report those smoke emissions generated on federal lands, such as the Daniel Boone National Forest.

Regional Haze (Visibility)

Haze is caused when sunlight encounters tiny pollution particles in the air. Some light is absorbed by particles and some light is scattered away before it reaches an observer. The more pollution present in the air equates to more absorption and scattering of light, ultimately reducing the clarity and color of what an observer sees. The responsible air pollutants come from a variety of natural and manmade sources. Natural sources can include windblown dust, and soot from wildfires. Manmade sources can include motor vehicles, electric utility and industrial fuel burning, and manufacturing operations.

The reduction in visibility is of particular concern in areas where it can obscure scenic vistas. As such, the CAA affords extra protections for certain national parks and wilderness areas, called "**Class I Areas**"; as such, it requires state and federal agencies to implement plans to reduce visibility impacts in these areas. Known as the Regional Haze Rule, the CAA lists 156 specific Class I Areas across the nation, including Mammoth Cave National Park in Edmonson County, KY. Other nearby Class I Areas include the Great Smoky Mountains National Park in Tennessee, as well as Mingo Wilderness Area in Missouri. Mandatory areas represent all national parks larger than 6,000 acres and wilderness areas larger than 5,000 acres that were in existence when the CAA was amended in 1977. When planning for prescribed fire, potential impacts from smoke on visibility in nearby Class I areas should be considered.

Map of Mandatory Class I Areas

Source: *https://www.nps.gov/subjects/air/class1.htm*

References:

USEPA. Criteria Air Pollutants. Webpage. March 2018. https://www.epa.gov/criteria-air-pollutants

USEPA. Visibility and Regional Haze. Webpage. October 2019. https://www.epa.gov/visibility

National Ambient Air Quality Standards (March 2022) *Current NAAQS can be viewed at: https://www.epa.gov/criteria-air-pollutants/naaqs-table*		
Pollutant	**Primary Standard**	**Secondary Standard**
Carbon Monoxide		
8-Hour Average	9 ppm (1)	----------
1-Hour Average	35 ppm (1)	----------
Lead		
Rolling 3-Month Average	0.15 µg/m^3 (2)	Same as primary
Nitrogen Dioxide		
Annual Average	53 ppb (3)	Same as primary
1-Hour Average	100 ppb (4)	----------
Particulate Matter (measured as PM_{10})		
24-Hour Average	150 µg/m^3 (5)	Same as primary
Particulate Matter (measured as $PM_{2.5}$)		
Annual Average	12.0 µg/m^3 (6)	15.0 µg/m^3 (6)
24-Hour Average	35 µg/m^3 (7)	Same as primary
Ozone		
8-Hour Average	0.070 ppm (8)	Same as primary
Sulfur Dioxide		
1-Hour Average	75 ppb (9)	----------
3-Hour Average	----------	0.5 ppm (1)

µg/m3= micrograms per cubic meter **ppm= parts per million** **ppb= parts per billion**

Footnotes:

(1) Not to be exceeded more than once per year.

(2) In addition to the 2008 lead standard (final rule signed Oct. 15, 2008).

(3) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(4) To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective Jan. 22, 2010).

(5) The estimated number of exceedances must be equal to or less than one, on average over 3 years.

(6) To attain this standard, the 3-year average of weighted annual means must not exceed 12.0 µg/m^3 (final rule signed on Dec. 14, 2013; rule effective on March 18, 2013). The previous primary standard was set to 15.0 µg/m^3, as a 3-year average of annual weighted means, and was instead retained as a secondary standard.

(7) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 .

(8) To attain this standard, the weighted 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.070 ppm (effective December 28, 2015).

(9) To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb (final rule signed June 22, 2010).

Chapter 5.0:
Understanding the EPA's Exceptional Events Rule

The EPA may allow data collected at ambient air monitoring stations to be excluded from certain regulatory decisions, when the data has been influenced by an "**Exceptional Event**." According to the 2016 Exceptional Events Rule (EER), an Exceptional Event is defined as an event:

- with a clear causal relationship to the monitored exceedance/violation;
- that is not reasonably preventable or controllable;
- that is caused by human-activity that is unlikely to recur at a particular location or is a natural event; and,
- that is determined by the EPA Administrator to be an Exceptional Event in accordance with 40 CFR 50.14.

Exceptional Events include natural events such as wildfires and dust storms, as well as certain human-caused events, such as firework displays, industrial accidents, and prescribed fires. Exceptional Events do not include air pollution events directly related to emissions from source non-compliance, such as industrial emissions, and do not include events caused by certain meteorological conditions, such as atmospheric stagnations and inversions, drought, and high temperatures.

With regards to prescribed fire, Exceptional Events are most often associated with fires that are set on "**wildlands**"; however, fires set on other land-use types may also be eligible on a case-by-case basis. The EER defines wildlands as an area in which development is essentially non-existent, except for roads, railroads, powerlines, and similar transportation facilities. Structures, if any, are widely scattered. Wildlands include parks, forests, and wilderness areas on state and federal lands, as well as some lands on military bases and lands within wildland-urban interfaces. Private lands and agricultural lands are not automatically considered "wildlands". However, it is important to note that fires that occur on lands not meeting the definition of "wildland" may still be classified as an Exceptional Event on a case-by-case basis. The application of the EER to such fires is similar to fire occurring on wildlands, as such this VSMP recommends that fires follow the same general prescriptions, as much as is practicable.

The remainder of this chapter addresses each of the criteria and the definitions related to the EER. Much of the content was summarized from the EPA's 2019 "Exceptional Events Guidance: Prescribed Fire on Wildland that May Influence Ozone and Particulate Matter Concentrations".

Human Activity Unlikely to Recur Criterion

Under the EER, an Exceptional Event must be an event caused by human activity that is unlikely to recur at a particular location or a natural event. Unlike a wildfire, prescribed fire is defined as a human activity; therefore, air agencies must address the "unlikely to recur at a particular location" criterion. **Recurrence** for prescribed fires is defined by either:

- the natural fire-return interval; and/or,
- the prescribed fire frequency needed to establish, restore, and/or maintain a sustainable and resilient wildland ecosystem, as described in a multi-year land or resource management plan with a stated objective to establish, restore and/or maintain a sustainable and resilient wildland ecosystem and/or to preserve endangered or threatened species through a program of prescribed fire .

Exceptional Event demonstrations submitted to the EPA by an air agency must include a description of the actual frequency of fire application. This typically consists of the following information:

- Physical description of the area burned
- Description of the predominate fuel-type
- Geographical parameters of the fire
- Date of the burn
- Date of past burns
- Times of burn (Ignition & Extinguishment)
- Total Acres Burned

Whenever possible, the descriptions of prescribed-fire application and/or natural fire return intervals should be included in the burn plan/permit under which the prescribed fire program was conducted, and/or a post-burn review document from the burn manager.

Exceptional Event demonstrations may also include a description of an area's natural fire-return intervals. These descriptions typically demonstrate:

- the number of years between successive naturally occurring fires for a given vegetation type; and,
- the actual frequency by which the prescribed fires were conducted compared to the natural fire return interval.

Whenever possible, multi-year land/resource management plans should include documentation of these established fire intervals and/or the broad targets for prescribed fire frequency. On a case-by-case basis, the natural fire return interval can be obtained from other documents, such as scientific literature. The EPA expects that land managers may deviate from the general targets in a multi-year plan due to unexpected differences between planned and actual fire behavior, landscape or ecosystem characteristics, fuel loading patterns, and/or weather patterns; as such, stated frequencies are not held to precise schedules.

Not Reasonably Controllable or Preventable Criterion

EPA has interpreted this criterion to mean an Exceptional Event must be both not reasonably controllable and not reasonably preventable at the time the event occurred. As such, air agencies must demonstrate that an event met both sub-criteria.

In order to meet the "controllability" aspect, the state must either:

- certify to the Administrator that it has adopted and is implementing a "Certified" Smoke Management Program (CSMP); or,
- demonstrate that the burn manager employed appropriate **Basic Smoke Management Practices (BSMPs)**.

As mentioned previously, this document does not meet the criteria necessary to be classified as fully adopted, implemented, and certified. Instead, this **Voluntary Smoke Management Plan (VSMP)** seeks to encourage prescribed fire practitioners to use Basic Smoke Management Practices during every prescribed fire used in the State, regardless of whether that prescribed fire is being set on wildland, private land, or agricultural lands.

Where a burn manager employs appropriate **Basic Smoke Management Practices (BSMPs)**, an air agency may rely on a statement or other documentation provided by the burn manager that he or she employed those practices. If an exceedance or violation of a NAAQS occurs when a prescribed fire has employed an appropriate basic smoke management practices approach, the State and the burn manager must undertake a review of the subject fire, including a review of BSMPs applied during the subject fire to ensure the protection of air quality and public health and the progress towards restoring and/or maintaining a sustainable wildland ecosystem. The documentation of the post-burn review must accompany any demonstration submitted to the air agency by an air agency. BSMPs are discussed further in Chapters 6-12.

The EER requires interagency collaboration for air agencies employing BSMPs to satisfy the not reasonably controllable criterion. If the air agency anticipates satisfying this rule criterion by

documenting the implementation of BSMP, then the air agency, FLMs, and other entities as appropriate, must periodically collaborate with burn managers operating within the jurisdiction of the state to discuss and document the process by which air agencies and land managers will work together to protect public health and manage air quality impacts during the conduct of prescribed fires on wildland. EPA does not define these discussions or the mechanism by which they are conducted or documented, they must include outreach and education regarding general expectations for the selection/application of BSMPs and strategies for advancing/increasing adoption, communication, and use of BSMPs. Mechanisms could be formal, such as a Memorandum of Understanding or an Interagency Agreement, or it could be a more informal letter of agreement or other documentation. **This VSMP, along with participation in the KPFC, provides a mechanism for agreement, collaboration, communication, outreach, and education in Kentucky.**

In order to satisfy the "preventability" aspect, the air agency can simply describe the benefits that would not have been achieved had the fire not occurred. In other words, the air agency justifies "why" the burn had to occur. The information can be obtained from a multi-year land/resource management plan, as discussed earlier in this chapter. A multi-year land/resource management plan must have the specific objectives of establishing, restoring, or maintaining a wildland ecosystem or preserving endangered or threatened species via a prescribed fire program. The multi-year plan may include objectives that relate to the maintenance of resilient wildland ecosystems to the diminished impacts of catastrophic wildfires.

Clear Causal Relationship Criterion

Exceptional Events must affect air quality in such a way that there exists a clear causal relationship between the event and the monitored exceedance or violation. An air agency may demonstrate a clear causal relationship by analyzing pollutant concentrations observed during the event to historical concentrations, proving that an event did indeed occur and defining its geographic extent, establishing spatial and temporal relationships (including smoke-transport) between the event and recorded concentrations, determining the chemical or physical composition of air monitoring samples, and comparing event-affected data to known non-event data. Observations of fire/smoke behavior during a prescribed fire may aid an air agency in establishing such relationships; however, the air agency will typically be responsible for providing most of the data needed.

Determined to be an Exceptional Event by the EPA Regional Administrator

Exceptional Event determinations are ultimately made by the applicable EPA Regional Administrator. Data that are not determined to meet the criteria of an exceptional event by the EPA Regional

Administrator are not eligible for exclusion from regulatory actions.

In order for a determination to be made, the state must first flag the data affected by the exceptional event and add a description of the event in the national air monitoring database, known as the EPA's **Air Quality System (AQS).** While previous versions of the EER required air agencies to provide flags by July 1 in the year following the event, the new rule removed this requirement and instead relies upon other regulatory deadlines to determine when flags must be added. Air agencies must discuss regulatory implications with their EPA Regional Office. Based upon these discussions, the EPA Regional Administrator then provides a due date for demonstration package submittals. The air agency must prepare a demonstration package, in order to prove that the data affected was indeed impacted by an exceptional event and to justify excluding the data from regulatory decisions. Once a demonstration package has been submitted by the state, the EPA Administrator adds additional flags in AQS, if concurrence is granted.

Source: *https://www.kyfire.org/gallery*

References:

US EPA. 40 CFR Parts 50 and 51: Treatment of Data Influenced by Exceptional Events. Final Rule. Federal Register, Vol. 81, No 191. October 3, 2016. https://www.epa.gov/air-quality-analysis/federal-register-notice-final-revisions-exceptional-events-rule

US EPA. Exceptional Events Guidance: Prescribed Fire on Wildland that May Influence Ozone and Particulate Matter Concentrations. EPA-457/B-19-004. August 2019.

Chapter 6.0:
Overview of Basic Smoke Management Practices (BSMPs)

The decision to use prescribed fire as a land management tool and the specific methods for conducting a prescribed fire are influenced by many inter-related variables, of which, smoke management is included. Other factors that influence a practitioner's decision to use prescribed fire and the techniques for conducting a prescribed fire include the ultimate land management goals, costs, resource-availability, complexity, meteorology, fuel-characteristics, time-constraints, and foremost, safety.

Basic Smoke Management Practices (BSMPs) help practitioners predict the amount of smoke that may be produced, the direction of smoke transport, and the people and places that may be impacted. Ultimately, they help practitioners identify, minimize, and mitigate smoke impacts. If a decision is made to use prescribed fire, practitioners should evaluate and use BSMPs for each and every burn conducted, whether the fire is set on wildland, private land, or agricultural land.

The Exceptional Events Rule adopted a list of six general BSMPs, as they were presented by the Natural Resource Conservation Service (NRCS). These BSMPs are not strict prescriptive requirements, but rather over-arching recommendations that can guide smoke management practices before, during, and after a prescribed fire. The list is not comprehensive; allowing flexibility for practitioners to manage smoke as necessary. Regardless, each of these six BSMPs should be considered, and their practicality evaluated, for each prescribed fire conducted. Finally, it should be noted that the six BSMPs are not separate and discrete steps, but are rather inter-related and ongoing throughout the entire prescribed fire process.

The chart on the following page shows a modified list of the BSMPs presented in the NRCS document, with details added from the technical note's verbiage. Each individual BSMP is described in more detail in the following chapters.

References:

US EPA. 40 CFR Parts 50 and 51: Treatment of Data Influenced by Exceptional Events. Final Rule. Federal Register, Vol. 81, No 191. October 3, 2016.

Natural Resources Conservation Service. Basic Smoke Management Practices. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf

Summary of Basic Smoke Management Practices (BSMPs)				
Basic Smoke Management Practices (BSMPs)		**Objective**	**Timing**	**Potential Elements**
1	Evaluation of Smoke Dispersion Conditions	Predict Smoke Impacts	Before, During, After	-Identify Fuel Type & Loading -Identify Probable Smoke-Impact Areas -Identify Smoke Sensitive Targets -Determine Meteorological Criteria
2	Monitoring Effects on Air Quality	Maintain awareness of smoke transport and potential impacts	Before, During, After	-Checking Air Quality Forecasts & Conditions -Tracking Smoke Transport
3	Communication /Public Notification	Notify neighbors, stakeholders and those potentially impacted by smoke.	Before, During	-Communication with Government Entities -Communication with Emergency Personnel -Communication with the General Public
4	Consideration of Other Emission Reduction Techniques	Reduce emissions through other mechanisms that reduce fuel loadings.	Before, During	-Reduce the Burn Area -Reduce the Fuel Load -Reduce/Change the Fuel -Increase Combustion Efficiency
5	Coordination of Area Burning/ Sharing the Airshed	Coordinate multiple burns in an area to manage impacts combined smoke.	Before, During, After	-Formalized Procedures between Agencies -Informal/voluntary Actions among Practitioners -Kentucky Prescribed Fire Portal
6	Documentation/ Journaling	Document and retain information about the weather, fire, smoke, and negative air quality impacts.	Before, During, After	-Burn Journaling/Log -Burn Plan -Post-Burn Report -Record Keeping/Archival

Chapter 7.0:
BSMP 1—Evaluation of Smoke Dispersion Conditions

Basic Smoke Management Practices		Objective	Deployment
BSMP 1	*Evaluation of Smoke Dispersion Conditions*	*Predict Smoke Impacts*	*Before, During, After*
BSMP 2	Monitoring Effects on Air Quality	Maintain awareness of smoke transport and potential impacts	Before, During, After
BSMP 3	Communication/Public Notification	Notify neighbors, stakeholders, and those potentially impacted by smoke.	Before, During
BSMP 4	Consideration of Other Emission Reduction Techniques	Reduce emissions through other mechanisms that reduce fuel loadings.	Before, During
BSMP 5	Coordination of Area Burning/Sharing the Airshed	Coordinate multiple burns in an area to manage impacts combined smoke.	Before, During, After
BSMP 6	Documentation/Journaling	Document and retain information about the weather, fire, and smoke.	Before, During, After

The objective of BSMP 1 is to predict of smoke before, during, and after a prescribed fire. Based upon the insight gleaned from this BSMP, adjustments can be made to certain aspects of a planned burn, such as the firing sequence, mop-up procedures, or the date/time of ignition. There are four potential elements that are involved in the evaluation smoke dispersion conditions and their potential impacts. Those elements are:

1. Determine fuel-type and loading
2. Identify the areas of probable smoke impacts
3. Identify smoke sensitive targets
4. Determine meteorological criteria

BSMP1, Element 1: Identify Fuel Type & Loading

The fuel type of an area directly impacts the intensity and duration of fire and the resulting smoke. Short grasses, leaf litter, and pine needles tend to produce a relatively short flame-length with less smoke. These fuel-types also tend to burn to completion more quickly. Meanwhile, tall grasses tend to produce much longer flame lengths and more smoke; these fuels also tend to burn-out quickly. Slash-type fuels, although harder to ignite, are capable of burning for long periods of time and are also capable producing considerable amounts of smoke. The way fuels are distributed or piled can also have a significant impact on the amount of smoke produced. For example, burning slash that has been piled into long continuous rows, called **windrows**, produces large amounts of smoke and is

responsible for a high number of smoke incidents, especially in the southern US. **As such, this VSMP, does not recommend burning windrowed fuels, unless absolutely necessary.**

Practitioners are free to use any fuel-characterization model available or they may follow the characterization presented in this SMP. The fuel-type determined in this step will be used in later steps of the smoke characterization process. Generally, fuels in Kentucky can be classified into seven broad **fuel-types**:

- Grass (GR)
- Grass/Shrub (GS)
- Shrub (SH)
- Timber Understory (TU)
- Timber Litter (TL)
- Slash/Blowdown (SB)
- Non-Burnable (NB)

A more detailed pictorial identification guide to fuel types can be found in Appendix C. Additionally, examples of more advanced fuel-models can be found in the following resources:

- Scott, Joe H.; Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. USDA Forest Service. Available at: https://www.fs.fed.us/rm/pubs/rmrs_gtr153.pdf
- Southern Forest Fire Laboratory. 1976. Southern forestry smoke management guidebook. Gen. Tech. Rep. SE-10. USDA Forest Service. Available at: https://www.srs.fs.usda.gov/pubs/gtr/uncaptured/gtr_se010.pdf

The amount of fuel present will also need to be determined. **Fuel-loading** is defined as the amount of fuel available per one acre of land. Higher fuel-loads equate to more heat that will be produced during a fire. While experienced practitioners conducting complex and/or large burns may need to utilize advanced fuel-models, fuel-loading can be more simply characterized as being greater than or less than 10 tons per acre. Generally, total fuel-loading will be less than less than 10 tons per acre for the following fuel-types:

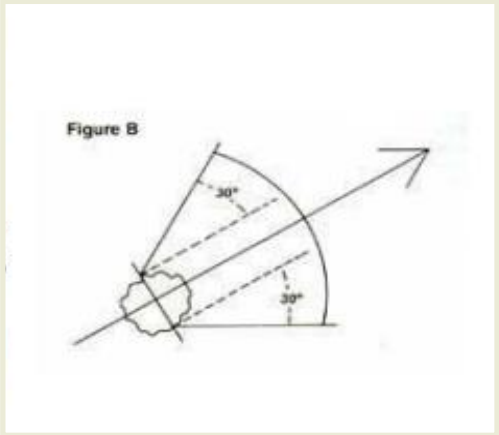
- Grass (with or without a pine overstory): when the **rough** (the amount of growth/fuel-accumulation since the last fire) is of any age
- Light Brush/Shrub (areas of no fuel-canopy): when the age of the rough is 7-years or less
- Hardwood Leaf Litter: when the age of the rough is of any age

It is not advised that private land-owners attempt prescribed fires on lands with fuel loads greater than 10 tons per acre without professional assistance.

BSMP1, Element 2: Identify Probable Smoke-Impact Areas

Prior to burning, practitioners should evaluate the weather conditions that will be necessary for both achieving the land management objectives of the burn, as well as meeting smoke management objectives. Practitioners can use any number of tools to identify smoke trajectories, including publicly -available smoke dispersion models and smoke trajectory plots. However, practitioners should be aware that most tools do not account for local topography.

A **Smoke Trajectory Plot** is simple and widely-used method for predicting probable smoke impact areas utilizing a paper map and protractor. A step-by-step guide to creating a smoke trajectory plot can be found in Appendix E.



Smoke Trajectory Plot

The Florida Forest Service hosts the **Simple Smoke Screening Tool**, which is a digital version of the paper smoke trajectory plot method at: http://fireweather.fdacs.gov/Simple-Smoke/. The Simple Smoke Screening Tool assists with identification of smoke sensitive targets, but does not predict concentrations.

Simple Smoke Screening Tool

The Georgia Forestry Commission hosts the user-friendly smoke dispersion model, **VSmoke-Web**, at: http://weather.gfc.state.ga.us/GoogleVsmoke/vsmoke-Good2.html. The tool allows practitioners to enter basic information about the prescribed fire, fuels, and wind direction to quickly determine the areas that will likely be impacted by smoke. Expected $PM_{2.5}$ concentrations, displayed as color-coded Air Quality Index (AQI) values, are projected onto a map or satellite image. Outputs can be downloaded as KML files.

VSmoke-Web

The National Interagency Fire Center lists a number of more advanced smoke modeling tools on their website at https://www.nifc.gov/smoke/smoke_modeling.html.

BSMP 1, Element 3: Identify Smoke Sensitive Targets

Once the area of potential impact has been determined, practitioners should identify and consider potential **Smoke Sensitive Targets** within that area of impact. Practitioners may use choose to use Geographic Information Systems (including tools such as Google Earth®), physical maps, online resources, and/or a simple physical survey of the area to determine the existence of any Smoke Sensitive Targets.

Smoke Sensitive Targets (SSTs) are populations, areas, or landmarks where a smoke intrusion could have a particularly devastating effect. Examples of SSTs include, but are not limited to:

- Airports
- Roads and Highways
- Hospitals and Nursing Homes
- Schools
- Class 1 Areas for Regional Haze
- Ambient Air Quality Monitors
- NAAQS Non-Attainment Areas
- Populated Areas

Practitioners should also be cautious of the potential hazards posed by ignitable organic soils and high voltage electrical cables within the burn-field. Some highly organic soils, soils overlain with extensive duff or root mats ignite easily. Particulate matter within heavy smoke can cause electricity to ground-arc near high voltage electrical cables.

If no SSTs are identified to be with in the probable area of smoke impact, the burn under their current prescription. However, if any SSTs are identified, the practitioner should determine if any targets exist a **Critical Smoke Sensitive Area**. A Critical Smoke Sensitive Area is an area with an existent air quality or visibility issue, such an area with a poor air quality forecast for the day, or an area with a SST that exists within a determined area of likely and/or heavy smoke impact.

Critical Smoke Sensitive Areas are determined utilizing the smoke screening tools discussed previously, such as a **Smoke Trajectory Plot**. Instructions for creating a Smoke Trajectory Plot and using the tool to identify Critical Smoke Sensitive Areas can be found in Appendix E.

If it is determined that the Critical Smoke Impact Area contains an SST or if air quality is expected to be poor on the day of the burn, practitioners should consider the following:

- Prescribe a new wind direction to avoid targets and re-analyze smoke impact areas/targets.
- Reduce the area or fuel-loading to minimize smoke production and re-analyze smoke impact areas/targets.

- Ensure fires are extinguished and mopped-up prior to sundown.
- Consider other alternatives to burning.

Ultimately, if practitioners do decide to burn, risk to SSTs and Critical Smoke Sensitive Areas can be minimized by meeting the following criteria:

- Atmospheric mixing layer height of 1,650 feet (500 meters) or greater.
- Transport wind speed of 9 mph (4 meters per second) or greater.
- Background visibility of least 5 miles within the plotted area.
- Use of a backing fire for rough older than 2 years. (If burn can be completed 3 hours before sunset, and/or if no smoke-sensitive areas are located in the first half of the impact area, another firing techniques can be used.)
- Promptly mop-up and monitor to minimize smoke hazards.
- If a smoke-sensitive area is in the overlapping trajectory of two smoke plumes, it should be at least 1 mile from either source (2 miles from logging debris fires).
- For night burns, backing fires with surface wind speeds greater than 4 mph and relative humidity under 80 percent should be prescribed.
- If it appears that stumps, snags, or logs may cause a residual smoke problem, take steps to keep them from burning. If they do ignite, extinguish them immediately.
- Daytime dispersion index between 41 and 60 is adequate for small fires and low levels of burning activity. However, as either the size of the fire increases or the level of burning activity increases, the acceptable dispersion index rating should also increase.

BSMP 1, Element 4: Determine Meteorological Criteria

Together with topography and fuels, weather is one of the three major components of fire behavior. Weather influences nearly all aspects of prescribed fire and is one of the most variable components with which a practitioner must contend. Meteorological conditions must be outlined in order to determine a fire's specific prescriptions, must be checked prior to ignition, must be monitored during a burn, and must even be monitored after a burn has been completed. An overview of basic fire weather terminology can be found in Appendix B of this plan.

During the planning process, practitioners must determine the meteorological conditions that will be necessary to promote good dispersal away from smoke sensitive targets and prevent smoke from accumulating near the ground. On the day of the burn prior to ignition, it is critical that practitioners obtain a current meteorological forecast to determine if the previously prescribed meteorological criteria can be met. If the meteorological criteria can not be met, the practitioner should consider if they are still able to burn within their prescription. If not, the burn may need to be cancelled.

Practitioners should use extreme caution if a "**Fire Weather Watch**" or a **"Red Flag Warning"** has been issued. These warnings mean that critical fire weather conditions (i.e. strong winds, low humidity, and warm temperatures) are either currently present or are forecasted to develop in the near future. Ignition under such conditions is extremely hazardous as fire may quickly become uncontrolled. Local governments may also enact burn bans during such conditions. This SMP recommends that private landowners and novice practitioners **not** burn under such conditions.

Representatives of government agencies should obtain a **Fire Weather Spot Forecast** from the National Weather Service's (NWS) Spot Forecast Request service. The service is not available to private land-owners; however, both current and forecasted weather conditions can be obtained freely on the NWS's webpage at https://weather.gov/. Forecasts should be retained with the burn plan as documentation.

The NWS's Fire Weather page also has a variety of information that is accessible to both experienced and novice practitioners. The website can be accessed at https://weather.gov/fire/. In addition to the NWS, the National Interagency Coordination Center (NICC) operates a Predictive Services Program website with various tools that may be useful to practitioners at https://www.predictiveservices.nifc.gov/weather/weather.htm.

Once a fire has been ignited, fire managers must continuously verify weather conditions during the burn. Weather may be monitored with on-site equipment, visual observations of fire and weather behavior, as well as radar and other and remote-access data sources.

After the fire has been extinguished, weather conditions must still be monitored. Smoke may still be generated from smoldering fuels and transported into smoke sensitive areas. Additionally, weather conditions could promote fire re-ignition. In the evening, smoke from a previous fire could intrude into valleys. The potential for complications after a burn has been completed should be anticipated, which may warrant the consideration of more aggressive mop-up procedures.

Finally, as a part of evaluating suitable meteorological conditions, professional practitioners should check to ensure that atmospheric conditions are conducive to good smoke dispersion. A **Dispersion Index** is a numerical indicator of how well and how rapidly smoke will be dispersed during a fire. As either the size of a fire or the burning activity increases, the acceptable value of the Dispersion Index should also be increased. Professionals may obtain a current dispersion index from the NWS's Spot Weather Forecast or may decide to manually calculate according to their agencies procedures.

The following table shows the relationship between a Dispersion Index and on-the-ground burning conditions. Depending on the fire, the daytime index should be greater than 30 for good smoke dispersal and less than 70 to prevent erratic fire behavior.

Atmospheric Dispersion Index	
Index Value	**Burning Conditions**
>100	**Too Good** - burning conditions are so good that fires may become hazardous and become uncontrolled. Reassess decision to burn.
61 - 100	**Good** - preferred range for prescription burns.
41 - 60	**Generally OK** - climatological afternoon values in most inland forested areas fall in this range.
21 - 40	**Fair** - stagnation may be indicated if accompanied by low wind speeds. Reassess decision to burn.
13 - 20	**Generally Poor** - do not burn. Represents stagnant conditions if persistent, although better than average dispersion night-time conditions.
7 - 12	**Poor** - do not burn. Stagnant during the day, but near or above average at night.
1 - 6	**Very poor** - represents the majority of night-time conditions at many locations.

Source: *https://www.weather.gov/media/rnk/fire/ADI_Guide.pdf*

References:

Natural Resources Conservation Service. Basic Smoke Management Practices. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf

Southern Forest Fire Laboratory. 1976. Southern Forestry Smoke Management Guidebook. Gen. Tech. Rep. SE-10. USDA Forest Service. https://www.srs.fs.usda.gov/pubs/gtr/uncaptured/gtr_se010.pdf

Kentucky Prescribed Fire Council. Kentucky Basic Controlled Burn Workshop. Student Manual. 2012.

Chapter 8.0:
BSMP 2—Monitoring Effects on Air Quality

Basic Smoke Management Practices		Objective	Deployment
BSMP 1	Evaluation of Smoke Dispersion Conditions	Predict Smoke Impacts	Before, During, After
BSMP 2	*Monitoring Effects on Air Quality*	*Maintain awareness of smoke transport and potential impacts*	*Before, During, After*
BSMP 3	Communication/Public Notification	Notify neighbors, stakeholders, and those potentially impacted by smoke.	Before, During
BSMP 4	Consideration of Other Emission Reduction Techniques	Reduce emissions through other mechanisms that reduce fuel loadings.	Before, During
BSMP 5	Coordination of Area Burning/Sharing the Airshed	Coordinate multiple burns in an area to manage impacts combined smoke.	Before, During, After
BSMP 6	Documentation/Journaling	Document and retain information about the weather, fire, and smoke.	Before, During, After

Throughout the prescribed-fire process, practitioners must continuously access air quality conditions, both in the immediate area of the burn and downwind. This assessment occurs prior to ignition, during the burn, and after the fire has been extinguished. Monitoring the effects on air quality may consists of the following elements:

- Monitoring Air Quality Forecasts & Current Conditions
- Tracking Transport

BSMP 2, Element 1: Checking Air Quality Forecasts & Conditions (AirNow)

Prior to ignition, practitioners should always get the most-up-to date air quality forecast for the day of the burn. Whenever internet-connectivity allows, current air quality conditions should be checked continuously as the burn progresses. These checks should include areas in both the immediate vicinity of the burn, as well as the areas of possible downwind impacts. Perhaps the best resource for air quality forecasts is the **EPA's AirNow website**, due to it's widespread availability and user-friendliness. AirNow can be accessed at https://www.airnow.gov/.

AirNow utilizes ambient air data collected using from federal, state, local, and tribal air monitors to generate maps of forecasted and near-real time air quality conditions. The AirNow website also contains an interactive Fire and Smoke Map that combines satellite-detected smoke and fire points, with data from both regulatory-type air monitors and low-cost air sensors.

The AirNow website converts pollutant concentrations into a color-coded **Air Quality Index (AQI)** for communicating daily air quality and potential health impacts to the general public. The higher the AQI value, the greater the level of air pollution and the greater the health concern. Maps on the AirNow website are interactive.

This SMP recommends that prescribed fires not be conducted when wind directions could potentially transport smoke into an area with a forecasted AQI of Orange (Unhealthy for Sensitive Groups), Red (Unhealthy), Purple (Very Unhealthy), or Maroon (Hazardous).

BSMP 2, Element 2: Tracking Smoke Transport

During a prescribed fire, the practitioner must continuously observe and assess smoke behavior and transport. While tracking smoke transport and impacts can be accomplished with any number of sophisticated tools, such as aircraft observations and satellite imagery, as well as the previously discussed weather and air quality tools, tracking smoke can most easily be accomplished with **visible observations by the practitioner in the field**.

Visible observations should be documented throughout the burn. Helpful observations include:

Air Quality Index (AQI)		
Level of Concern (Color)	**Numerical Value**	**Meaning**
Good (Green)	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate (Yellow)	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups (Orange)	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy (Red)	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy (Purple)	201-300	Health alert: everyone may experience more serious health effects.
Hazardous (Maroon)	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

- Observed transport winds:
  - Where is the smoke going?
  - How quickly is the plume traveling?
- Observed atmospheric stability
  - How high is the plume lifting in the atmosphere?
  - Is the plume lifting and then assuming a more flattened appearance indicating the presence of an inversion?
- Observed smoke production
  - How much smoke is being produced compared to what was anticipated?
  - Are "white-out" conditions locally present or potentially forming?

Most importantly, observations should be documented for later reference.

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Members of the Kentucky Prescribed Fire Council conduct a demonstration burn. September 2014.

References:

USEPA. AirNow: Air Quality Index Basics. Website. https://www.airnow.gov/aqi/aqi-basics/

Natural Resources Conservation Service. Basic Smoke Management Practices. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf

Kentucky Prescribed Fire Council. Kentucky Basic Controlled Burn Workshop. Student Manual. 2012.

Chapter 9.0:
BSMP 3— Communication/Public Notification

Basic Smoke Management Practices		Objective	Deployment
BSMP 1	Evaluation of Smoke Dispersion Conditions	Predict Smoke Impacts	Before, During, After
BSMP 2	Monitoring Effects on Air Quality	Maintain awareness of smoke transport and potential impacts	Before, During, After
BSMP 3	*Communication/Public Notification*	*Notify neighbors, stakeholders, and those potentially impacted by smoke.*	*Before, During*
BSMP 4	Consideration of Other Emission Reduction Techniques	Reduce emissions through other mechanisms that reduce fuel loadings.	Before, During,
BSMP 5	Coordination of Area Burning/Sharing the Airshed	Coordinate multiple burns in an area to manage impacts combined smoke.	Before, During, After
BSMP 6	Documentation/Journaling	Document and retain information about the weather, fire, and smoke.	Before, During, After

Perhaps one of the most important BSMPs is communication with the stakeholders- the people and agencies that may be impacted by fire and smoke. The methods of communication and the information presented will be dictated by the intended target. Generally, stakeholders in an individual fire can be classified as:

- Government Entities
- The General Public

BSMP 3, Element 1: Communication with Government Entities

Of utmost importance, practitioners must always ensure that they are burning in accordance with all state, local, and/or federal laws. Certain local governments may require that a burn permit be obtained prior to ignition. Others may simply request that the local fire department or public health office be notified. It is the practitioners responsibility to know and understand the local and state laws regarding prescribed fire.

However, regardless of local laws, communication with certain entities is required or encouraged. **First, practitioners are required to notify their local Kentucky Division of Forestry (KDF) Regional Field Office at least 24-hours prior to a igniting a prescribed fire.** The map on the following pages lists the appropriate contacts at each KDF Regional Field Office and the counties covered by each office.

Kentucky Division of Forestry
Regional Field Office Locations and Prescribed Fire Contacts
Please contact the appropriate field office for prescribed fire notifications.

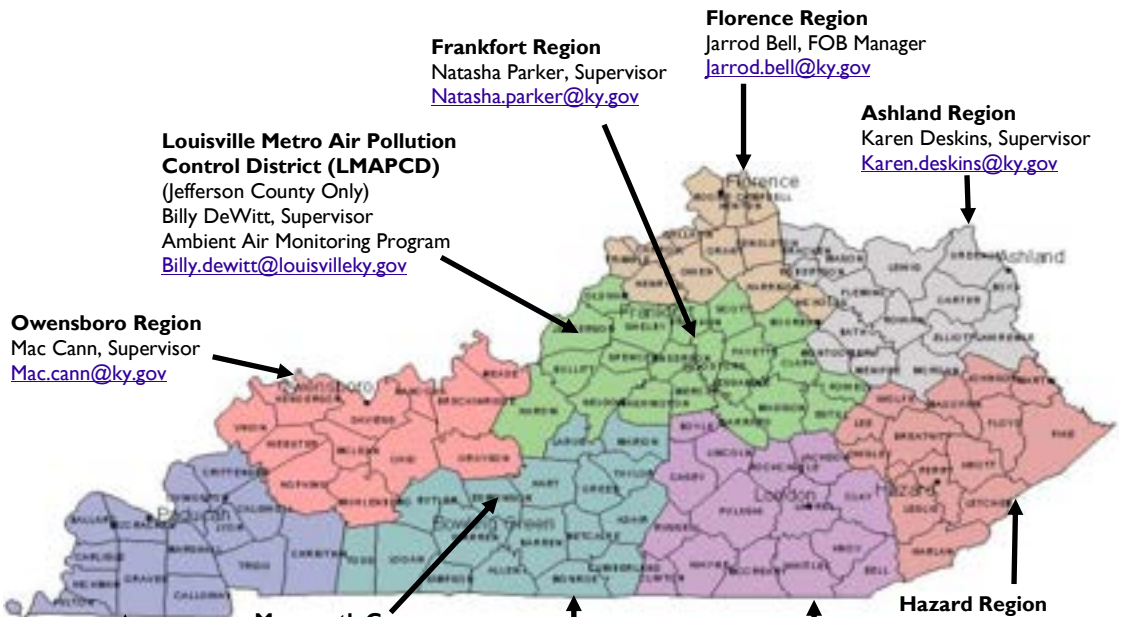
Campbellsville	**Madisonville**	**Frankfort**	**Pineville**	**Hazard**	**Morehead**
Seth Dykes	Chuck Porter	Matt Haywood	Deanio Carmical	Jake Hall	James MacDonald
120 Gaines Drive	P.O. Box 465	P.O. Box 516	12008 US Hwy 25E	154 Grand Vue Plaza	255 Rodburn Hollow
Campbellsville, KY 42718	Madisonville, KY 42431	Frankfort, KY 40602	Pineville, KY 40977	Hazard, KY 41701	Morehead, KY 40351
270-465-5071	270-824-7527	502-573-1085	606-337-3939	606-435-6073	606-783-8625

Practitioners are also asked to notify their local Kentucky Division for Air Quality (KDAQ) Regional Office or local air agency (NPS, LMAPCD) **particularly if the burn is expected to be large, or if smoke impacts a Smoke Sensitive Target after the burn has been ignited.** The map on the following page lists the appropriate KDAQ prescribed fire contacts and outlines regional office boundaries.

Finally, practitioners should always notify their **local fire department**. Not only will this allow the local fire department to be on standby should a fire become uncontrolled, but also because the fire department may be contacted about smoke by concerned neighbors. **The burn plan should include a list of all stakeholders**.

Kentucky Division for Air Quality and Local Agency
Prescribed Fire and Exceptional Event Contacts (March 2022)

Please contact the appropriate regional office or agency for prescribed fire notifications.



KDAQ Smoke Management Plan Contact:
Jennifer F. Miller,
Jenniferf.miller@ky.gov

KDAQ Exceptional Events Contact:
Jenna Nall,
Jenna.nall@ky.gov

BSMP 3, Element 2: Communication with the General Public

Practitioners should strive to promote **Smoke Awareness** with the general public, as opposed to smoke tolerance. Smoke tolerance implies that the public must tolerate a potentially hazardous condition because they are helpless in preventing an impact. This type of interaction can lead to resentment in the community, not to mention detrimental public health impacts.

Instead, smoke awareness seeks to educate the general public and empower individuals to take steps to protect their own health, in addition to the steps being taken by the practitioner. It should be noted that empowering the general public to protect their own health does not alleviate the responsibility of the practitioner.

Smoke Awareness promotes open communication with the public, and is most effective when messaging includes the following:

- The benefits of prescribed fire
- The negative impacts of smoke (especially on sensitive populations)
- The actions being taken by the practitioner to mitigate smoke impacts, including contingency plans
- The actions that the general public can take to mitigate smoke impacts (i.e.- stay inside, close windows, limit outdoor exercise, check the AQI)
- Contact information of the individual/group responsible for the burn (i.e.- landowner, burn boss, agency contact)

The method of communicating with the general public can be in-person or via media. Useful communication methods include:

- Door-to-door contact with neighbors
- Flyers and handouts to neighbors
- Phone calls
- Media campaigns (TV/radio/newspapers)
- Billboards
- Social media
- Road signs
- Agency websites

An example of a prescribed fire notification that was posted on the website for the Land Between The Lakes National Recreation Area is included on the following page. The notification provides information to stake-holders regarding the planned date and location of the fire, the necessity of the fire, the size of the planned fire, and smoke management coordination. The notification also provides stake-holders with contact information and a method for obtaining updates on the status of the fire.

References:

Natural Resources Conservation Service. Basic Smoke Management Practices. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf

Example Prescribed Fire Media Release by the USFS
Land Between the Lakes National Recreation Area

Home » Stewardship » Fire » Franklin Creek Prescribed Fire at Land Between the Lakes

Franklin Creek Prescribed Fire at Land Between the Lakes

Posted on March 24, 2017 Posted in Fire, Natural Resource Management, News Release, Stewardship

LAND BETWEEN THE LAKES, KY/TN – March 24, 2017 – Weather permitting, Land Between the Lakes National Recreation Area will conduct a prescribed burn in the Franklin Creek area during the week of March 27. Franklin Creek burn unit is located east of the Woodlands Trace, north of US68/KY80 and is within the Northern Oak-Grassland Demonstration Area.

Firefighters keep a watchful eye on fire

Fire management staff will also take advantage of any favorable conditions to continue treatments in open lands near Brandon Springs and Crossroads areas.

"These burns are a continuation of the fire management program at Land Between the Lakes," says Todd Lerke, Fire Management Specialist at Land Between the Lakes. "Prescribed fire is a tool we can use to reduce hazardous fuels, improve forest health, increase diversity, and re-establish fire's natural role in the forest ecosystem."

The Franklin Creek prescribed burn is 2,641 acres. Prescribed burns only occur if variables including specific weather, fuel conditions, agency guidelines, and protocols are favorable and support desired results.

Smoke will be visible and may have variable short term effects on surrounding communities. The bulk of smoke output will last 2-3 days with each subsequent day sequentially less. Coordination with the National Weather Service, Kentucky Division for Air Quality, predictive services, and on site monitoring will all play an active role in the implementation to minimize potential impacts. Keep windows, doors, and vents closed at night to reduce exposure.

Land Between the Lakes will notify local media outlets on days when prescribed fires are scheduled. Daily updates on prescribed fires can be found at www.landbetweenthelakes.us/alerts-notices or by calling 270.924.2000.

Chapter 10.0:
BSMP 4— Consideration of Other Emission Reduction Techniques

Basic Smoke Management Practices		Objective	Deployment
BSMP 1	Evaluation of Smoke Dispersion Conditions	Predict Smoke Impacts	Before, During, After
BSMP 2	Monitoring Effects on Air Quality	Maintain awareness of smoke transport and potential impacts	Before, During, After
BSMP 3	Communication/Public Notification	Notify neighbors and those potentially impacted by smoke.	Before, During
BSMP 4	*Consideration of Other Emission Reduction Techniques*	*Reduce emissions through other mechanisms that reduce fuel loadings.*	*Before, During*
BSMP 5	Coordination of Area Burning/Sharing the Airshed	Coordinate multiple burns in an area to manage impacts combined smoke.	Before, During, After
BSMP 6	Documentation/Journaling	Document and retain information about the weather, fire, and smoke.	Before, During, After

Whenever practicable, prescribed fire practitioners should consider the use of Emission Reduction Techniques (ERTs). ERTs can be used to either completely replace the use of fire on a particular parcel of land, or more commonly, supplement prescribed-fire activities. According to the 2001 Smoke Management Guide by National Wildfire Coordination Group, supplementing a prescribed-fire with ERTs may reduce the emissions produced as much as 60%. Just a few of the ERT categories include techniques that:

- Reduce the burn area
- Reduce the fuel load
- Reduce/change the fuel (via scheduling)
- Increase combustion efficiency

It must be stressed that land-managers are under no obligation to use any ERT if it impedes the achievement of land and ecological management objectives.

BSMP 4; ERT 1: Reduce the Burn Area

Obviously, practitioners can reduce their emissions by reducing the size of the area to be burned. Practitioners may weigh the benefits of reducing the amount of smoke produced during a prescribed fire, with the possibility of those emissions being released later during an uncontrolled wildfire. The practice of reducing the burn area is most effective when a long-term plan truly reduces the amount

of emissions over-time. Some examples of ERTs that reduce the area of burning are:

- **Small Unit Burning:** The application of fire on subsets of a larger land parcel over multiple days. The practice does not reduce the total emissions produced, but rather redistributes the emissions temporally.
- **Mosaic Burning:** The application of fire on defined patches of land. The technique is similar to small unit burning, except burn units are defined by the topographical or fuel-characteristics of the parcel. The practice is well-suited to landscapes that lack homogeneity and contain a variety of non-continuous fuel types.
- **Fuel Isolation:** The isolation of fuels that have the potential to burn or smolder for a long period of time, such as large logs, snags, large duff-pockets, and sawdust. Isolation of such fuels from a burn can result in a fire that burns faster, safer, and is more cost-effective.
- **Frequent Burning:** The practice of burning units more frequently in order to avoid the accumulation of unwanted fuels.

BSMP 4; ERT 2: Reduce the Fuel Load

For certain landscapes and/or objectives, practitioners may be able to reduce the amount of fuel loading in area to be burned. Some examples of ERTs that can be used to reduce fuel-loading are:

- **Mechanical Removal:** The physical removal of certain fuels form the area to be burned. This may include the harvesting of timber and other profitable biomass, or the removal of logging debris or fuels that may smolder for long periods of time.
- **Chemical Treatments:** The application of herbicides to reduce biomass in the area to be burned.
- **Animal Grazing:** The use of grazing-ungulates (cattle, sheep or goats) in order to reduce biomass in an area to be burned.

BSMP 4; ERT 3: Reduce/Change the Fuel (via Scheduling)

Sometimes, emissions can be reduced by carefully scheduling a prescribed fire so that only certain fuels or limited fuels are present.

- **Burning prior to Litter-Fall:** The scheduling of a burn prior to trees and shrubs dropping their leaves in the fall. Leaf-litter can add a lot of material to a fuel-bed.
- **Burning prior to Green-Up:** The scheduling of a burn prior to the appearance of leaves and vegetation in the spring.

BSMP 4; ERT 4: Increase Combustion Efficiency

Practitioners may be able to reduce their emissions by increasing the overall combustion efficiency of a fire . Under this technique, burners may attempt to burn the majority of fuels-present in the flaming phase (more complete combustion), as opposed to the smoldering phase (incomplete combustion), of the fire. Or, they may attempt to consolidate fuels so that fires produce more heat and burn faster.

Some examples of this ERT include:

- **Burn Piles:** The consolidation of fuels into clean, dry piles. This ERT is most effective with forest-type fuels. This SMP does not recommend the use of windrows, which are more likely to have a variety of fuels and fuel-moisture contents, and may contain dirt.

- **Backing Fires:** The ignition of a fire so that it spreads against the wind or downslope or a fire lit at ground-level in the absence of wind. Backing fires spread slowly, allowing for fuels to be more completely consumed.

- **Mass Ignition:** The use of rapid-ignition techniques to light fuels, typically very dry and fine, and often in a large open area. Mass ignition is sometimes achieved via aerial ignition methods.

Source: *https://www.kyfire.org/gallery#gallery-50*

References:

National Wildfire Coordination Group. NWCG Smoke Management Guide for Prescribed and Wildland Fire. February 2018. https://www.nwcg.gov/sites/default/files/publications/pms420-2.pdf

National Wildfire Coordination Group. NWCG Glossary of Wildland Fire. January 2018. https://www.nwcg.gov/glossary/a-z

Natural Resources Conservation Service. *Basic Smoke Management Practices*. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf

Chapter 11.0:
BSMP 5— Coordination of Area Burning ("Sharing the Airshed")

Basic Smoke Management Practices		Objective	Deployment
BSMP 1	Evaluation of Smoke Dispersion Conditions	Predict Smoke Impacts	Before, During, After
BSMP 2	Monitoring Effects on Air Quality	Maintain awareness of smoke transport and potential impacts	Before, During, After
BSMP 3	Communication/Public Notification	Notify neighbors and those potentially impacted by smoke.	Before, During
BSMP 4	Consideration of Other Emission Reduction Techniques	Reduce emissions through other mechanisms that reduce fuel loadings.	Before, During
BSMP 5	*Coordination of Area Burning/Sharing the Airshed*	*Coordinate multiple burns in an area to manage impacts combined smoke.*	*Before, During, After*
BSMP 6	Documentation/Journaling	Document and retain information about the weather, fire, and smoke.	Before, During, After

Area coordination encourages the formation of communications and information-sharing partnerships among agencies, burn bosses, and private landowners so that multiple burns aren't conducted within close vicinity of each other on the same day. When practitioners "Share the Airshed," they ensure that smoke impacts don't compound each other. Ideally, area coordination involves both:

- Formalized procedures between agencies
- Informal/voluntary actions among practitioners/land-owners
- Kentucky Prescribed Fire Portal

BSMP 5; Element 1: Formalized Procedures Between Agencies

While many states have fully-funded smoke management programs, equipped with the ability to track and approve permits for prescribed fire on a daily basis, Kentucky does not. However, state agencies are required to provide the Kentucky Division of Forestry (KDF) with a notice at least 24-hours before a burn.

BSMP 5; Element 2: Informal/Voluntary Actions among Practitioners

In the absence of formalized procedures, practitioners can communicate with each other via many of the same methods already established under **BSMP 3-Communication/Public Notification**. Private landowners and land-managers may choose to speak with their neighbors, not only to inform

them of the planned prescribed fire, but also to ensure that they aren't also planning to burn. Land-managers can coordinate with other land-managers during the planning phases of a burn to determine if other agencies are planning to burn on land parcels in the vicinity of each other.

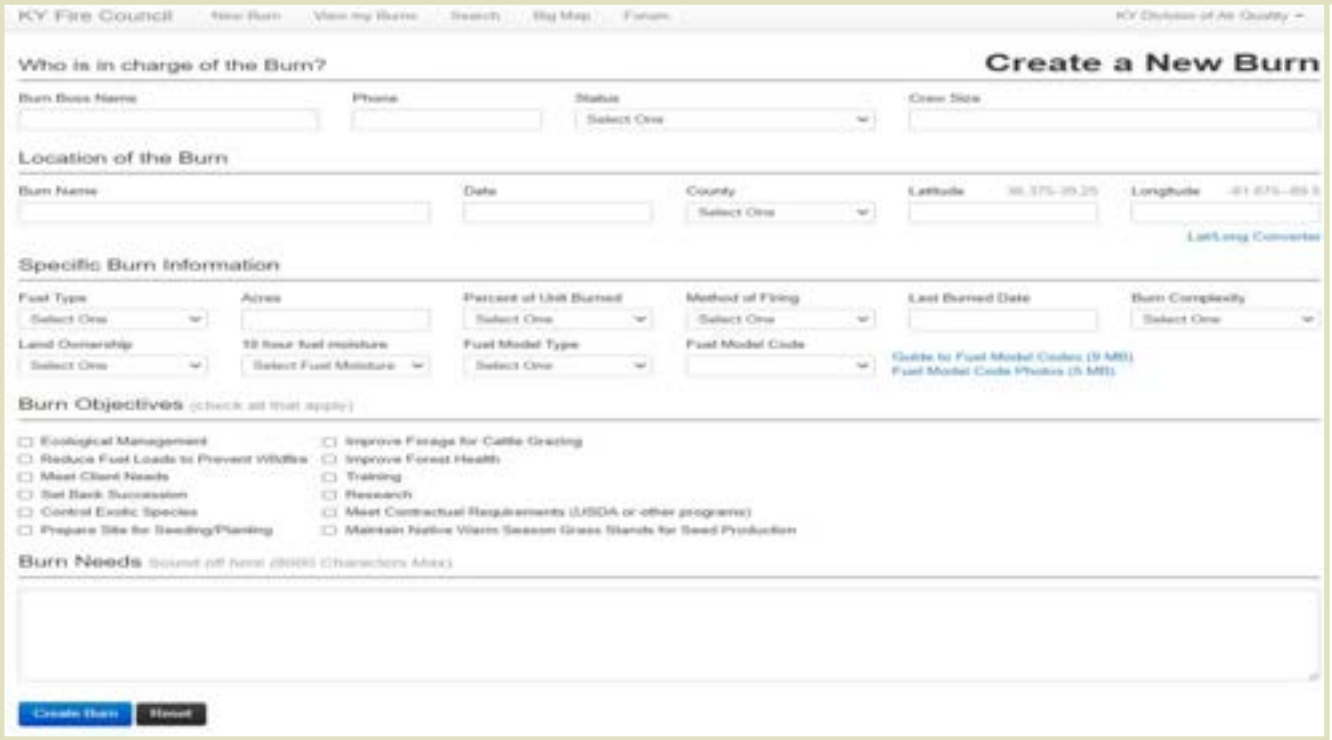
BSMP 5; Element 3: The Kentucky Prescribed Fire Portal

The Kentucky Prescribed Fire Council maintains the **Kentucky Fire Portal**- a reporting tool on its website that can assist member practitioners, including private landowners, in the coordination and reporting of prescribed fire in the Commonwealth. The portal allows for both future and completed burns to be documented. While participation is voluntary, **this VSMP recommends that members of the KPFC utilize the Kentucky Fire Portal to document all burns conducted and to consult the fire portal prior to ignition in order to coordinate with other practitioners.** The Fire Portal can be accessed on the KPFC website at https://www.kyfire.org/. Its use offers the following benefits:

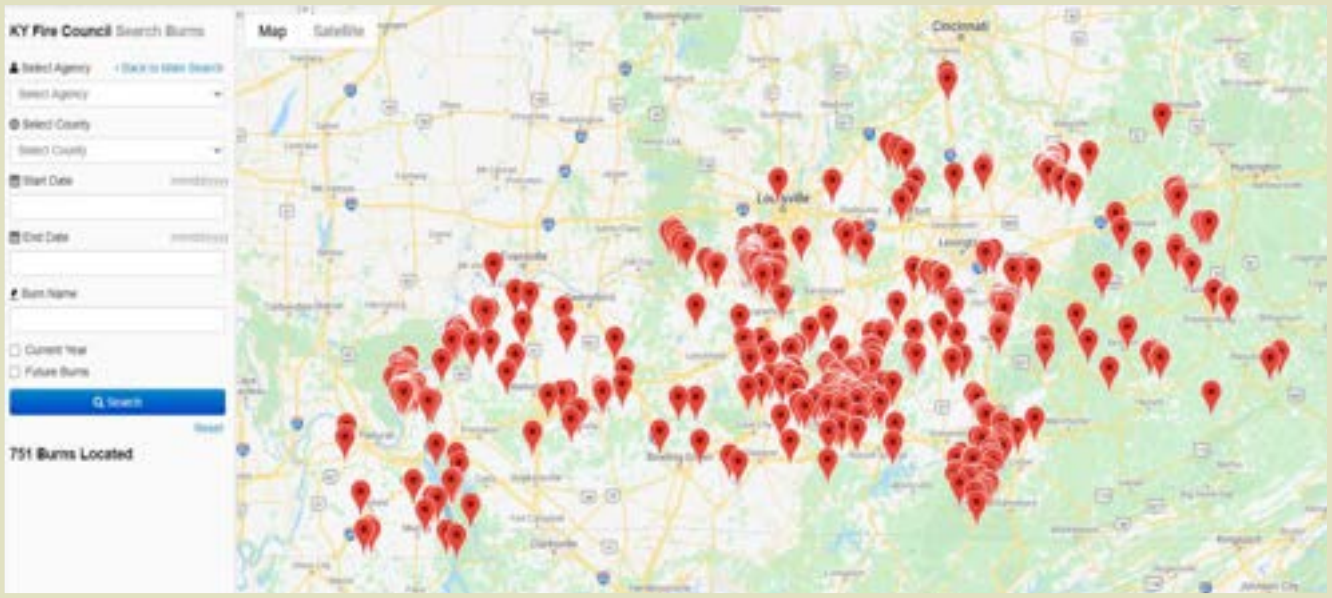
- Provides contact information for the burn boss
- Contains general burn information including:
  - Locational information
  - Crew size
  - Burn dates
- Contains more specific burn information including:
  - Fuel type
  - Burn unit acreage and % burned
  - Method of firing
  - Land ownership
  - 10-hour fuel moisture
  - Fuel model utilized
  - Burn objectives
- Provides a GIS interface in which to view the nearby prescribed fires that may be conducted on a particular day.

Additionally, the Fire Portal provides a basic tool that could be developed further to include more accurate characterizations of smoke emissions, as opposed to relying upon the modeled-estimates provided by EPA. The portal could also be developed to include more advanced tools to assist with the documentation and coordination of prescribed fire and smoke management. The images on the following page demonstrate a few of the Fire Portal's current capabilities.

Kentucky Prescribed Fire Council's Fire Portal: New Burn Entry Form



Kentucky Prescribed Fire Council's Fire Portal: Burn Map



References:

Natural Resources Conservation Service. *Basic Smoke Management Practices*. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf.

USEPA, AirNow. Website. *https://fire.airnow.gov/*

Chapter 12.0:
BSMP 6— Documentation & Journaling

Basic Smoke Management Practices		Objective	Deployment
BSMP 1	Evaluation of Smoke Dispersion Conditions	Predict Smoke Impacts	Before, During, After
BSMP 2	Monitoring Effects on Air Quality	Maintain awareness of smoke transport and potential impacts	Before, During, After
BSMP 3	Communication/Public Notification	Notify neighbors and those potentially impacted by smoke.	Before, During
BSMP 4	Consideration of Other Emission Reduction Techniques	Reduce emissions through other mechanisms that reduce fuel loadings.	Before, During
BSMP 5	Coordination of Area Burning/Sharing the Airshed	Coordinate multiple burns in an area to manage impacts combined smoke.	Before, During, After
BSMP 6	*Documentation/Journaling*	*Document and retain information about the weather, fire, and smoke.*	*Before, During, After*

Practitioners should be diligent in documenting the BSMPs employed during a burn, the weather conditions that were in place during a burn, and how the smoke behaved during a burn. Practitioners should retain, and in some cases must retain, that information indefinitely. The information collected during a prescribed fire could be invaluable should an air quality impact occur, which necessitates that an "Exceptional Event" designation be requested from the EPA. The information can also be used to evaluate the effectiveness of the BSMPs being employed during prescribed fires and to guide the methods utilized during future fires.

Practitioners should consider collecting and retaining notes on activity of the fire, photographs of the burn and resulting smoke, emails and other forms of communication, media articles about the burn, and air quality/meteorological forecasts. The remainder of this chapter discusses some options for documenting and retaining this information, much of which, will be included in any well-written **burn plan and/or post-burn report.** Practitioners may also find that maintaining a **burn journal** can assist with note-taking and retention.

BSMP 6; Element 1: The Burn Plan

The most important document in any prescribed fire process is the burn plan. A prescribed fire burn plan is site specific document used to guide the burn leader and any crew in the action necessary to safely implement the burn while meeting objectives, including smoke management. The burn plan is

typically considered a legal document, especially when developed by government agencies. As such, a burn plan should be adhered to during all phases of a prescribed fire, unless modifications are justified and documented. The burn plan should be retained indefinitely. A burn plan will typically include the following information:

- Planning Information
- Geographic Information
- Emergency Assistance Sources & Contacts
- Pre-Burn Notifications
- Burn Unit Description
- Goals & Objectives
- Fuel and Weather Parameters
- Fire Behavior
- Smoke Management
- Equipment
- Burn Management
- Contingency Plans
- Safety and Medical Information
- Post-Burn Activities
- Maps
- Burn Day Checklist (GO/NO-GO Checklist)
- Crew Briefing Checklist

It may be able to include an additional **BSMP checklist** with a burn-plan that provides a cross-walk between each of the six general BSMPs and the applicable section of the burn plan or where the applicable information is located. Such a checklist might be utilized during the planning phase to ensure that the burn plan contains adequate smoke management protections, during the burn to ensure that BSMPs are followed, and after a burn to ensure necessary information is retained. An example checklist is provided in Appendix G.

BSMP 6; Element 2: The Post Burn Report

Practitioners may choose to utilize a post-burn report to evaluate the successfulness of a burn in achieving its prescription parameters and burn objectives. A BSMP checklist similar to the one used in a burn plan could be utilized after a prescribed fire has been conducted for evaluating the success of the any BSMPs employed, as well as any lessons-learned. The Post Burn Report may include much of the same information as the Burn Plan. Ultimately, EPA recommends that reports contain the information, as shown by the chart below:

SMP 6; Element 3: Burn Journaling/Log

A burn journal or log is a dedicated set of notes recorded by practitioners regarding their experiences with prescribed fire and smoke management. The burn log can be used to supplement and enhance other methods of documentation, such as the burn plan. The burn log can be used to document all the BSMPs employed during a fire, the observed successes or failures of any particular BSMPs, the lessons-learned during a fire, and whether the objectives of a burn were met.

The table below was extracted from an EPA exceptional events guidance document for prescribed fire. Whenever possible, the information recommended by the table should be documented and retained.

Elements that May Be Included in Burn Plans and Post-Burn Reports for Prescribed Fires Submitted as Exceptional Events		
Element	**Burn plan**	**Post-Burn report**
Fire Name	Include	Include
Permit number (if appropriate)	Include	Include
Latitude/longitude and physical description	Include	Include
Date of burn, ignition time and completion time (duration of burn)	Include	Include
AQI status on burn day, if available (both in the vicinity of the fire and in the affected upwind area)	Predicted	Actual
Acres burned	Predicted	Actual (blackened)
Description of fuel loading	Planned Estimated	Actual (tons consumed)
Meteorological data (weather conditions, wind speed and direction, dispersion)	Predicted conditions (including predicted dispersion).	Actual conditions (including actual dispersion)
Smoke Impacts	Anticipated smoke impacts	Observed or reported smoke impacts (include nature, duration, spatial extent and copies of received complaints)
BSMP actions to reduce impacts	Expected BSMP actions	Actual BSMP actions
Recommendations for future burns in similar areas	n/a	Include
Analytics (modeled/actual fire spread, satellite imagery and analysis, webcam/video, PM/O3 concentrations over the course of the fire)	n/a	Include
Source: *https://www.epa.gov/sites/production/files/2019-08/documents/ee_prescribed_fire_final_guidance_-_august_2019.pdf*		

References:

Natural Resources Conservation Service. *Basic Smoke Management Practices*. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf.

Kentucky Prescribed Fire Council. Kentucky Basic Controlled Burn Workshop. Student Manual. 2012.

Appendix A:
Acronyms

AQI	Air Quality Index	**NEI**	National Emissions Inventory
AQS	Air Quality System database	**NFEI**	National Fire Emissions Inventory
BSMP	Basic Smoke Management Practice	**NO_x**	Nitrogen Oxides
CAA	Clean Air Act	**NPS**	National Park Service
CO	Carbon Monoxide	**NRCS**	National Resource Conservation Service
CSMP	Certified Smoke Management Plan	**NWS**	National Weather Service
EIS	Emissions Inventory System	**NWTF**	National Wild Turkey Federation
EPA	US Environmental Protection Agency	**O_3**	Ozone
ERT	Emission Reductions Technique	**OKNP**	Office of Kentucky Nature Preserves
FLM	Federal Land Managers	**PM**	Particulate Matter
FS	US Forest Service	**ppb**	parts per billion
FWS	US Fish and Wildlife Service	**PPE**	Personal Protective Equipment
KAR	Kentucky Administrative Regulations	**ppm**	parts per million
KDAQ	Kentucky Division for Air Quality	**SIP**	State Implementation Plan
KDF	Kentucky Division of Forestry	**SMP**	Smoke Management Plan *or* Program
KDFWR	Kentucky Department of Fish and Wildlife Resources	**SST**	Smoke Sensitive Target
		TNC	The Nature Conservancy
KPFC	Kentucky Prescribed Fire Council	**ug/m^3**	micrograms per cubic meter
KRS	Kentucky Revised Statutes	**VOC**	Volatile Organic Compound
NAAQS	National Ambient Air Quality Standard	**VSMP**	Voluntary Smoke Management Plan

Appendix B:
Overview of Fire Weather

The most basic components of fire weather are:

- Ambient temperature
- Relative humidity
- Precipitation
- Atmospheric stability
- Wind speed and direction

This appendix discusses each of these terms briefly. The appendix also includes an overview of meteorological phenomena that either cause, or indicate the existence of, critical fire weather conditions. Such conditions include:

- Weather fronts and thunderstorms
- Dust devils and fire whirls

Components of Fire Weather

Hot **ambient temperatures** and direct sunlight can dry fuels making them easier to burn, whereas cooler temperatures have the opposite effect. Generally, as the temperature of the air increases, so does the potential for fire and the intensity of fire.

Relative humidity is the amount of moisture in the air, expressed as a percentage. Low relative humidity (less than 30%) is an indicator of potential fire-danger, as fuels may be very dry and ignite easily. High relative humidity (greater than 80%) may result in poor burning conditions and increased smoke production.

Relative humidity and fuel moisture is influenced by the amount and duration of **precipitation** that an area receives. Wet conditions may result in an inefficient burn and will contribute to smoke production.

Atmospheric stability is a measure of atmosphere's tendency for vertical movement. A stable atmosphere resists upward motion throughout the atmospheric column, creating poor smoke dispersal conditions. A **temperature inversion** is a very stable atmospheric condition that results when a layer of cooler surface air is overlain by a layer of warmer air. An inversion layer may trap

smoke near the ground. The stability of the atmosphere is also reflected in the **Mixing Height**– the height from the ground to the height in the atmosphere where vigorous mixing occurs due to convection. Visual indicators of a stable atmosphere include:

- Layered or stratus cloud formations
- Poor visibility due smoke or haze
- Fog
- Low winds
- Drifting of smoke columns with limited rise
- Smoke or plumes that rise and then flatten out

An **unstable atmosphere** results when a parcel of air warms and lifts to a higher altitude than that of the surrounding air. An unstable atmosphere allows for better smoke dispersal conditions, but also results in potentially more dangerous and unpredictable fire behavior. Visual indicators of an atmospheric instability include:

- Cumulus cloud formations
- High cloud cover
- Gusty winds or storms
- Good smoke dispersal
- Dust devils and fire whirls

Of all the weather elements affecting fire behavior, **wind** is the most critical since it is the most variable over time and space. When discussing weather, wind direction is always referenced by the direction of origin (i.e. the direction the wind is blowing from). For example, a "west wind" refers to a wind that is blowing from the west towards the east. Slope winds refer to local daily wind patterns that develop in hilly terrain due to differences in heating and cooling. They typically flow upslope during the day and downslope at night.

Wind speed and direction must be constantly monitored by prescribed fire practitioners. The effects of wind on fire behavior include, but are not limited to, the following:

- Increases the supply of oxygen to the fire
- Determines the direction of fire-spread
- Influences the speed of fire-spread
- Increases the drying (moisture content) of fuels
- Carries sparks ahead of the fire potentially causing new spot fires
- Bends flames resulting in preheating of fuels ahead of the fire

- Influences the amount of fuel consumed by affecting how quickly the fire moves through an area

There are three wind-types that a burn boss will need to plan for when writing a burn plan and monitoring for when conducting a prescribed fire:

- **Eye Level (Midflame Wind)**- The wind speed that affects a surface fire and that will directly affect the movement of the flaming front. Burn bosses commonly use sling psychrometers or Kestrels (electronic device) to directly measure eye-level winds.
- **20-Foot Surface Winds**- Wind measured 20 feet above the ground in a clearing or 20 feet above the average vegetative cover. The National Weather Service (NWS) provides fire weather forecasts for local areas and will provide you with a maximum expected 20-foot wind speeds for that day.
- **Transport Winds**- Transport winds are the measure of the average rate of the horizontal wind speed and direction from the surface to the mixing height. Transport winds move smoke out of an area and help disperse it in the atmosphere.

Critical Fire Weather Conditions

Winds associated with **frontal passages** can be particularly dangerous, not only because of the strength of the wind may be enhanced, but also because wind directions may shift rapidly as the front passes through an area. Additionally, low pressure systems and **thunderstorms** may have strong downdraft winds or updraft winds. Strong and variable winds will result in sudden changes in the speed, direction, and intensity of fire, which makes fire behavior difficult to control and predict.

Dust devils are a common indicator of unstable air and dry conditions. They occur on hot, dry days when skies are clear and winds are light. Similarly, **fire whirls** also indicate the existence of dry and unstable fire conditions. Practitioners should be cautious if such conditions are present during a burn.

References:

KY Basic Controlled Burn Workshop: Student Manual. Kentucky Prescribed Fire Council. 2012

Certified Burn Boss Workshop. Student Manual. Kentucky Prescribed Fire Council. 2021

Appendix C

Pictorial Fuel Model

Grass Type Fuel Models

GR3 - Low Load, Very Course

Very coarse grass, average depth about 2 feet.

Spread rate high; flame length moderate.


GR5 - Low Load

Dense, coarse grass, average depth about 1 to 2 feet.

Spread rate very high; flame length high.


GR6 - Moderate Load

Dryland grass about 1 to 2 feet tall.

Spread rate very high; flame length very high.


GR8 - High Load, Very Course

Heavy, coarse, continuous grass 3 to 5 feet tall.

Spread rate very high; flame length very high.


GR9 - Very High Load

Very heavy, coarse, continuous grass 5 to 8 feet tall.

Spread rate extreme; flame length extreme.


Grass/Shrub Type Fuel Models

GS3 - Moderate Load

Moderate grass/shrub load, average grass/shrub depth less than 2 feet.

Spread rate high; flame length moderate.

GS4 - High Load

Heavy grass/shrub load, depth greater than 2 feet.

Spread rate high; flame length very high.

Shrub Type Fuel Models

SH3 - Moderate Load

Moderate shrub load, possibly with pine over-story or herbaceous fuel, fuelbed depth 2 to 3 feet.

Spread rate low; flame length low.

SH4 - Low Load, Timber-Shrub

Low to moderate shrub and litter load, possibly with pine over-story, fuelbed depth about 3 feet.

Spread rate high; flame length moderate.

SH6 - Low Load

Dense shrubs, little or no herb fuel, depth about 2 feet.

Spread rate high; flame length high.

Shrub Type Fuel Models (Continued)

SH8 - High Load

Dense shrubs, little or no herb fuel, depth about 3 feet.

Spread rates high; flame length high.

SH9 - Very High Load

Dense, finely branched shrubs with significant fine dead fuel, about 4 to 6 feet tall; some herbaceous fuel may be present.

Spread rate high, flame length very high.

Timber-Understory Fuel Type Models

TU2 - Moderate Load

Fuelbed is moderate litter load with shrub component.

Spread rate moderate; flame length low.

TU3 - Moderate Load, Timber-Grass-Shrub

Fuelbed is moderate litter load with grass and shrub components.

Spread rate high; flame length moderate.

Timber Litter Type Fuel Models

TL1 - Low Load Compact Conifer Litter

Light to moderate load, fuels 1 to 2 inches deep.

Spread rate very low; flame length very low.


TL2 - Low Load Broadleaf Litter

Low load, compact.

Spread rate very low; flame length very low.


TL3 - Moderate Load Conifer Litter

Moderate load conifer litter.

Spread rate very low; flame length low.


TL4 - Small Downed Logs

Moderate load, includes small diameter downed logs.

Spread rate low; flame length low.


TL5 - High Load Conifer Litter

High load conifer litter; light slash or mortality fuel.

Spread rate low; flame length low.


TL6 - Moderate Load Broadleaf Litter

Moderate load, less compact.

Spread rate moderate; flame length low.


Timber Litter Type Fuel Models (Continued)

TL7 - Large Downed Logs

Heavy load, includes larger diameter downed logs.

Spread rate low; flame length low.

TL8 - Long Needle Litter

Moderate load and compactness may include small amount of herbaceous load.

Spread rate moderate; flame length low.

TL9 - Very High Load Broadleaf Litter

Very high load broadleaf litter; heavy needle-drape in otherwise sparse shrub layer.

Spread rate moderate; flame length moderate.

Slash-Blowdown Type Fuel Models

SB1 - Low Load

Fine fuel load is 10 to 20 tons/acre, weighted toward fuels 1 to 3 inches diameter class, depth is less than 1 foot.

Spread rate moderate; flame length low.

SB2 - Moderate Load / Low Load Blowdown

Fine fuel load is 7-12 tons/acre, evenly distributed across 0-0.25, 0.25-1, and 1-3 inch diameter classes, depth is about 1 foot. / Blowdown is scattered, with many trees still standing.

Spread rate moderate; flame length moderate.

Slash-Blowdown Type Fuel Models (Continued)

SB3 - High Load / Moderate Load Blowdown

Fine fuel load is 7-12 tons/acre, weighted toward 0-0.25 inch diameter class, depth is more than 1 foot. / Blowdown is moderate, trees compacted to near the ground.

Spread rate high; flame length high.

SB4 - High Load Blowdown

Blowdown is total, fuelbed not compacted, foliage still attached.

Spread rate very high; flame length very high.

Non-Burnable Fuel Type Models

NB1

Urban/Developed

NB2

Snow/Ice

NB3

Agriculture

NB8

Open Water

NB9

Bare Ground

References:

Joe H. Scott, Robert E. Burgan. Standard Fire Behavior Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model. United Stated Department of Agriculture. June, 2005.

Southern Group of State Foresters Wildfire Risk Assessment Portal. Available at https://southernwildfirerisk.com/.

Appendix D:
Constructing a Smoke Trajectory Plot

A **Smoke Trajectory Plot** is a simple and widely-used method for predicting probable smoke impact areas. A Smoke Trajectory Plot can be easily constructed using the steps below.

a. Locate the planned burn area on a map and draw a line representing the centerline of the path of the smoke plume (direction of transport wind) for the distance indicated. (see Figure 1). If the burn will last 3 or more hours draw another line showing predicted wind direction at completion of the burn. The areas analyzed for potential impacts should extend at least:

- 5 miles for grass fuels regardless of method of ignition/fire-type
- 5 miles for line-backing fires regardless of fuel-type
- 10 miles for line-heading fires regardless fuel-type
- 10 miles for burns of 250 acres or more
- 30 miles for piled logging debris fires

If the previously determined fuel-loading is greater than ten tons per acre, the areas analyzed for impacts should be doubled. It is not advised that private land-owners attempt prescribed fires on lands with fuel loads greater than 10 tons per acre without professional assistance.

b. To allow for horizontal dispersion of smoke as well as shifts in wind direction, draw two other lines from the fire at an angle of:

- 30 degrees from the center-line(s) if the on-site observed wind direction is used; or,
- 45 degrees from the center-line(s) if the forecasted wind direction is used.

Constructing a Smoke Trajectory Plot

Figure 1

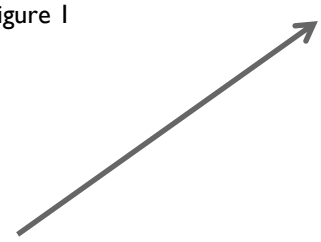


Figure 2

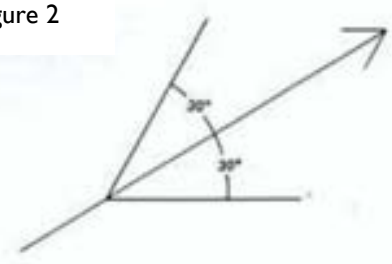
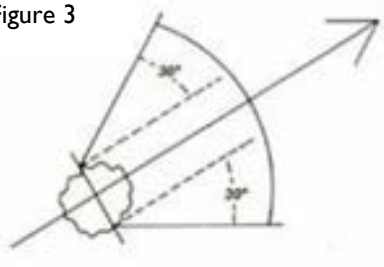


Figure 3



c. If the fire is small, similar to a spot fire, draw the lines as shown by Figure 2. The resulting plot in your **daytime smoke impact area.** If a larger area will be ignited, additional lines will need to be drawn, as shown in Figure 3.

d. If the burn will not be fully completed within at least three hours before sunset, the **probable night-time impact area** should also be determined. The probable night-time impact area can only be predicted with a simple smoke trajectory plot if night-time winds are forecasted to be light and directionally-stable. Otherwise, the burn plan should ensure that the fire is fully extinguished at least three-hour before sunset.

e. The night-time impact area will generally extend down-wind a distance that is one-half of that determined in Step "a" based upon the fuel-type. However, special consideration must be given to areas of complex terrain, as smoke will accumulate in, and spread along, valleys and bottoms. To determine the **probable nighttime impact area**, draw an area down-drainage for 1/2 the distance obtained in Step C and spread out to cover to any valleys or low-lying areas.

f. Identify all **Smoke Sensitive Targets (SSTs)** located within the plotted area, including:

- Airports
- Roads and Highways
- Hospitals and Nursing Homes
- Schools
- Class 1 Areas for Regional Haze
- Ambient Air Quality Monitors
- NAAQS Non-Attainment Areas
- Populated Areas

If no SSTs are found, the burn may occur as prescribed. However, if any SSTs are located in the plotted area, further evaluation is necessary.

g. Identify **Critical Smoke Sensitive Areas.** Critical Smoke Sensitive Areas are areas with an existing air quality or visibility issue, such as a non-attainment area or an area with forecasted poor air quality (AQI); and/or where an SST is located in an area of critical smoke impact as determined below:

Critical Smoke Sensitive Areas	
Distance of Smoke Trajectory Plot	**Critical Area of Smoke Impact**
5 miles	1/2 mile
10 miles	1 mile
30 miles	3 miles
Fuel-loads > 10 tons per acre	Double trajectory and area of critical impact

If it is determined that the Critical Smoke Impact Area contains an SST or if air quality is expected to be poor on the day of the burn, do not burn under present prescription. Practitioners should consider the following:

- Prescribe a new wind direction to avoid targets and re-analyze smoke impact areas/targets.
- Reduce the area or fuel-loading to minimize smoke production and re-analyze smoke impact areas/targets.
- Ensure fires are extinguished and mopped-up prior to sundown.
- Consider other alternatives to burning.

Appendix E:
NRCS Technical Note - Basic Smoke Management Practices

When drafting the 2016 Revisions to the Exceptional Events Rule (EER), EPA relied heavily upon the Natural Resources Conservation Service (NRCS) technical note for outlining Basic Smoke Management Practices. In fact the EER adopted the six BSMPs listed in Table 1 of the NRCS technical note verbatim. The Kentucky Voluntary Smoke Management Plan (VSMP) also relies heavily upon this technical note, with the understanding that it was last revised in 2011, which was well before revisions to the EER and subsequent guidance documents by the EPA.

BSMPs are not strict requirements, but rather generalized recommendations that can guide smoke management practices before, during, and after a prescribed fire. The list is not intended to be comprehensive nor limiting; instead allowing the flexibility necessary for practitioners to manage smoke as they deem necessary. However, each of these six BSMPs should be considered, and their practicality evaluated, for each prescribed fire conducted. Finally, it should be noted that the six BSMPs are not separate and discrete steps, but are rather inter-related and ongoing throughout the entire prescribed fire process.

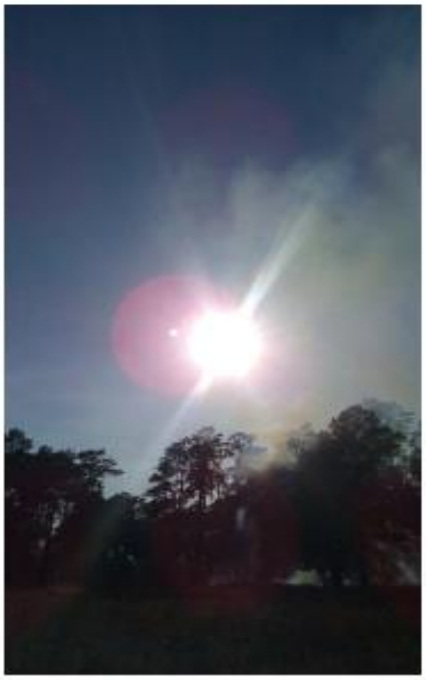
The original NRCS technical note is included as a reference document in this Appendix. Where possible, updated website links are included as footnotes on each page. The NRCS technical note can be accessed at: **https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf**.

References:

O'Neill, Susan; Lahm, Pete. 2011. Basic Smoke Management Practices. USDA Natural Resources Conservation Service. 12 p.

Basic Smoke Management Practices

October 2011



Fire is an essential ecological disturbance, providing many benefits to the environment in terms of wildlife, water and soil quality, and nutrient cycling. Prescribed burning can also be a means of protecting air quality by mitigating the occurrence of large wildfires and reducing invasive species. However, fire produces smoke which contains particulate matter (PM), ozone precursors, greenhouse gases, and other trace gases. Basic Smoke Management Practices (BSMPs) applied on prescribed burns can mitigate the impacts of smoke to public health, public safety and nuisance, and visibility.

Smoke is not like other air pollution sources--a direct control cannot be put on it such as can be applied to a power plant smoke stack--rather a variety of environmental factors must be taken into account to manage both the burn and the smoke from the burn. BSMPs outlined here offer a suite of options that a fire manager can utilize to reduce the impacts of their smoke. The Smoke Management Guide for Prescribed and Wildland Fire, 2001 edition (http://www.treesearch.fs.fed.us/pubs/5388) and the national smoke management website (http://www.nifc.gov/smoke) offer further technical information on how to manage smoke.

The six BSMPs discussed in this Technical Note (and summarized in Table 1) have applicability depending on the type of burn, fuels to be burned and level of effort needed to address air quality concerns. Not all BSMPs are applicable to all situations, therefore fire managers are urged to investigate the information available and applicable to their area and needs. Furthermore, these six BSMPs are only a subset of possible BSMPs and others can be adopted as needed such as no burning after November 15 due to inversions. BSMP's are utilized by the individual fire manager and may be an expectation of a state-wide smoke management program or employed to maintain the social acceptability of using prescribed fire and managing air quality impacts of smoke.

Table 1. Summary of Basic Smoke Management Practices (BSMPs), benefit achieved with the BSMP, and when it is applied (before, during or after the burn).

Basic Smoke Management Practice	Benefit achieved with the BSMP	When the BSMP is Applied – Before/During/After the Burn
Evaluate Smoke Dispersion Conditions	Minimize smoke impacts	Before, During, After
Monitor Effects on Air Quality	Be aware of where the smoke is going and degree it impacts air quality	Before, During, After
Record-Keeping/Maintain a Burn/Smoke Journal	Retain information about the weather, burn and smoke. If air quality problems occur, documentation helps analyze and address air regulatory issues	Before, During, After
Communication – Public Notification	Notify neighbors and those potentially impacted by smoke, especially sensitive receptors	Before, During
Consider Emission Reduction Techniques	Reducing emissions can reduce downwind impacts	Before, During

Share the Airshed – Coordination of Area Burning	Coordinate multiple burns in the area to manage exposure of the public to smoke	Before, During, After

BSMP #1: Evaluate smoke dispersion conditions to minimize smoke impacts

There are many ways to evaluate smoke dispersion conditions such as identifying smoke sensitive receptors, smoke modeling to determine where smoke may go and degree of impact, and most importantly use of readily available meteorological forecasting of conditions that influence smoke dispersion. Based on all this information, adjustments can be made as necessary to ignition date/time, firing sequence, and post-burn mop-up procedures, etc. The Appendix gives information about the type of meteorological information that may be available in your area and atmospheric parameters that influence smoke dispersion, such as: wind speed (near the surface and aloft), wind direction, mixing height, ventilation index, atmospheric stability, vertical temperature profile of the atmosphere and inversions, and water vapor (both in the atmosphere or released from the fire).

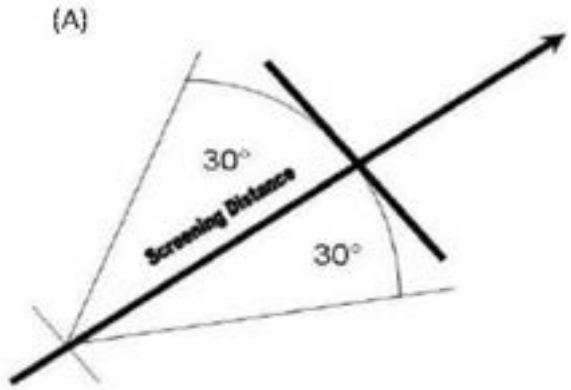
Prior to burning it is important to identify smoke sensitive areas downwind of burn areas such as highways, communities, airports, scenic vistas, Class 1 visibility protection areas, air quality nonattainment areas (see page 8), etc. Fire managers should then determine meteorological conditions including wind speed, direction and mixing height that will promote smoke dispersal away from sensitive areas and prevent ground level smoke accumulations. Burning should be avoided when mixing heights are low or a temperature inversion exists (see the Appendix for more information).

During burn operations

- **(Critical)** Fire managers should obtain and use the most up-to-date meteorological forecast (National Weather Service (NWS, http://radar.srh.noaa.gov/fire/) Spot Fire Weather Forecast or other data source), to inform whether to ignite a burn or not and to time ignitions to maximize dispersion away from sensitive areas.
- Where possible, obtain and use air quality forecasts such as AirNOW (http://www.airnow.gov) for your area and downwind to help time ignition to avoid periods when air quality is expected to be exceeding, or close to exceeding, the National Ambient Air Quality Standards (NAAQS). Nearby air quality monitoring sites may also be assessed to verify current air quality conditions.
- Verify the forecasted weather conditions whenever possible with local observations such as from Remote Automated Weather Stations (RAWS), and on-site or nearby weather monitoring sites. Small test burns or use of pilot balloons (which give wind speed and wind direction information vertically in the atmosphere) are also a means of getting an idea of both potential fire behavior and smoke dispersion.

After burn operations smoke can continue to be generated from smoldering fuels such as piles, large down trees/stumps, and in some areas of the country the organic duff layer. Meteorological and topographical features can keep the smoke near the surface and transport it along drainages, especially during the nighttime hours (see the Appendix). This should be assessed for potential impacts to smoke sensitive receptors and especially roads and post burn mop-up procedures may be needed to extinguish smoldering fuels.

Updated Links: https://www.weather.gov/fire/



Simple Smoke Screening Tool – Recommended
(http://shrmc.qgy.uga.edu/maps/screen.html)
The online simple smoke screening tool is a simple, easy-to-use application that relies on google maps and the methodology laid out in the Southern Forestry Smoke Management Guide (http://www.srs.fs.usda.gov/pubs/viewpub.php?index=683, Figure (A)) to highlight the critical smoke impact area (shown in red, Figure (B)) and the smoke impact area of concern (shown in yellow, Figure (B)) downwind from a fire. This tool was developed and is hosted online by the Forest Service Southern Research Station. By entering information about fire location, acres to burn, fuel type (grass, shrubs, litter, slash), ignition method (backing fire, heading fire), and wind direction, the application will identify the potential downwind smoke impact area. Zoom and pan capabilities, used to identify smoke sensitive receptors such as towns, highways, schools, etc., are provided with this google map application. Actual ground level impact will vary based on mixing height and other meteorological conditions and topographical elements influencing the burn (see the Appendix), but the tool provides an excellent first step in understanding potential levels of smoke impacts from a proposed burn. **Use of this tool is highly recommended.**

Updated Links: **http://fireweather.fdacs.gov/Simple-Smoke/**

BSMP #2: Monitor the effects of the fire on air quality

Monitoring the effects of fire on air quality can include keeping track of where the smoke goes, how high it goes and whether it disperses well or is tight and dense, which can be done through visual monitoring and can be documented by notes, photographs, aircraft observations, satellite imagery, air quality monitoring data, and post-burn evaluations. The air quality in the vicinity of sensitive receptors such as towns, highways, schools, etc. is of particular importance to monitor.

Turtleback Dome, Yosemite National Park, California – Clear

Turtleback Dome, Yosemite National Park, California – Smokey

Before igniting, assessing the air quality conditions is a good way to avoid making a condition worse. Utilize the AIRNOW forecast for your area and assess current air quality conditions by checking local and downwind air quality monitors when available.

To give an idea of how smoky conditions can correlate with visible range, Figures A and B are shown here. They are examples from a smoke photo series under development by the US Forest Service in cooperation with the National Park Service (NPS). Figure A shows a non-smoky atmosphere and how visible a point 2.6 miles away is, while Figure B shows the same view but under smoky conditions and the affect on visible range. The reduction in visible range typically indicates the degree of impact of pollution. When evaluating smoke effects on visible range it is important to take into account relative humidity and the presence of urban/anthropogenic pollution – a given visual range for northern California (as shown here) could be very different in the southeastern US which has much higher humidity (See the Appendix Water Vapor Section). In situations with smoke and high relative humidity white-out conditions can occur which can be of particular concern for roadways. For judging the severity of air quality impacts, the air quality index provides a scale from "good" for clean air to "hazardous" for extremely polluted situations. See http://airnow.gov/index.cfm?action=aqibasics.aqi for more information.

BSMP #3: Record-keeping of BSMP's, fire activity, and smoke behavior

Record-keeping can be as simple as keeping a personal burn/smoke journal. Having a record of the weather, BSMPs applied on the burn, the fire activity (fuels, area burned, ignition time, etc.) and smoke behavior can be used to help assess the conditions and burns that meet goals, and provide lessons learned if goals were not met to expectation or if there were smoke problems identified at downwind receptors (for example, did smoke cause hazardous conditions across a road?). In cases where air quality monitoring data exceed national and/or local standards, and if the state decides to seek to remove the data from the monitoring record, then documentation of BSMPs are critical. In these cases the state may not seek such documentation until several years after the event. Record-keeping should document the BSMPs used and include: notes on weather forecast and conditions both during and after the burn which influenced the dispersion of smoke, acres treated, location, date, and time of the burn, how much and what was burned (fuels information), and noting smoke impacts if any. This documentation should be retained by the fire manager long enough to meet regulatory time frames.

BSMP #4: Communication – Public Notification

Fire managers need to notify appropriate authorities and those potentially affected by the smoke including the public at sensitive receptors. In addition, it is useful to prepare for contingency actions during the fire to reduce exposure of people at such receptors if an unintended impact were to occur.

Routine procedures should be established to notify the public of the burn (especially sensitive populations and appropriate authorities such as air regulators, public health officials and local fire department). As a contingency measure during the burn, notification of these same parties and appropriate air quality and/or county health authority should occur if there is an unintended smoke impact. Fire mangers should consider fire management and suppression options such as mop-up or cutting off a burn to minimize such an impact.

BSMP #5: Consider use of emission reduction techniques (ERTs)

There are several methods for reducing emissions that can be considered when planning and conducting a burn. Care should be taken to ensure the methods chosen actually reduce the amount of total emissions over time, not just delay them. Some ERTs can also reduce plume rise and could increase surface smoke concentrations. It is recommended that documentation be kept on the use of ERTs and where possible a quantification of emissions averted for air quality regulatory purposes. Key ERTs include reducing the fuel load and burning the minimum material to meet objectives, reducing fuel burned (for example, burn only the area needed and prevent the fire from spreading, extinguish the smoldering burns, burn prior to precipitation, or burn before litter falls), and increasing burning efficiency (for example, allow the

material to dry before burning, minimize soil content in slash piles, burn in piles, or use a backing fire when grass is burned).

Identify and document appropriate NRCS conservation practices that can help reduce emissions, such as: Brush Management, Clearing and Snagging, Firebreak, Forest Stand Improvement, Fuel Break, Prescribed Grazing, and Woody Residue Treatment.

For more information on emission reduction techniques see The Smoke Management Guide for Prescribed and Wildland Fire, 2001 edition (http://www.treesearch.fs.fed.us/pubs/5388) and the Western Regional Air Partnership Fire Emissions Joint Forum document on ERTs at: http://www.wrapair.org/forums/fejf/documents/ert/index.html

BSMP #6: Share the airshed/air basin to minimize exposure of the public – Coordination of Area Burning

Develop a communications and information-sharing network among fire managers who may be in the burn vicinity on the same day or who could cumulatively impact an area or sensitive receptor. This enables coordination and planning of ignitions to cooperatively limit burning so as not to overwhelm the ability of the atmosphere to disperse the smoke from burns and minimize exposure of the public. This also helps prevent contributing to cumulative or adverse downwind impacts from smoke. Determining air quality conditions before ignition takes place should be a consideration for coordination. Air quality information can be obtained from the EPA AIRNOW website (http://www.airnow.gov) or from local/state air quality monitoring networks or agencies. The National Oceanic Atmospheric Administration (NOAA) Hazard Mapping System (HMS) analyzes satellite fire detections from multiple satellites to present a view of current fire hot-spots and satellite-visible smoke plumes across North America (http://www.osdpd.noaa.gov/ml/land/hms.html). This can give information about other burning occurring across the region.

RELATED TOPICS AND TRAINING

Air Quality and Atmospheric Change in NRCS

NRCS has four Air Quality and Atmospheric Change (AQAC) resource concerns: Odor, Particulate Matter, Ozone Precursors and Greenhouse Gasses. **Four online courses have been developed that are available through AgLearn, they are: Air Quality, Climate Change and Energy; Why Should we Care About Air Quality?; Air Quality Resource Concerns; and Greenhouse Gasses and Carbon Sequestration.** To learn more about AQAC issues within the agency and to access the online courses, visit the AQAC website at http://www.airquality.nrcs.usda.gov.

Smoke and the Clean Air Act

BSMPs can protect the public from smoke exposure, help avoid an exceedance of a National Ambient Air Quality Standard (NAAQS) and minimize impacts on sensitive areas such as Class 1 visibility areas. There are six criteria pollutants regulated under the clean air act; particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide and lead. With regards to fire, particulate matter and ozone are of concern, and near the fire carbon monoxide can be a concern as well. When concentrations of a criteria pollutant are measured above the level of the standard for the particular pollutant, then an area can be

Updated Links: https://www.ospo.noaa.gov/Products/land/hms.html#maps

determined to be in nonattainment of the standard and subject to controls as delineated in a State Implementation Plan (SIP). The Exceptional Event Rule (e.g. "EPA 40 CFR Parts 50 and 51 Treatment of Data Influenced by Exceptional Events") affords the states protection from being put into nonattainment for events that are not controllable. Such events can be natural (ex. wildfires) or due to other reasons including prescribed fires. Documented use of BSMPs can allow for a state to flag data and seek exclusion for an exceedance of the NAAQS if appropriate Exceptional Event Rule (EER) criteria are met. BSMPs can also be considered as smoke management techniques as cited in the Regional Haze Rule (RHR) and therefore used to address pollution that causes visibility impairment in Class I areas; approximately 156 national parks and wilderness areas across the US. **Fire managers can learn more about this by taking the approximately one hour online course "Smoke Management and Air Quality for Land Managers" available at**: http://www.cnr.uidaho.edu/smoc/.

National Coordination on Smoke Issues

The National Wildfire Coordinating Group (NWCG) Smoke Committee (SmoC) has been established to provide interagency leadership, coordination and integration of air resource and fire management objectives to support overall land management goals. Members are from the Bureau of Land Management, Fish & Wildlife Service, National Park Service, Bureau of Indian Affairs, USDA Forest Service, and the National Association of State Foresters (eastern and western representatives), as well as the Natural Resources Conservation Service, the National Association of Clean Air Agencies (NACAA), The Nature Conservancy (TNC), and Department of Defense (DoD). SmoC has three Subcommittees; The Smoke Managers Subcommittee which works to provide relevant technical, administrative, and organizational information and feedback for operational smoke managers, forecasters and modelers; The Technical Smoke Topics Subcommittee which addresses technical smoke issues; and The Training subcommittee which works to advance training in smoke and air quality topics for the wildland fire community. More information is available on the public MyFireCommunity "Air Quality and Fire Issues" neighborhood at:
http://www.myfirecommunity.net/Neighborhood.aspx?ID=279

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Attribution: The information provided in this document is based on discussions between Forest Service, NRCS, and Department of Interior prescribed fire practitioners, smoke management specialists, and air quality program personnel.

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Updated Links: https://www.frames.gov/smoke/tutorial/overview
https://www.wildfirelessons.net/participate/faq

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APPENDIX – Meteorological Parameters for Smoke Dispersion

This appendix discusses meteorological parameters applicable to smoke dispersion. Many of these parameters may be available from local forecasts. Check with your local National Weather Service office, air quality regulatory department, or other public land management agencies in the area.

Wind Speed and Direction

Wind speed and direction can play an important role in the dispersion of smoke and the location of potential smoke impacts. ***Wind speed will help disperse a plume; however, strong surface wind speeds will also cause a plume to lay-down near the surface and inhibit vertical dispersion.*** Surface drag will reduce winds at the surface, then winds will gradually increase with height away from the surface causing the smoke to disperse differently (slower) at the surface than aloft which can be important when considering a backing versus heading fire. Wind direction at the surface can also be very different than wind direction aloft. Thus, depending on smoke impact concerns, whether concerned about nearby sensitive receptors or receptors further downwind, both parameters should be noted. Topography can particularly influence the wind direction of surface winds as well, where winds may flow along a valley near the surface but be quite different aloft (away from the topographical influences). ***In valleys, there can be downslope flows due to surface cooling in the evening which is important if smoke is still being produced after dark and the drainage crosses a road.*** Similarly, in the morning there can be upslope flows from the valley with surface heating. All these factors are important for smoke dispersion.

Mixing Height

The mixing height is the height of the atmosphere above the ground which is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable. The mixing height defines the depth of the mixed layer. Smoke released into the atmosphere has the potential to disperse vertically in the atmosphere up to the height of the mixing height depending on wind speed and atmospheric stability. ***A low mixing height can limit how the smoke disperses and can lead to greater smoke concentrations near the ground for longer periods of time.***

Ventilation Index (VENT)

Ventilation Index (VENT) is typically the product of the mixing height and the transport wind speed. The transport wind speed is typically the average wind speed through the mixed layer. By combining the two parameters of mixing height and transport wind into one index, the dispersive potential of the atmosphere can be rated. Care should be taken to note when transport winds are high and mixing height is low because these conditions will keep smoke traveling close and confined to the surface. Conversely, when transport winds are low but mixing height is high, the smoke will loft high into the atmosphere (good dispersion) but fire behavior could be erratic and thus problematic. A single national scale does not exist for the ventilation or dispersion index so investigate your local implementation of this parameter.

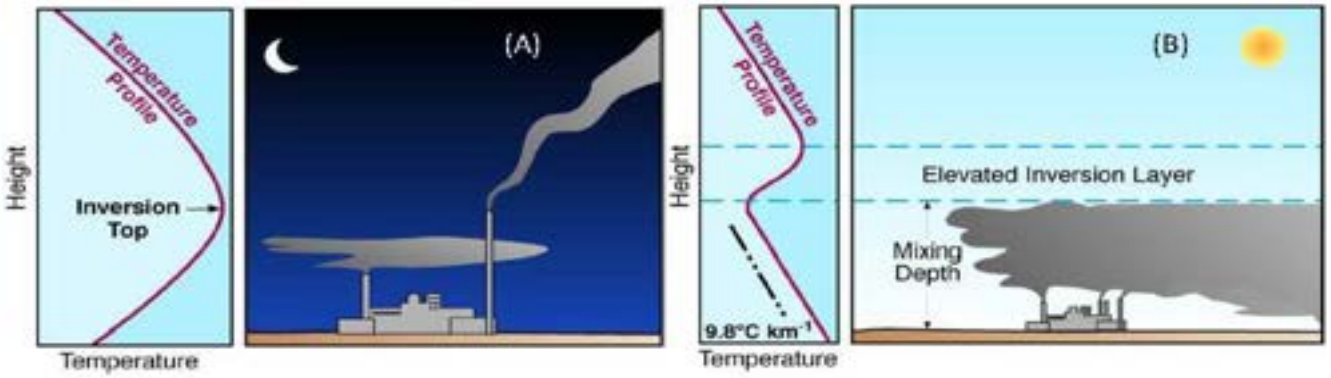
Atmospheric Stability

Atmospheric stability is a measure of the atmosphere's tendency to encourage or deter vertical motion. In unstable conditions, a lifted parcel of air will be warmer than the surrounding air at altitude. Because it is warmer, it is less dense and will continue to rise. Figure (A) is an example of ***smoke behavior in an unstable atmosphere – smoke is lofted away from the ground and transported downwind by the upper level winds. In a stable atmosphere the temperature of a rising parcel of air becomes cooler than its surroundings causing it to sink back to the surface, thus vertical motion is limited and smoke will tend to stay close to the surface.*** Figure (B) is an example of a stable atmosphere where smoke is fumigating the area beneath the mixing height and most vertical motion is due to the heat of the fire itself. Atmospheric stability can be estimated based on wind speed and solar insolation (Turner, 1994) on a scale of A (very unstable) to D (neutral) to F (very stable). Often the local NWS fire weather forecast will provide an estimation of atmospheric stability.

(photos by Roger Ottmar, USFS)

Atmospheric Vertical Temperature Profile and Inversions

The vertical temperature profile of the atmosphere is also related to atmospheric stability. On most days, the temperature of air in the atmosphere decreases with altitude. This is because most of the sun's energy is converted to sensible heat at the ground, which in turn warms the air at the surface. The warm air rises in the atmosphere, where it expands (due to lower pressure aloft) and cools. Sometimes, however, the temperature of air actually increases with height. The situation of having warm air on top of cooler air is referred to as a temperature inversion, because the temperature profile of the atmosphere is "inverted" from its usual state. There are two types of temperature inversions: surface inversions (Figure A) that occur near the Earth's surface, and aloft inversions (Figure B) that occur higher in the atmosphere. Figures used by permission from Whiteman (2000).



The most common manner in which surface inversions form is through the cooling of the air near the ground at night. Once the sun goes down, the ground loses heat very quickly, and this cools the air that is in contact with the ground. However, since air is a very poor conductor of heat, the air just above the surface remains warm. Conditions that favor the development of a strong surface inversion are calm winds, clear skies and long nights. Calm winds prevent warmer air above the surface from mixing down to the ground, and clear skies increase the rate of cooling at the Earth's surface. Long nights allow for the cooling of the ground to continue over a longer period of time, resulting in a greater temperature decrease at the surface. Since the nights in the wintertime are much longer than nights during the summertime, surface inversions are stronger and more common during the winter months. A strong inversion implies a substantial temperature difference exists between the cool surface air and the warmer air aloft. During the daylight hours, surface inversions normally weaken and disappear as the sun warms the Earth's surface. However, under certain meteorological conditions, such as strong high pressure over the area, these inversions can persist as long as several days. In addition, local topographical features can enhance the formation of inversions, especially in valley locations. Adapted from: http://www.wrh.noaa.gov/slc/climate/TemperatureInversions.php

Surface temperature inversions play a major role in how smoke disperses and in air quality conditions in general. The warm air above cooler air acts like a lid, suppressing vertical mixing and trapping the cooler air at the surface. ***If smoke is emitted into these conditions or is transported and trapped in the inversion then this can lead to poor air quality conditions.*** Care should be taken when burning during inversions or when one is expected to setup. Nighttime inversions can burn-off during the day therefore, depending on burn objectives and forecasted conditions, ignition during an inversion can be undertaken with caution and close monitoring. Also, if an inversion is expected to setup quickly post-burn (such as at night), it has the potential to trap smoke, and mitigation techniques such as mop-up can be employed to reduce the longer-term smoldering. In complex terrain, burning on slopes above an inversion can keep the smoke aloft and away from the valley floor (where roadways and communities are often located), but again, this should be undertaken with caution and close monitoring. ***Persistent (multiple-day) inversions in particular can create poor air quality conditions and burning under such conditions is not recommended.***

Water Vapor – Water Released from Fire and Atmospheric Water Content

As fuel is heated and combusted, water vapor is released into the atmosphere. This water can condense onto fine particulate matter from the fire and from other sources of pollution, reducing visibility and can play a role in the in-plume chemistry of secondary organic aerosol production. Where ambient atmospheric humidity can be high, a common situation in the Southeast US but possible across the country, the addition of water vapor from fire to the atmosphere, combined with nighttime cooling and inversions, can cause the atmosphere to become saturated (or nearly saturated). ***As temperatures decrease in the evening and especially early morning hours, the water vapor will condense out of the atmosphere onto the fine particulate matter released from the fire. This can quickly create a thick white out fog ("superfog") that pools in low-lying areas reducing visibility to near zero.*** This phenomena and has been attributed to numerous traffic accidents (Achtemeier, 2003, Wade and Mobley, 2007). The Low Visibility Occurrence Risk Index (LVORI, Lavdas and Achtemeier, 1995) was

developed based on relative humidity and the smoke dispersion index to be an indicator of potential fog occurrence. Values range from 1 - 10, where a LVORI of one means there is almost no chance of low visibility, and a LVORI of ten indicates low visibility is likely. For more information see: http://www.erh.noaa.gov/gsp/fire/ADI_LVORI/ADI_LVORI.html

National Weather Service (NWS) Fire Weather Information (http://radar.srh.noaa.gov/fire/): The National Weather Service Fire Weather webpage is a portal to local meteorological forecasts and observational data regarding many of the meteorological parameters discussed above. Below is an example of a NWS fire weather forecast for an area in Texas. In this case, information is given for near surface winds, cloud cover, transport winds, ventilation index and the category smoke dispersion day. The category day is based on the ventilation index and is on a scale of 1 to 5 where 1 is poor dispersion and 5 is excellent dispersion. Local/regional NWS offices typically customize the information to meet the needs of the area and can also do special spot forecasts. ***Use of these forecasts is a critical BSMP element.***

TXZ012-017-161100-
POTTER-RANDALL-
207 PM CDT FRI JUL 15 2011

	TONIGHT	SAT	SAT NIGHT	SUN
CLOUD COVER	MCLEAR	PCLDY	PCLDY	PCLDY
PRECIP TYPE	NONE	NONE	NONE	NONE
CHANCE PRECIP (%)	0	0	0	0
MAX/MIN TEMPERATURE	69	103	68	100
RELATIVE HUMIDITY %	61	18	61	21
20FT WND - AM (MPH)		S 9		S 10
20FT WND - PM (MPH)	S 14 G21	SE 12 G20	SE 14 G21	SE 13
PRECIP AMOUNT	0.00	0.00	0.00	0.00
LAL	1	1	1	1
HAINES INDEX	3	3	3	2
MIXING HGT (M-AGL)		4572		4115
MIXING HGT (FT-AGL)		15000		13500
TRANSPORT WND (M/S)		SE 6		SE 5
TRANSPORT WND (KTS)		SE 13		SE 12
VENT RATE (M*M/S)		25924		21211
VENT RATE (KT-FT)		165000		135000
CATEGORY DAY		5		5

Smoke Modeling

Smoke models provide a means of using meteorological and fuels information to give more detailed information about where and how smoke could disperse and the concentration of PM and other trace gases in the plume. A smoke modeling system essentially takes into account all the meteorological parameters described above along with on the ground fuels information to predict smoke dispersion, transport, and in some cases the trace gas chemical reactions. Smoke modeling is a more advanced feature that will be described in another Technical Note. Smoke modeling options are also summarized at: http://www.nifc.gov/smoke.

Appendix F:
Example Burn Plan

Burn Plan

1) Planning Information

Burn Unit Name: Shaker Village of Pleasant Hill (SVPH)
Size: 367 acres (multiple tracts)
Burn Plan Preparer Name: Bob Burns
Signature: _____
Address: 220 Sportsman's Lane, Frankfort, KY 40601
Phone number: 502-892-4521
Date Prepared: 01/15/2020

Reviewed by: _____ **Signature:** _____

2) Geographic Information

County: Mercer
Coordinates: -84 44' 26.21" W 37 49' 3.25" N
Description of Location (narrative): (Appendix A) From Harrodsburg take US 68 East approximately 7 miles. Shaker Village Northwest Quadrant (NW) is located on left side of US 68 just past Shakertown Baptist Church. The Southwest Quadrant (SW) is located on the right side of US 68. The main entrance to the historic village (address below) is located at the caution light intersection of US 68 and Hwy 33.

3) Sources of Emergency Assistance:

Description	Contact Point Person	Phone Number
KDF	North Central District Office, Matthew Haywood	1-800-866-0876
VFD	Chief	(123) 456-7891
Dispatch	Mercer County Dispatch	859-734-3311
Medical	Nearest Medical Facility (location to be noted on Appendix D)	Usually call 911
Law Enforcement	Deputy Sheriff	(123) 456-7891
KDFWR Regional Coordinator	Derek Beard	502-229-8900

4) Burn Unit Description: *(Include project boundaries, topography, and size of burn unit. Describe vegetation type and fuel models within and adjacent to unit. List any special features, issues and/or constraints within the burn unit (i.e. fences to protect, T&E species or habitat, etc.)*

***9 separate units will be burned during this prescribed burn totaling 367 acres

Good Field North Unit: This unit is 22 acres is size and located in the central portion of SVPH. This unit is surrounded by SVPH property. This burn unit is ½ of a larger NWSG planting. Care will be needed to ensure that the fire does not cross the burn unit to the south and burn unwanted acreage. If fire does escape it can be contained using the trail system and rock walls and roads (Secondary Breaks in Unit Maps). Fuel consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers. Patches of trees are present within the unit and will be burned through. State highway US68 is located south of this unit, smoke will be managed as noted in the (6) Smoke Management Section. A power line runs roughly from reference point B2 to B4, smoke will be managed as noted in the (6) Smoke Management Section. The north side of this unit is bordered by the Waterline Unit which consists of short NWSG including little bluestem and sideoats gramma along with various

Page 1

forbs and wildflowers, separated by a rock wall and woody fence row. The west side of the unit is bordered by hardwood deciduous forest. The south side of the unit is bordered by NWSG (see above), as well as a portion of wood plank fence. The east side of this unit is bordered by hardwood deciduous forest and row crop separated by a stone wall and wooden fence. Mild elevation change is present throughout the unit.

Little Texas North Unit: This unit is 56 acres is size and located in the northern portion of SVPH. This unit is surrounded by private land to the northeast, northwest, and west and SVPH property on all other sides. This burn unit is ½ of a larger NWSG planting. Care will be needed to ensure that the fire does not cross the burn unit to the south and burn unwanted acreage. If fire does escape it can be contained using the trail system and rock walls and roads (Secondary Breaks in Unit Maps). Fuel consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers. Patches of trees are present within the unit and will be burned through. State highway US68 is located east of this unit, smoke will be managed as noted in the (6) Smoke Management Section. The north and east side of this unit is bordered by private land consisting of some pasture and hayland, separated by AT Dean Lane. The west side of the unit is bordered by hardwood deciduous forest. The south side of the unit is bordered by NWSG (see above). Mild elevation change is present throughout the unit.

Little Texas South Unit: This unit is 40 acres in size and located in the central portion of SVPH. This unit is surrounded SVPH property. The entire unit will be burned. Fuel consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers. Patches of trees are present within the unit and will be burned through. State highway US68 is located east of this unit, smoke will be managed as noted in the (6) Smoke Management Section. The north and west side of this unit is bordered by hardwood deciduous forest. The south and east side of the unit is bordered by NWSG, separated by a rock wall and woody fence row. Mild elevation change is present throughout the unit.

Long Field Unit: This unit is 50 acres in size and is located in the central portion of SPVH. The entire unit will be burned. This unit is surrounded by SPVH property on all sides. SVPH property consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers separated by wooded draws and fence rows. Fuel within the unit consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers and unwanted exotic grasses. A Shaker Village dwelling (historic building) is located on the SE corner of this unit, refer to (10) Fire Break Preparations for information on defense. State highway US68 is located to the east of this unit, smoke will be managed as noted in the (6) Smoke Management Section. Opening in rock fence occur near S5, S1 and S3. Woody plants in this unit will be burned through.

Southside Unit: This unit is 70 acres in size and is located in the south-central portion of SVPH. The entire unit will be burned. This unit is surrounded by SVPH property on the north and west sides, private property borders the east and south, separated by a rock wall. Fuel consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers and blackberries. Some woody vegetation is present within this unit and will be burned through. State highway US68 is located north and west of this unit, separated by a wire fence, smoke will be managed as noted in the (6) Smoke Management Section. A power line runs roughly from reference point A3 to A15, smoke will be managed as noted in the (6) Smoke Management Section. The west side of this unit borders a hardwood deciduous forest. The south side of this unit borders a field consisting of short NWSG, separated by a wire fence and a woody fence row. The east side of the unit borders row crop separated by a rock wall. The north side borders State Highway US68. Mild elevation change is present throughout the unit.

Switchgrass Unit: This unit is 5 acres in size and is located in the southwestern portion of SVPH. The entire unit will be burned. This unit is surrounded by SVPH property on the north and east sides, private property borders the west and south, separated by a woody fence row and a small drainage. Fuel consists of a production switchgrass planting on the western ½ of the unit and short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers in the eastern ½ of the unit. State highway US68 is located south of this unit, smoke will be managed as noted in the (6) Smoke Management Section. Some woody vegetation is present within this unit and will be burned through. The north side of the unit is bordered by the Anderson Drainage Unit which consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers, hay fields separated by a rock wall border the north, west, and south side of the Anderson Drainage Unit and will act as secondary control lines. The east side of the unit is bordered by hardwood deciduous forest. The south side of the unit is bordered by a woody fence row, drainage, and row crop. Low elevation change is present throughout the unit.

Tanyard Unit: This unit is 43 acres in size and is located in the east-central portion of SVPH. The entire unit will be burned. This unit is surrounded by SVPH property. Fuel consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers. Some woody vegetation is present within this unit and will be burned through. State highway US68 is located east of this unit, a power line runs roughly north of reference point A1 to A6, and SVPH historic property borders the south side of the unit, smoke will be managed as noted in the (6) Smoke Management Section. The north and west sides of the unit are bordered by short NWSG, separated by a rock wall and woody fence row. The south side of the unit is bordered by a small pasture and SVPH historic property, separated by a wood fence. The east side of the unit is bordered by a hay field. A gravel road runs through the unit from roughly north of reference point A2 to A5. A structure is located near the middle of the unit border. This structure is surrounded by low-mowed cool season grasses and a small pond. A local structural fire fighting unit will be on site to monitor this structure during the burn. Mild elevation change is present throughout the unit.

West Lot #2 Unit: This unit is 52 acres in size and is located in the northwest portion of SVPH. The entire unit will be burned. This unit is surrounded by SVPH property to the north, south, and east. Private property surrounds the west side of this unit. Fuel consists of short NWSG including little bluestem and sideoats gramma along with various forbs and wildflowers. Woody vegetation in this unit will be burned through. A power line runs roughly through reference point A5 to A2, smoke will be managed as noted in the (6) Smoke Management Section. SVPH stables lay to the southeast of this unit (reference point A1), smoke will be managed as noted in the (6) Smoke Management Section. The north side of this unit is bordered by short NWSG separated by a rock wall and woody fence row. The west side of this unit is bordered by hay fields separated by a wire fence and gravel road. The south side of this unit is bordered by some NWSG and mowed areas, separated by a wire fence. The east side of this unit is bordered by hardwood deciduous forest, separated by a gravel road. An old road runs from reference point A5 to A2. Mild elevation change is present throughout the unit.

West Lot #4 Unit: This unit is 33 acres in size and is located in the northwest portion of SVPH. Two separate units make up the whole West Lot Unit 4, the entire unit will be burned. This unit is surrounded by SVPH property. Fuel consists of tall NWSG including big bluestem, Indian grass, and switchgrass along with forbs including ragweed patches. Woody vegetation in this unit will be burned through. A power line runs between reference point A6 to reference point A3, smoke will be managed as noted in the (6) Smoke Management Section. The north and east sides of this unit are bordered by hardwood deciduous

forest. The west and south sides of the unit are bordered by short NWSG, separated by a rock wall and woody fence row. Mild elevation change is present throughout the unit.

5) Goals and Objectives:
These burns are being conducted with one major objective in mind; 1) management and disturbance of existing habitat - control woody encroachment, create bare ground for ground dwelling wildlife, and create quality brood rearing habitat for northern bobwhite.

6) Fuel and Weather Prescriptions *(define a range of fuel and weather conditions during which the controlled burn may be ignited and held.)*

	Minimum	Preferred	Maximum
Temperature	30	60	70
Relative Humidity %	30	35	55
Surface Winds (mph)	1	4-7	10
Transport Winds (mph)	10	20	25
Wind Direction	any	(310°-130°) (E/N/SE/NW)	any
Days Since Rain	1	2-4	5

7) Fire Behavior *(Describe the fire behavior desired in order to meet objective listed in section 5)*
In order to ensure objectives are met, the fire will need to spread as slowly as possible to maximize time in which woody stems are exposed to heat. All units have NWSG component and flame lengths will range from 1' to 5' on gently sloping units with dense grasses, requiring backing fire to minimize fire intensity.

8) Smoke Management *(Identify smoke sensitive areas in a radius appropriate for burn unit size and fuel type including; roads, homes, airports, hospitals, Class I air sheds, chicken houses, etc. Include desired wind direction in order to mitigate sensitive areas. List required burn permits and/or notifications for burns in or adjacent to non-attainment areas.)*
Appendix C: Smoke Maps (1/2 & 2.5 mile radii)

US 68 (highway) is the main smoke sensitive area in close proximity to the SVPH burn units. Winds from the south will eliminate any smoke issues associated with this roadway, with the exception of the Southside Unit. If smoke lifts vertically, a south wind will not affect the roadway when burning the Southside Unit. However, if conditions change or wind direction sends smoke towards the roadway, smoke signs will be in place to notify drivers. Trucks equipped with yellow flashing caution lights will also be available to alert drivers if needed.

Shaker Village Historic Property is located directly south of the Tanyard Unit. Care will be given to keep smoke away from these buildings by burning with a proper wind direction from the S, SE, or E. These buildings are surrounded by low-mowed cool season grasses.

There are power lines (high tension and residential) running through the following units: Good Field North Unit, Southside Unit, Tanyard Unit, West Lot Unit 2, and West Lot Unit 4. All power lines will have a mowed strip (30'-40') positioned directly below the lines and disked around wood power poles. Smoke will be monitored and lift will be assessed to reduce the potential for arcing.

There are houses near SVPH property lines and if wind direction will send smoke towards these structures, fire will not be ignited in these units unless the wind direction changes or unless smoke is rising vertically.

9) Burn Organization *(Specify the minimum number of people required for implementation and control of the controlled burn. List the skills desired for the organization. List actual burn crew names the day of the burn.)*

Minimum 5 personnel *Note: we will attempt to burn using 2-3 burn crews to expedite the process. If this is feasible, Ben Robinson will lead one crew and he will assign a qualified burn leader(s) to the second and third crew.

Minimum crew = 1 crew leader (non-burner, only fire leader) and 5 crew members
Minimum total personnel needed for 2 crews = 12
Minimum total personnel needed for 3 crews = 18

10) Equipment *(Specify the minimum number and type of equipment required for implementation and control of the controlled burn)*
(Items with an * are required for each person and ** required for each crew)

*Nomex Clothing: Complete outfit (coveralls or shirt & pants)
*Hard hats w/Nomex neck protector, eye protection
*Leather Gloves
*Leather boots
*Two-way Radio & Spare Battery
**Cellular Phone: Required for Fire Leader (kept on person)
**Adequate water (nearby homes or > 250 portable gallons)

**First Aid Kit: > 1 min.	(Actual Need:__1___)
**Weather Kit or Kestrel Meter: >1 min.	(Actual Need:__1___)
**Flappers: > 2 min.	(Actual Need:__3___)
**Shovels: > 2 min.	(Actual Need:__2___)
**Rakes: > 2 min.	(Actual Need:__2___)
**Axe: > 2 min.	(Actual Need:__2___)
**Chain Saws: 1 min.	(Actual Need:__1___)
**Backpack Sprayers: > 2 min.	(Actual Need:__4___)
**Drip Torches: > 2 min.	(Actual Need:__4___)
**Smoke Signs:	(Actual Need:__2___)
**ATV's min. 15-25 gal. sprayers: > 2 min.	(Actual Need:__3___)

Other Equipment Needed: Fire Shelters if available.

11) Managing the Burn *(Include a description of each topic listed)*
Firebreak Preparation

All burn units will have a mowed strip 10-15' wide surrounding them. A heavily disked 8-10' strip will also be present around all units. Some firebreaks will also have winter wheat planted to act as a green buffer strip to stop fire. If wheat has been established, disked strip may not be present. SVPH has a complex hiking/horseback trail system across its grounds along with an extensive network of paved roads and several miles of rock fence. The trails, paved roads, and rock fences will all serve as contingency fire breaks to prevent fire from escaping to unwanted parts of the property.
A 30' mowed strip will be centered under all low hanging powerlines. A disked circle will be created around wooden powerline poles.

Ignition Plan
Start in downwind and/or upslope corner with test fire. If all is acceptable, proceed with firing unit by sending 2 crews in opposite directions lighting backfires initially (leaving minimum of 10 ft. of black as they proceed), followed by flanking fires along sides, then headfires as needed. Crew leader will monitor smoke lift throughout the burn day. If smoke is lifting vertically, wind direction will not be an issue. If smoke shows poor lift, winds from the W, NW, N, NE, and SW will be monitored to prevent smoke issues on highway US 68.

Estimated time to complete burn: 1 crew = 25 hours 2 crews = 12 hours 3 crews = 6 hours

Holding Plan
Holding crews will consist of at least 3 ATV with water and working sprayer, hand tools, and backpack sprayers. The holding crew will coordinate with igniters thru the fire leader to ensure that the fire progresses in a manner that allows for holding crew to maintain the control lines and prevent any escape in a manner that reduces risk of injury to personnel. Holding crews will conserve water when possible by allowing fire break to extinguish fire as it reaches bare dirt thus preserving water for any areas that require special attention or in the event of spot fires or slop over. Holding crews will be responsible for monitoring the fire line to ensure that no spotting or escapes occur and will immediately report any fire outside of the desired control line to the fire leader. The holding crew will address any spots or slop over that can be controlled using direct attack with their ATV sprayers or hand tools. In addition the holding crew for each line will have one individual on ATV to patrol the line all the way back to ignition throughout the burn.

Back up sources of water
Appendix B: Unit Maps
Backup water is located directly south of West Lot Unit #2, 500m due west of Tanyard Unit, and 500m due east of Southside Unit.

Communications
All resources will have two-way radios. Channels will be determined for each of the three crews, with B. Robinson and other 2 crew bosses scanning channel assignments every 30 minutes. Cell phone coverage is excellent throughout site, crew bosses will be informed of other crew boss phone numbers.

Mop Up Standards
100% mop-up within each unit will be attempted before Robinson, Rhoden, & Leffew depart for the day. The exception; smoldering logs/snags. However, these situations will be evaluated and

if suitable "black" surrounds them, they will be deemed safe and will be left alone to extinguish but will be monitored by Leffew.

Public Relations

- **Notifications**
- Neighboring homeowners will be notified via flyer or phone call prior to burning. Additional notifications include KDF and County Dispatch.

Legal Considerations *(describe ownership, management etc.)*
This land is owned and managed by Shaker Village of Pleasant Hill.

Contingency Plan
SVPH presents a unique opportunity for burn crews in that the majority of burn units are surrounded by SVPH property. In the event of a spot or an escape, fire can generally be contained within SVPH boundaries vs. privately owned lands. If a slop-over or spot fire occurs outside of a designated burn unit, the Burn Boss will evaluate the situation and determine the amount of holding resources needed to contain the incident. If the contingency can be contained with available resources within a reasonable timeframe, the fire shall be declared an "escape". Ignitions operations will cease, all fire personnel will be notified of the escape declaration, and on-hand resources will be ordered to the site of the escape by the Burn Boss. The escape will be suppressed utilizing wildfire suppression tactics and secondary control lines if necessary. If fire does escape the burn unit, either to another SVPH field or onto private land, a qualified crew member will be assigned during the morning briefing to stay with/monitor current burn unit while main burn boss (Robinson) or 2nd crew leaders (TBD) to address the situation and potentially establish an "emergency" burn crew. Immediate attention will be given to the escape and crew members and equipment will be reassigned by main burn boss (Robinson) or 2nd crew leaders (TBD) to address the situation. 1-2 crew members will remain at the original burn unit to monitor that fire but no additional fire will be placed on the ground until the escape is extinguished. If escape becomes unmanageable by the "emergency" burn crew, Mercer County Fire Dept. and/or KY Division of Forestry will be notified to assist. If the escape fire endangers life, structures and/or property with fire or smoke impacts, or cannot be contained with available resources within a reasonable timeframe, the escape fire will be declared a "wildfire". The burn boss will immediately notify local dispatch, the KY Division of Forestry, and the Regional Coordinator. Suppression efforts will be minimized to ensure crew safety once a wildfire declaration has been made. The burn boss will monitor the wildfire until emergency fire personnel arrive. The burn boss will then relinquish all control of the fire to the first responding legal fire unit. A volunteer fire department is located on the SVPH property and they could be on scene in a short amount of time. If a spot or escape fire occurs were there are no openings in a wire or stone fence, an opening will be created.
If weather parameters are exceeded as the day progresses, the burn boss will make a decision, based on the day's fire behavior and smoke conditions, whether to proceed. He/she will consult with other experienced crew members and will make a decision regarding how to proceed.

Who declares an escaped fire?
The burn boss declares an escape fire. The burn boss will determine when the escaped fire becomes a wildfire. Once declared a wildfire, KDF and county dispatch will be called.

Who is in charge in case of escape?
The burn boss will remain in charge of the escaped fire. Once declared a wildfire, the burn boss will remain in charge until KDF or VFD personnel arrive.

Locations secondary control lines
Appendix B: Unit Maps

SVPH presents a unique opportunity for burn crews in that the majority of burn units are surrounded by SVPH property. In the event of a spot or an escape, fire can generally be contained within SVPH boundaries vs. privately owned lands. The trails, paved roads, and rock fences will all serve as contingency fire breaks to prevent fire from escaping to unwanted parts of the property.

12) Safety and Medical Information *(Describe provisions to be made to provide for public and personnel safety. Include description of emergency medical procedures and locations of emergency facilities.)*
A first aid kit and directions to the nearest hospital are on hand for each crew boss. Most personnel are First Aid and CPR certified. Cell coverage in the area is excellent and first responders have access to property.

Escape routes and safety zones?
Appendix B: Unit Maps
Firebreaks will be used as escape routes. Black is the primary safety zone. Green shaded areas located in cool season mowed grass and eastern deciduous forest can be noted on Unit Maps as safety zones.

Hospital Directions: (Appendix D) James B Haggin Memorial Hospital is the nearest medical facility. Take US-68 west 7.5 miles then left onto S College St for 0.3 miles, then right onto Moorland avenue for 463 feet, then left onto Linden Ave for 0.1 miles, hospital is located on the right.

If injury occurs, one person will assess the victim. If the injury is severe and cannot be addressed with on-site resources, 911 will be called.

13) Post-Burn Activities *(Describe the follow up activities to ensure containment of prescribed burn. List the monitoring requirements to determine whether the prescribed burn met objectives.)*
The burn will be visited the following day to ensure that nothing has flared up. Fire effects will be monitored during and after the burn to see if objectives were met.

14) Maps *(Include burn unit map with scale and north arrow. Consider including smoke screening maps and emergency medical facility location map.)*
SEE attached Appendices A – D

15) Burn Day Checklist (Go/No-Go Checklist)

PRE-BURN GO/NO GO CHECKLIST

Site Name: Shaker Village of Pleasant Hill Burn Unit: _____ Date:_____

Has the area (inside and outside the unit) experienced unusual drought conditions or does it contain above-normal fuel loadings which were not considered in the prescription development? If YES, go to question below. If NO, continue with Section A.	YES	NO
If YES, have appropriate changes been made to plans for ignition, holding, mop-up and patrol? If YES, continue with Section A. If NO, stop and consult Fire Manager.		

PRIOR TO CREW BRIEFING

- ☐ Fire Unit is as described in plan and copy of plan is on site.
- ☐ Required firebreaks complete and are consistent with current and predicted conditions.
- ☐ Certified Burn Boss present, permits obtained. Give permit #'s:
- ☐ Required number of crew present with required protective clothing.
- ☐ Weather forecast obtained and within prescription. Long-range forecast checked for chance of severe weather.
- ☐ Official and neighbor notifications complete.
- ☐ Required equipment for holding, weather monitoring, ignition and suppression is on-site and functioning.
- ☐ Crew has reviewed equipment.
- ☐ Planned ignition and containment methods are appropriate for current and predicted conditions.
- ☐ Planned contingencies and mop-up are appropriate for current and predicted conditions.
- ☐ List of emergency phone numbers are in each vehicle.
- ☐ Off-site contingency resources are operational and available.

16) CREW BRIEFING

- ☐ Each crew member has a map

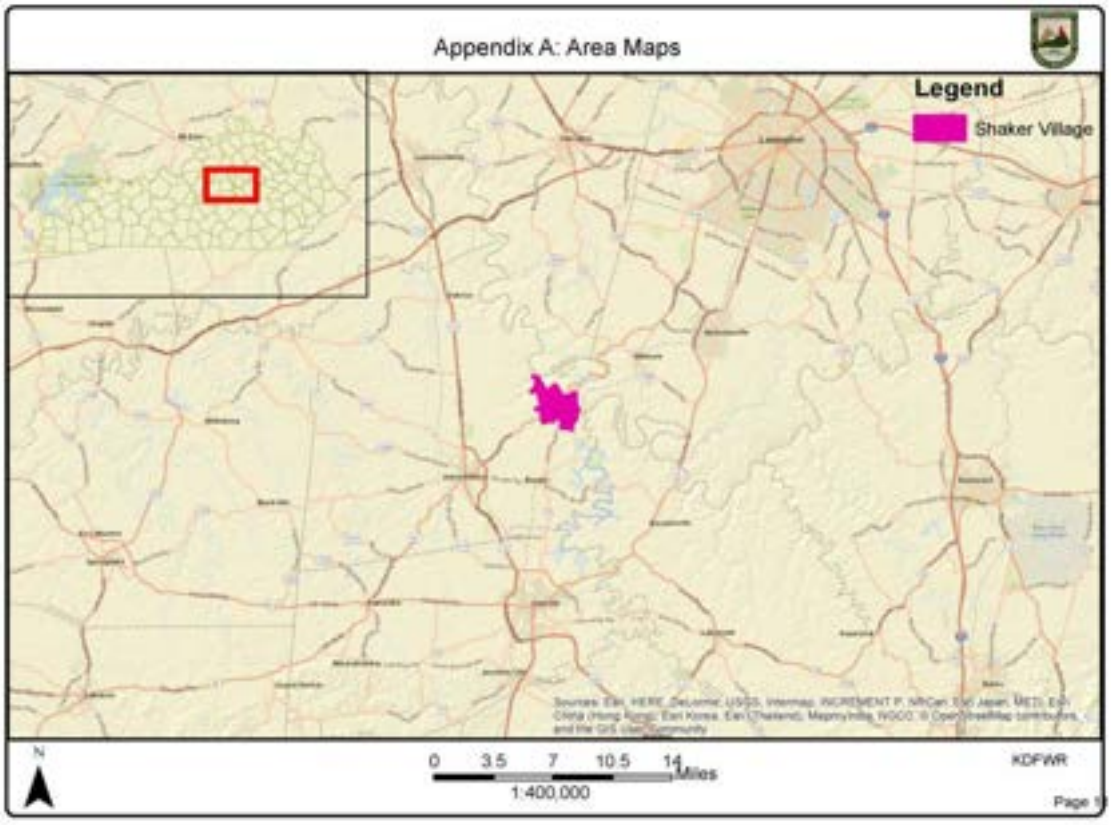
Each item below has been discussed with crew:

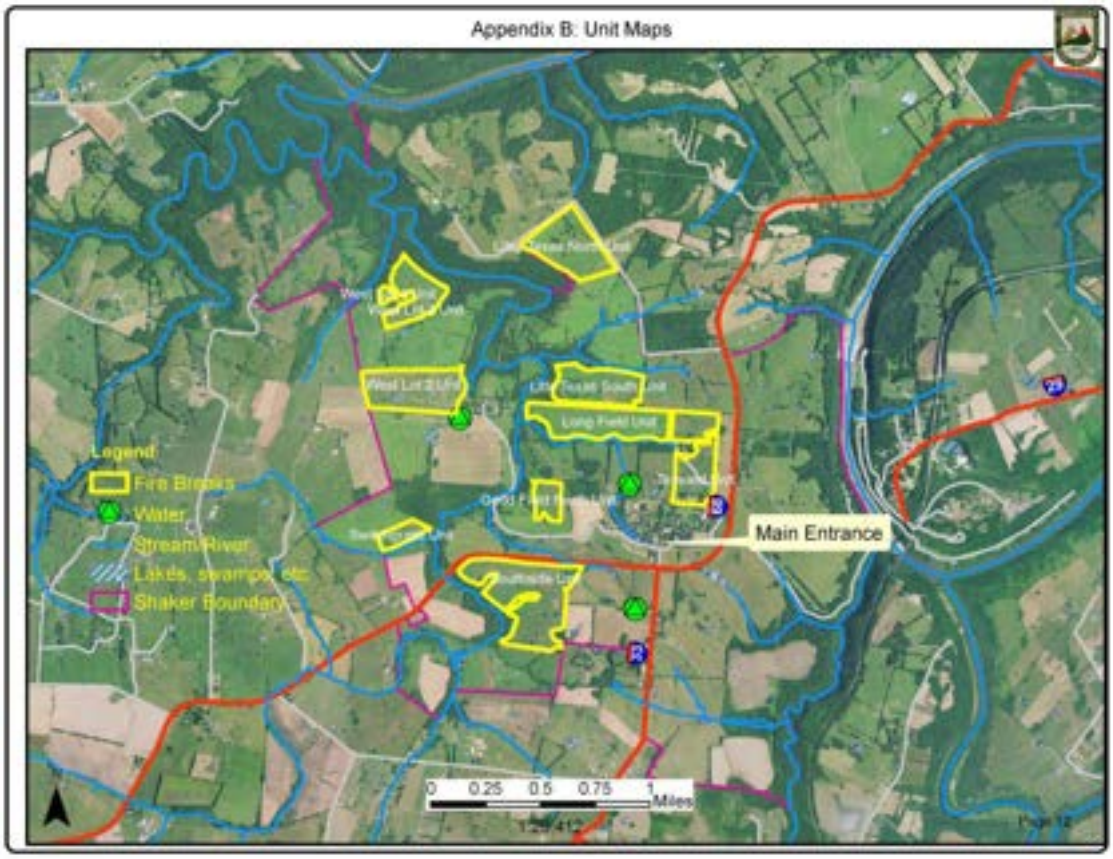
- ☐ Burn unit size and boundaries.
- ☐ Burn unit hazards and safety issues, including LCES.
- ☐ Purpose of burn, anticipated fire and smoke behavior.
- ☐ Organization of crew and assignments.
- ☐ Methods of ignition, holding, mop-up, communications.
- ☐ Contact with the public; traffic concerns.
- ☐ Location of main roads, vehicles, keys, and nearest phone.
- ☐ Location of back-up equipment, supplies, and water.
- ☐ Contingencies for escaped controlled burn.
- ☐ Contingencies for medical emergency
- ☐ Wildland Urban Interface concerns.
- ☐ Answer questions from crew.

PRIOR TO IGNITION

- ☐ On-site weather and fuel conditions are within prescription and consistent with forecast.
- ☐ Test burn conducted; fire and smoke behavior within prescribed parameters.

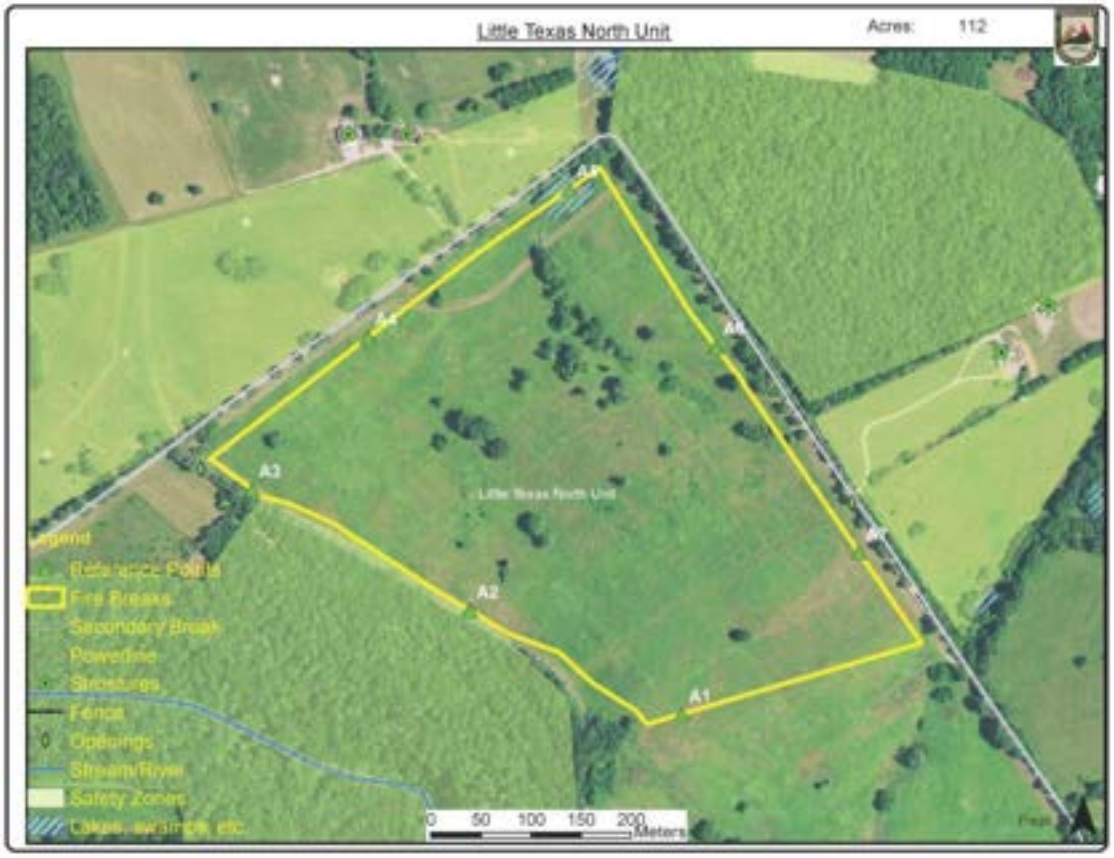
Burn Boss:_____ Signature: _____


Appendix A: Area Maps
Legend
Shaker Village
N
0 3.5 7 10.5 14 Miles
1:400,000
KDFWR

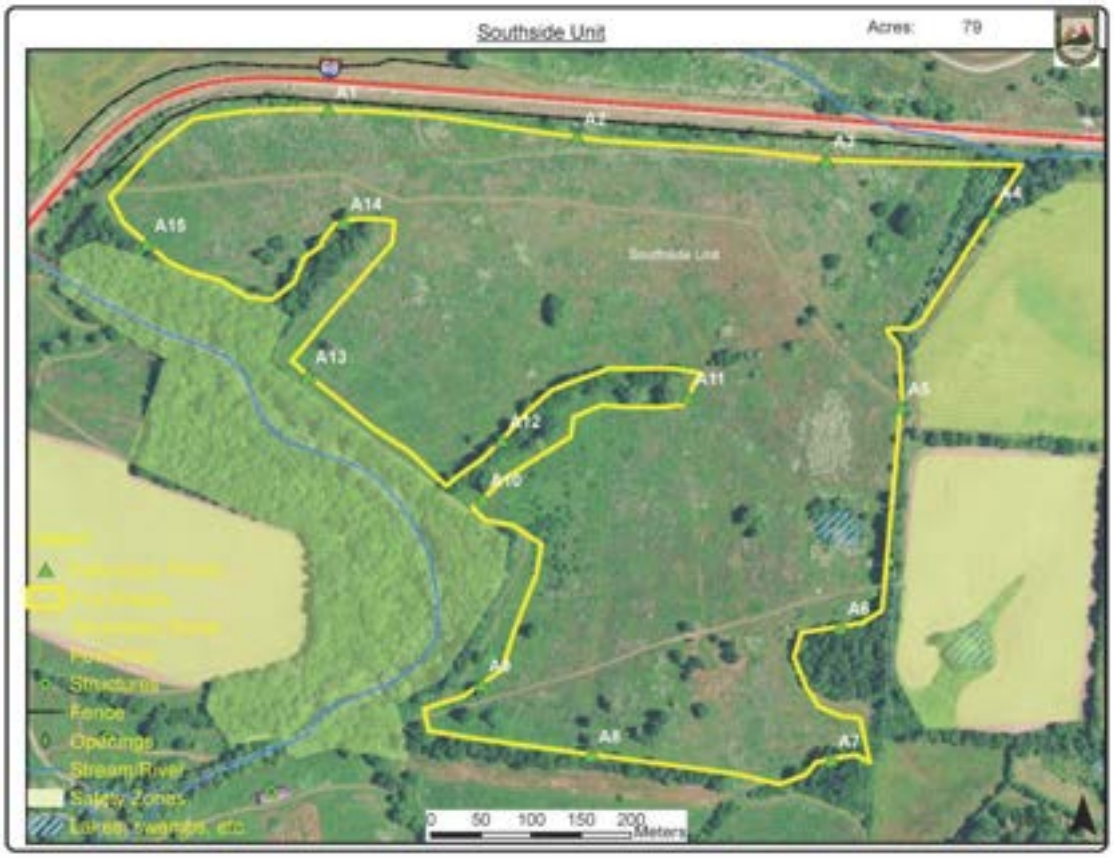

Appendix B: Unit Maps
Legend
Fire Breaks
Water
Stream/River
Lakes, swamps, etc.
Shaker Boundary
Main Entrance
0 0.25 0.5 0.75 1 Miles


Good Field North Unit
Acres: 13
B4
B1
B3
B2
Good Field North Unit
Legend
Reference Points
Fire Breaks
Secondary Break
Powerline
Structures
Fence
Openings
Stream/River
Safety Zones
0 50 100 150 200
Meters

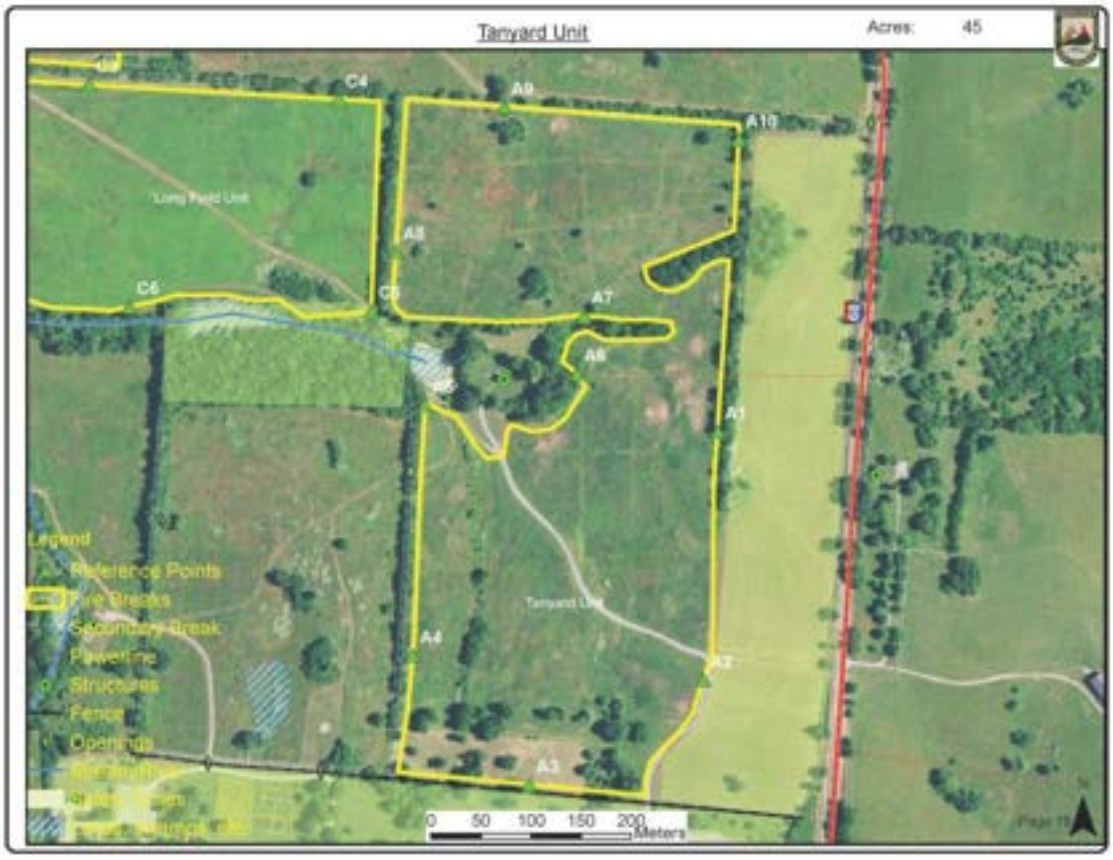

Little Texas South Unit
Acres: 45
A4
A5
A6
A3
Little Texas South Unit
A2
A1
A7
C1
C2
C3
C4
C5
Long Field Unit
C6
C7
C8
Legend
Reference Points
Fire Breaks
Secondary Break
Powerline
Fence
Openings
Stream/River
Safety Zones
Lakes, swamps, etc.
0 50 100 150 200
Meters


Little Texas North Unit
Acres: 112
A1
A2
A3
A4
A5
Legend
Reference Points
Fire Breaks
Secondary Break
Powerline
Structures
Fence
Openings
Stream/River
Safety Zones
Lakes, swamps, etc
0 50 100 150 200
Meters


Long Field Unit
Acres: 55
A1
A2
A3
A4
A5
A6
A7
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Legend
Reference Points
Fire Breaks
Secondary Break
Powerline
Structures
Fence
Openings
Stream/River
Safety Zones
Lakes, swamps, etc
0 50 100 150 200
Meters

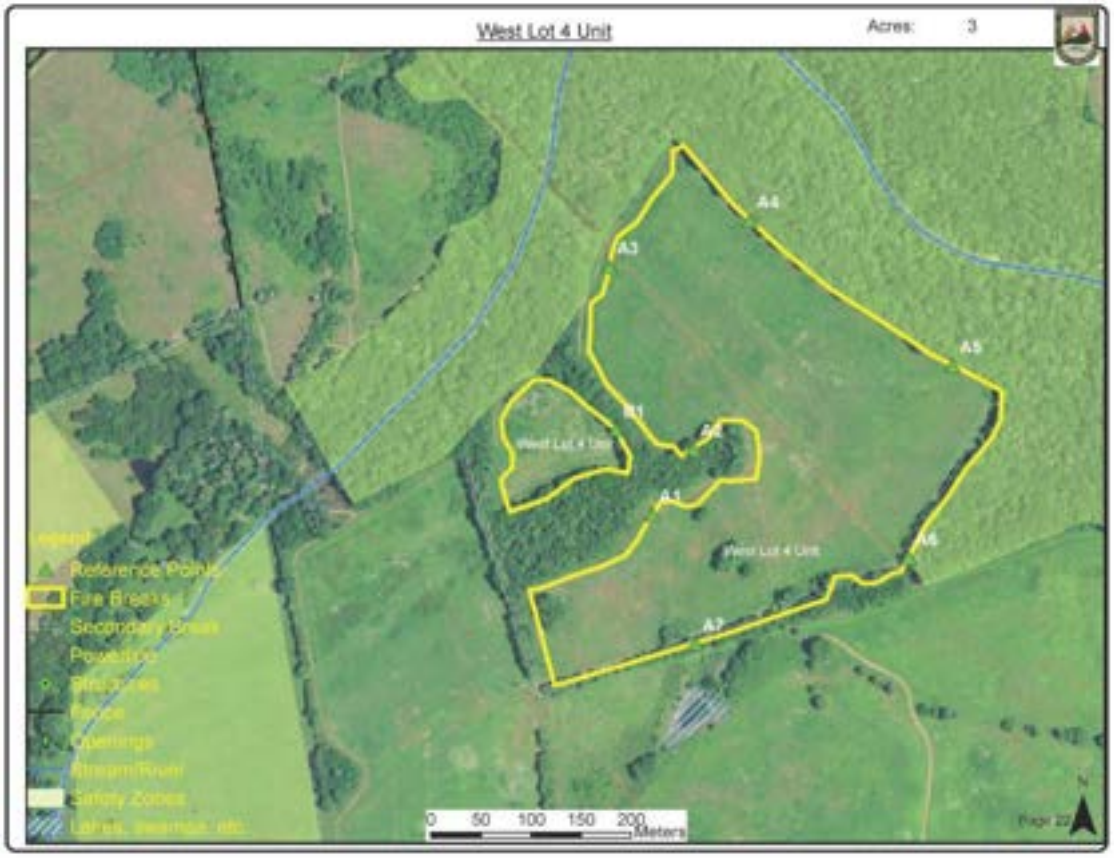

Southside Unit
Acres: 79
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
Southside Unit
Structures
Fence
Openings
Stream/River
Safety Zones
0 50 100 150 200
Meters


Switchgrass Unit
Acres: 10
A1
A2
A3
Switchgrass Unit
Legend
Fire Breaks
Secondary Break
Powerline
Structures
Fence
Openings
Stream/River
Safety Zones
0 50 100 150 200
Meters
Southside Unit
A15


Tanyard Unit
Acres: 45
C4
A9
A10
A8
C6
C5
A7
A6
A1
A4
A2
A3
Legend
Reference Points
Tie Breaks
Secondary Break
Structures
Fence
Openings
0 50 100 150 200
Meters


West Lot 2 Unit
Acres: 53
A1
A2
A3
A8
A4
A7
A6
A5
0 50 100 150 200
Meters


West Lot 4 Unit
Acres: 30
A4
A3
A5
B1
B2
A1
A6
A7
Legend
Reference Points
Fire Breaks
Secondary Break
Powerline
Structures
Fence
Openings
Stream/River
Safety Zones
Lakes, swamps, etc.
0 50 100 150 200
Meters


West Lot 4 Unit
Acres: 3
A4
A3
A5
B1
B2
A1
A6
A7
Reference Points
Fire Breaks
Secondary Break
Powerline
Fence
Openings
Stream/River
Safety Zones
0 50 100 150 200
Meters

Appendix D: Hospital Map

Google Maps Shaker Village of Pleasant Hill to James B Haggin Memorial Hospital- Emergency Room Drive 8.1 miles, 13 min

Shaker Village of Pleasant Hill

Follow Shakertown Rd to US-68 W/E Lexington St

1. Head east on W Lot Rd toward Shakertown Rd
2. Turn right onto Shakertown Rd

Follow US-68 W/E Lexington St to Linden Ave in Harrodsburg

3. Turn right at the 1st cross street onto US-68 W/E Lexington St
4. Turn left onto S College St
5. Turn right onto Moorefield Ave

Continue on Linden Ave to your destination

6. Turn left onto Linden Ave

Page 24

7. Turn right onto James B Haggin Memorial Hospit
8. Turn right
9. Keep right

James B Haggin Memorial Hospital- Emergency Room

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Appendix G:
Example BSMP Checklist For Burn Plans

Basic Smoke Management Practices (BSMPs) help practitioners predict the amount of smoke that may be produced, the direction of smoke transport, and the people and places that may be impacted. Ultimately, they help practitioners identify, minimize, and mitigate smoke impacts. If a decision is made to use prescribed fire, practitioners should evaluate and use BSMPs for each and every burn conducted, whether the fire is set on wildland, private land, or agricultural land.

These BSMPs are not strict prescriptive requirements, but rather over-arching recommendations that can guide smoke management practices before, during, and after a prescribed fire. The list is not comprehensive; allowing flexibility for practitioners to manage smoke as necessary. Regardless, each of these six BSMPs should be considered, and their practicality evaluated, for each prescribed fire conducted. The six BSMPs are not separate and discrete steps, but are rather inter-related and ongoing throughout the entire prescribed fire process.

To assist prescribed fire practitioners, the checklist on the following page provides a cross-walk between each of the six general BSMPs and the applicable section of the burn plan or where the applicable information is located. The checklist was developed based upon the NRCS Basic Smoke Management Practices Technical Note, and this VSMP. Such a checklist might be utilized during the planning phase to ensure that the burn plan contains adequate smoke management protections, during the burn to ensure that BSMPs are followed, and after a burn to ensure necessary information is retained.

References:

Natural Resources Conservation Service. Basic Smoke Management Practices. Technical Note. October 2011. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046311.pdf

Basic Smoke Management Practices Checklist for Prescribed Fire

√		BSMP	Potential Elements/Actions	Burn Plan Section/ Information Location/ Actions Taken:
	1	**Evaluation of Smoke Dispersion Conditions** Predict smoke impacts before, during, and after fire	-Identify fuel type/loading -Identify probable smoke-impact areas *(Smoke Trajectory Plot, VSmoke, Simple Smoke Screening Tool, ect.)* -Identify smoke sensitive targets *(airports, roads, schools, cities, hospitals, air quality targets, ect.)* -Determine meteorological criteria	
	2	**Monitoring Effects on Air Quality** Maintain awareness of smoke transport/potential impacts before, during, and after fire	-Checking air quality forecasts/ *conditions (EPA AirNow, ect.)* -Tracking smoke transport	
	3	**Communication/Public Notification** Notify neighbors and those potentially impacted by smoke before and during fire	-Government entities *(KDF, KDAQ)* -Emergency personnel -General public *(neighboring land-owners, media)*	
	4	**Consideration of Other Emission Reduction Techniques** Reduce emissions/fuel loading through other mechanisms before, during, and after fire.	-Reduce the burn area -Reduce the fuel load -Reduce/change the Fuel -Increase combustion efficiency *(Is prescribed fire necessary to mimic natural fire return intervals and/or to meet land/ecological management objectives?)*	
	5	**Coordination of Area Burning/Sharing the Airshed** Coordinate multiple burns in an area to manage combined smoke impacts before, during, and after fire	-Formalized procedures between agencies -Informal/voluntary actions among practitioners -Kentucky Prescribed Fire Portal	
	6	**Documentation/Journaling** Document and retain information about the weather, fire, and smoke before, during, and after fire	-Burn Plan -Post-Burn Report -Burn Journaling/Log -Record Keeping/Archival	

KPFC VSMP 2021

2022

Kentucky Prescribed Fire Council

Air Quality Committee

A member of the Coalition of Prescribed Fire Councils