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**Southwestern
Region**

Prescott National Forest

Air Quality

Specialist Report

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for the
Forest Plan Revision
Environmental Impact Statement

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Introduction

The purpose of this report is to evaluate the potential environmental consequences to air quality that may result with the adoption of a revised land management plan. It examines the consequences of taking no action to revise the existing plan and of three alternative actions: the proposed revision of the Forest Plan, an alternative that emphasizes vegetation and wildlife habitat restoration, and an alternative that emphasizes dispersed recreation opportunities.

This report describes:

- The laws that are relevant to air quality and smoke management on the Prescott National Forest
- The environment affected by the alternatives
- The needs for change identified in revising the existing plan
- The portions of the alternative considered in detail that are relevant to air quality and smoke management
- The environmental consequences of the alternatives
- The cumulative effects to the environment of the alternatives

Relevant Laws, Regulations, and Policy that Apply

In 1955, Congress passed the first Federal Clean Air Act with later amendments in 1967, 1970, 1977, and 1990. Implementation of this Federal Law is largely the responsibility of the States which may develop programs that are more restrictive than the Clean Air Act requires but never less. The State of Arizona has a State Implementation Plan that outlines how the State is implementing the goals of the Clean Air Act, and Statutes that regulate burning, including use of wildland fire on Federal and State lands. Two types of air quality impacts are addressed by these laws and regulations: health hazards from pollutants, and visibility impacts in Class I Airsheds.

The Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for six principal pollutants that pose health hazards: carbon monoxide (CO), lead, nitrogen dioxide, particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone, and sulfur dioxide. The major pollutant of concern in smoke from wildland fire, both planned and unplanned ignitions, is fine particulate matter (Ottmar 2001). Particles larger than 10 microns in size tend to settle out of the air; smaller particles remain airborne, and can cause respiratory problems. Studies indicate that 90 percent of smoke particles emitted during wildland fires are PM 10, and about 90 percent of PM 10 is PM 2.5 (Ward and Hardy 1991). Human health studies on the effects of particulate matter indicate that it is PM 2.5 that is largely responsible for health effects (Dockery and others 1993). Because of its small size, PM 2.5 has an especially long residence time in the atmosphere and penetrates deeply into the lungs (Ottmar 2001). The Clean Air Act defines the NAAQS for PM 2.5 as an annual mean of 15$\mu g/m^3$, and a

24 hour average of 35µg/m^3. At this concentration or above, PM 2.5 is considered to have a detrimental effect on public health. It is important to note that it is not the total amount of emissions from a fire that have effects on human health, but rather how *concentrated* pollutants in ambient air are for a period of time. Atmospheric conditions during a fire have a considerable influence on how particulate matter is distributed through the ambient air, and its potential to affect public health. Wind speed, wind direction, mixing layer height, atmospheric temperature profile upward in the atmosphere, and atmospheric stability all effect where and how well smoke will disperse.

Regional haze is air pollution that is transported long distances, causing reduced visibility in national parks and wilderness areas. The same particulate matter that poses health risks is also largely responsible for these impairments to visibility. "The combination of light absorption by elemental carbon and light scattering caused by the very small particles that make up wildland fire smoke explains why emissions from wildland fire play such an important role in visibility impairment" (Core 2001).

Over 280 million people visit our nation's national parks and wildernesses areas every year. Visitors expect to view the scenery through clean fresh air. To protect visibility in these areas of high scenic value, Congress designated all wilderness areas over 5,000 acres and all national parks over 6,000 acres as mandatory federal Class I areas in 1977, subject to the visibility protection requirements in the Clean Air Act. There are 156 national parks and wilderness areas that have been designated by Congress as "mandatory federal Class I areas". There are two Class I areas most likely to be effected by Prescott National Forest activities: Pine Mountain Wilderness and Sycamore Canyon Wilderness. The national visibility goal of the Clean Air Act is, "the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I areas in which impairment results from manmade air pollution." Some manmade sources of visibility impairment are industry, transportation, construction, mining, agricultural activities, and home heating; prescribed fires fall into this category. Wildfires are considered to be natural sources of visibility impairment, and generally outside State control or prevention.

Land managers are increasingly using planned and unplanned ignitions to achieve resource objectives, and to reduce future risk of high severity wildfires. Federal land managers have somewhat conflicting roles when it comes to protecting visibility in Class I areas. On the one hand, they are given the responsibility of protecting and meeting visibility standards. On the other hand they are tasked to allow fire, as nearly as possible, to function in its natural role in the ecosystem (USDA, USDI 1995). This puts the land manager in the awkward position of being the polluter, and in the difficult position of explaining why wildland smoke may be acceptable, while other types of pollution are not. The response to this dilemma is that wildernesses and national parks are managed to preserve and protect natural conditions and processes. So in this context, smoke and visibility impairment from wildland fire that closely mimics what would occur naturally is generally viewed as acceptable (Peterson 2001).

The Regional Haze Rule, 40 CFR 51.308-309 (US EPA 1999), provides direction to the states for developing and adopting regional haze implementation plans. Under section 309, the State of Arizona has developed a State Implementation (SIP) plan with long-term strategies out to the year 2064 to make "reasonable progress in improving visibility in Class I areas inside the state and in neighboring jurisdictions (US EPA 1999)," and focuses on anthropogenic sources of emissions. The Arizona SIP outlines an Enhanced Smoke Management Plan meeting criteria in the Regional Haze Rule that comprises a series of key policies and management practices to address visibility protection.

Visibility is measured in deciviews (dv). Deciviews are a metric of visibility proportional to the logarithm of the atmospheric condition. The deciview haze index corresponds to incremental changes in visual perception from pristine to highly impaired conditions. Visibility conditions are monitored and tracked through the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. This site serves as a data clearinghouse for all of the Class I areas that have monitors, including Sycamore Canyon and Pine Mountain wilderness areas. The data can be accessed at http://vista.cira.colostate.edu/TSS/Results/Monitoring.aspx.

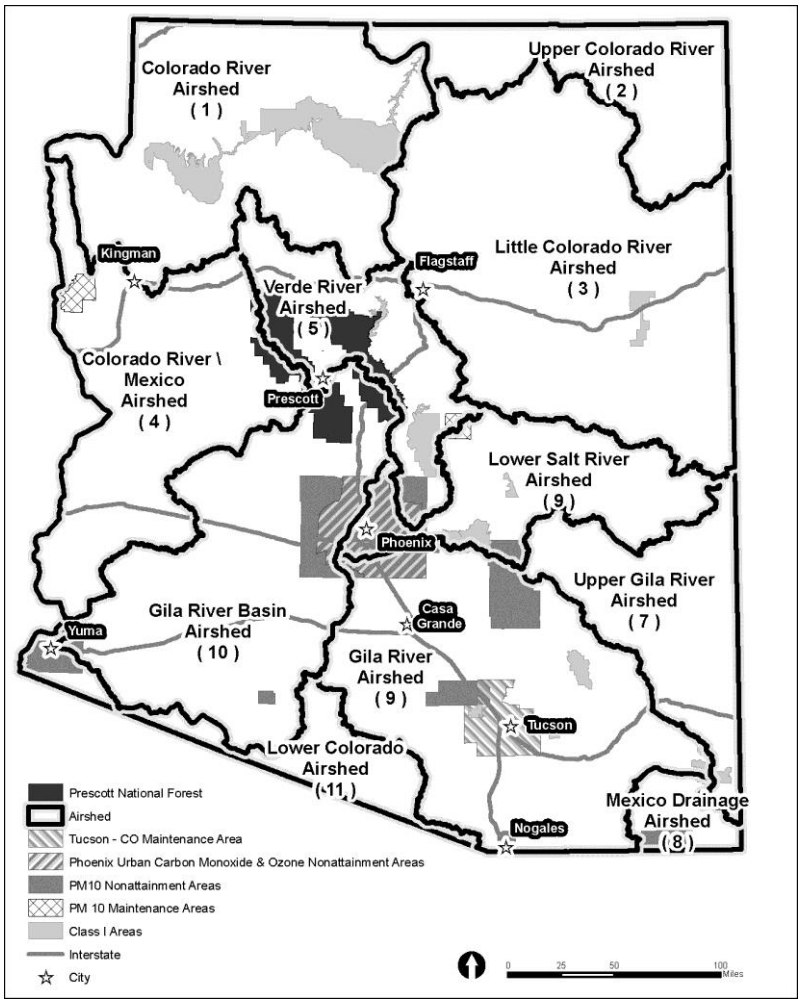
The key policy resulting from the Enhanced Smoke Management Plan pertaining to planned ignitions in Arizona is Arizona Revised Statute Title 18 Chapter 2 Article 15. This law regulates burning by Federal and State land managers, as well as burning by Tribal, private, and municipal burners who have a Memorandum of Understanding with the Arizona Department of Environmental Quality (ADEQ). This Statute defines the request and approval process for all planned ignitions, and provides the mechanisms for tracking emissions from those ignitions. Enforcement of this statute is facilitated by the Smoke Management Group, housed at ADEQ. This group is comprised of a Forest Service employee, a Dept. of Interior employee, and an ADEQ employee. This group collects all planned ignition requests daily, makes recommendations to ADEQ on requests to be approved based on forecasted meteorological conditions, number of concurrent planned and unplanned ignitions, residual pollutants from previous planned ignitions or other sources, and other factors. This group also performs much of the work to track and summarize annual emissions from planned and unplanned ignitions to prepare required annual reports, and monitors regional haze levels.

Problem or Nuisance Smoke is defined by the Environmental Protection Agency (EPA) as the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources. While there are no laws or regulations governing nuisance smoke, it effectively limits opportunities of land managers to use planned and unplanned ignitions to meet resource objectives. Public outcry regarding nuisance smoke often occurs long before smoke exposures reach levels that violate NAAQS (Achtemeir and others 2001). "Probably the most common air quality issues facing wildland fire managers are those related to public complaints about nuisance smoke. Complaints may be about the odor or soiling effects of smoke, poor visibility, and impaired ability to breathe or other health-related effects. Sometimes complaints come from the fact that some people don't like or are fearful of smoke intruding into their lives (Hardy and others 2001)."

Description of Affected Environment (Existing Condition)

Prescott National Forest lies within three airsheds as defined by ADEQ: the Verde River, the Gila River Basin, and the Colorado River/Mexico airsheds as shown in figure 1. The majority of the PNF falls within the Verde River airshed.

Figure 1. Airsheds for the state of Arizona.



NAAQS:

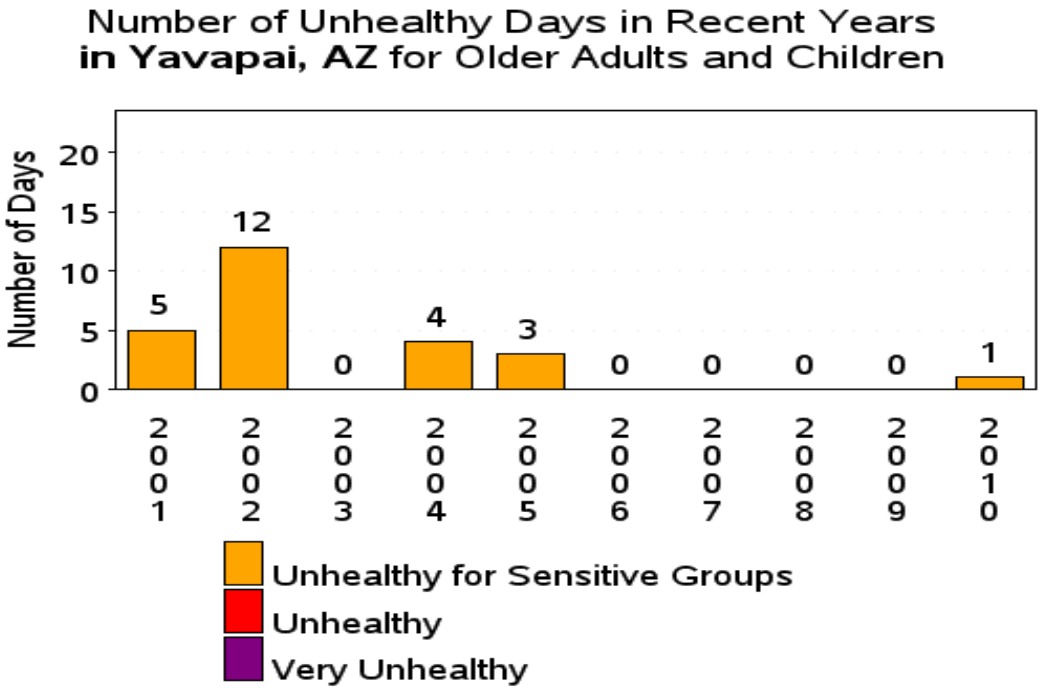
Air quality monitoring data has been collected in Yavapai County for three of the six criteria pollutants that pose a threat to human health (ground-level ozone, particles larger than 10 microns, and particles less than 2.5 microns in size) on a limited basis since 1993. Monitoring sites have varied from year to year with no one location having a complete monitoring record (US EPA, 2009a). Ground-level ozone measurements have been collected from only one site in western Yavapai County. The annual average ozone concentration exceeded the national standard 7 out of 8 years during the period from 1997 to 2004. For both sizes of particulate matter (larger

than 10 microns and less than 2.5 microns), several locations throughout Yavapai County were monitored, and the seasonally adjusted annual averages were far less than the national standard for each of the years 1990 to 2010.

The EPA has developed an Air Quality Index (AQI) for reporting how clean or unhealthy the air is and the associated health effects that may be a concern to the general public or sensitive groups (such as children, older adults, or those suffering from asthma or lung disease). The index is calculated from raw measurements and converted into a separate AQI value for each pollutant (ground-level ozone, particulate matter, carbon monoxide, and sulfur dioxide). The highest of these AQI values is reported as the AQI value for that day.

Air quality data used to calculate the AQI indicate that most residents of Yavapai County and visitors to the Prescott NF enjoy good air quality (see Figure x). Since 2001, 73 percent or more of the days monitored[1] were assigned to the Good category of the EPA Air Quality Index. Good is the best rating, where air pollution poses little risk to human health. Less than three percent of days per year were rated in the Unhealthy for Sensitive Groups category, and no days were rated Unhealthy, Very Unhealthy or Hazardous (US EPA, 2010). These air quality index ratings include emissions from Prescott NF prescribed fire activity that has averaged 7,640 acres per year under the direction of the 1987 Plan.

Figure X. Yavapai County Air Quality Indices 2001-2010.



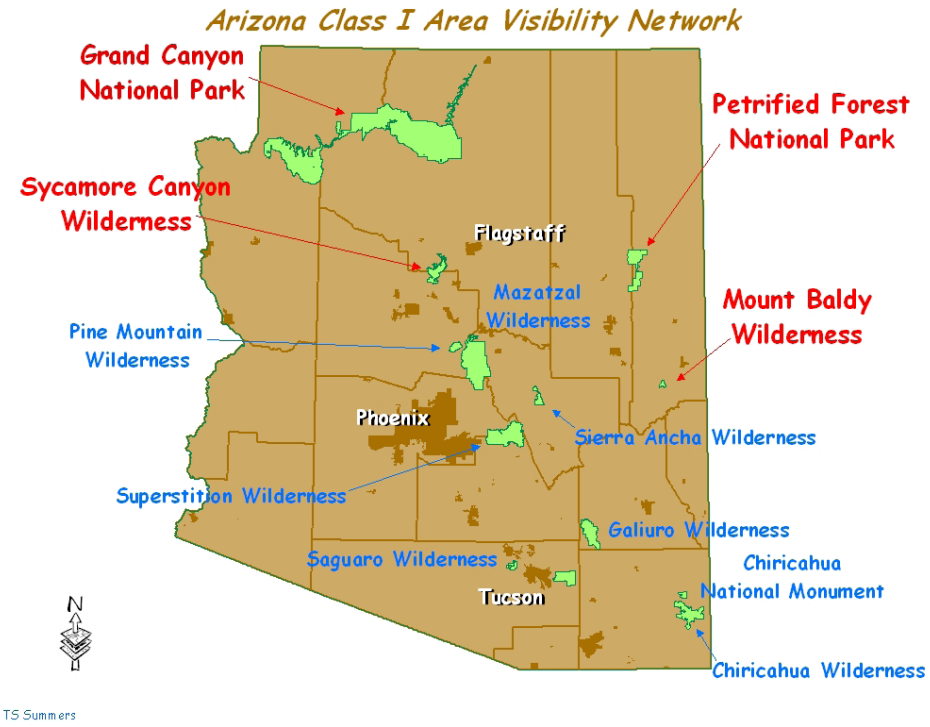
Source:http://www.epa.gov/aircompare/index.htm

[1] Some counties may not measure every pollutant used to calculate the AQI and the number of days each pollutant is measured may vary from one county to another.

Visibility:

There are a total of 12 mandatory Class I areas in Arizona (figure 2). Sycamore Canyon Wilderness and Pine Mountain Wilderness are the Class I areas designated within or adjacent to the Prescott NF. Class I airsheds are represented only by the air directly above each individual wilderness. Although this is a political boundary, air quality is affected by pollutants that are generated from within the wilderness, such as smoke from fires, and also by pollutants that flow into the airshed from other sources. This might include wood smoke from homes or prescribed fire, and dust from rock quarries or roads. Long range transport of pollutants from metropolitan areas and large industry many miles away is also possible.

Figure 2. Arizona Class I Areas (Source: ADEQ 2003).



Visibility in Pine Mountain and Sycamore Canyon wilderness areas, through implementation of the Regional Haze Rule, and the Arizona SIP, are projected to steadily improve (table 1). By 2064, visibility on the 20 percent of the average worst days should improve by 6.72 dv for Pine Mountain, and 8.24 dv for Sycamore Canyon (USFS 2009a).

Table 1. Baseline conditions and projected 2064 natural conditions for Class I Areas associated with the Prescott National Forest

Class I Airsheds	Baseline Data		2064 as Measured by Deciview
	Measured by Deciview	Years	
Pine Mountain Wilderness	13.4 dv	2000-2004	6.68 dv
Sycamore Canyon Wilderness	15.2 dv	2001-2004	6.96 dv

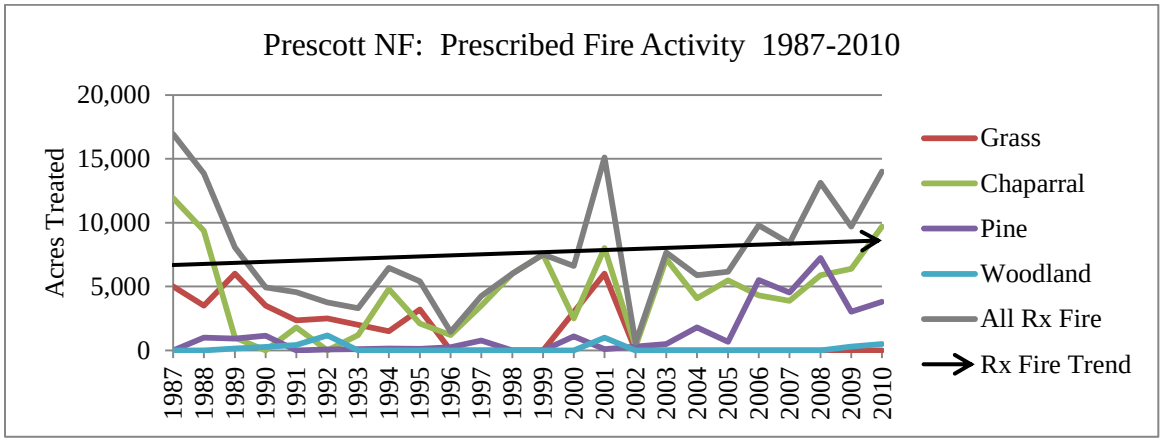
Source: IMPROVE Data (CSU 2006)

Air Quality Threats:

Threats to air quality in the form of particulate emissions come from many sources. The most prevelant ones include fossil fuel combustion, electricity generation, residential wood combustion, wildland fires, and road dust (US EPA 2009b).

In central and northern Arizona, the primary sources of particulate emissions are the activities associated with wildland fire management. Road dust has not been demonstrated to be a measurable contributor on a regional level to visibility in the Sycamore Canyon Wilderness and 15 other Class I areas located on the Colorado Plateau (ADEQ 2003). Under the direction of the 1987 forest Plan, the Prescott NF has burned an average of 7,640 acres per year using planned ignitions (figure 3).

Figure 3. Summary of prescribed fire activity for vegetation types of the Prescott NF.

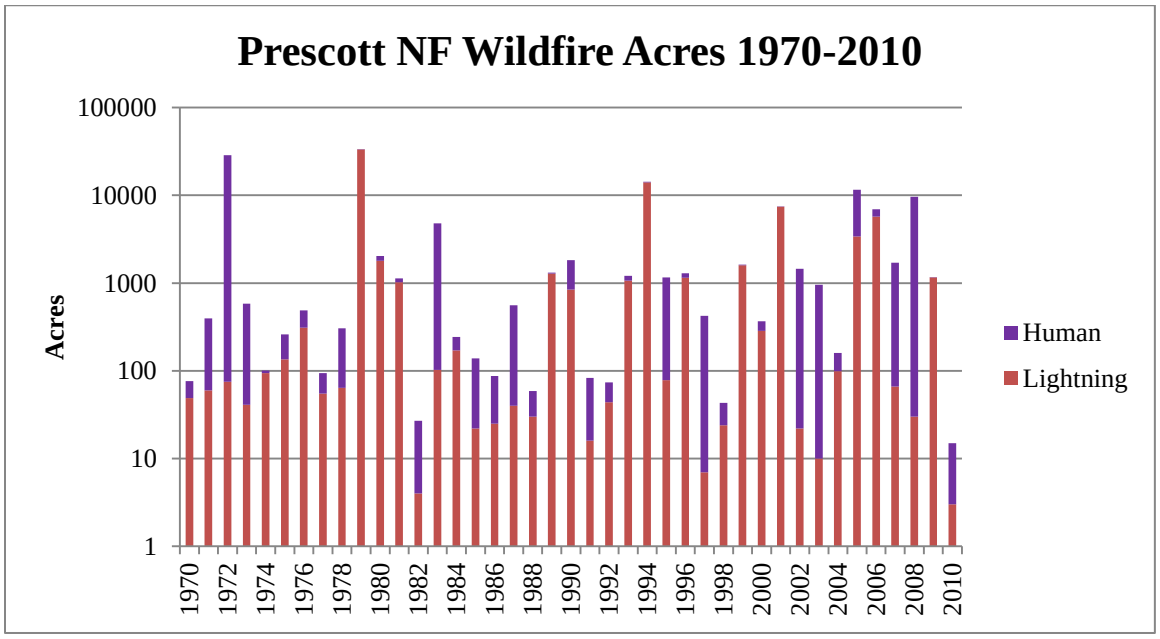


Wildfires also contribute to air quality impacts. If ignited by lighting, the Forest Service may use wildfires to achieve resource objectives if current and expected fire behavior is desirable (USDA, USDI 1995). In 2007, the Prescott NF amended the existing forest Plan to allow implementation of this policy for areas outside of designated wilderness and away from communities at the

wildland urban interface. In the three-year period since, two unplanned lightning-caused fires (totaling 1,034 acres) have been managed to meet resource objectives (USFS 2009c, USFS 2008).

Among the many factors fire managers and line officers must carefully weigh when deciding whether to suppress a wildfire, or manage it to perform its natural role in the ecosystem, is whether the potential benefits of the wildfire outweigh the smoke impacts to the airshed, affected communities and rural residents. On these fires, fire managers are able to manage smoke impacts to some degree. Burn out operations can often be timed to occur when ventilation conditions are favorable. It may be possible to check a fire's edge on days when reduced emissions are needed. Wildland fire activities in an airshed can be coordinated between fire managers, in conjunction with ADEQ, to either spread high emission producing events across several incidents over several days to reduce the concentration of pollutants, or facilitate these events to occur simultaneously on days with favorable ventilation to move the pollutants up and out of the airshed all at once, and reduce the duration of smoke impacts. Figure 4 displays the wildfire acres by ignition source that have occurred on the Prescott NF since 1970. Lightning accounts for 60 percent of the ignitions reported and 55 percent of the acres burned. The total area burned per year has averaged 3, 369 acres (range 15 – 33,652 acres).

Figure 4. Wildfire occurrence on the Prescott National Forest for the period 1970-2010.



Other land management activities, such as tree and shrub thinning, that reduce the likelihood of high severity wildfires in the future, have indirect beneficial effects on reducing smoke emissions. They alter stand structure so that wildfires burn as surface fires, thereby burning only accumulated litter and duff on the forest floor, but not the available fuels in the tree canopies, resulting in reduced air quality impacts, even though these results are not immediately realized at the time of project implementation.

Needs for Change Addressed in this Analysis

During an analysis of the management situation (USFS 2009b), the absence of specific goals and/or desired conditions related to air quality was identified as a need for change to the existing forest plan. With internal and external collaboration, the following **desired conditions for air quality** were drafted as components of the revised forest plan and are evaluated in this report:

- *Fire as a natural disturbance process occurs across the landscape.*
- *Smoke or dust levels meet national ambient air quality standards (NAAQS). Conflicts between smoke aversion and improvement of ecosystems using fire are minimized and smoke impacts to communities are minimized. Citizens are aware of timing, ignition sources, and benefits of fires and their resulting smoke.*
- *Forest Service management activities do not contribute to diminished visibility or increased atmospheric deposition of pollutants within the Sycamore Canyon Wilderness and Pine Mountain Wilderness.*

Summary of Alternatives

The sections below describe the alternatives in terms of vegetation, fire and fuel management activities as they relate to air quality and smoke management.

Alternative A – 1987 Forest Plan Direction:

Alternative A would continue management under the existing plan for the Prescott National Forest. The plan provides for timber production, fuelwood harvest, hazardous fuel reduction treatments, prescribed fire and management of unplanned ignitions to meet resource objectives.

Under Alternative A, thinning to alter or restore vegetation structure and composition would continue to occur on about 550 acres per year in ponderosa pine and on 300 acres per year in pinon-juniper vegetation. Fire managers would continue to treat about 7,835 acres per year using prescribed fire across all vegetation types (e.g. forests, woodlands, shrublands, and grasslands).

Planned ignitions would be coordinated with the Arizona Department of Environmental Quality, as well as with adjacent agencies, to ensure that exceedences of State or Federal emissions standards do not result.

Alternative B – The Proposed Revised Plan:

Alternative B represents approximately 1-2 years of collaborative work with citizens, agencies, and Prescott NF employees in an iterative manner to respond to suggested changes in proposed plan components. It places an emphasis on restoring vegetation, structure, composition, and desired characteristics of fire to five ecosystems that are moderately or highly-departed from desired conditions. It also addresses citizen concerns related to smoke emissions and responds to the anticipated effects of climate change. Eight potential wilderness areas are recommended.

Alternative B would increase the amount of thinning and prescribed fire occurring across the landscape. Planned ignitions would range from 10,600 to 25,300 acres per year on average. Thinning treatments to forests and woodlands would range from 750 to 6,500 acres per year on average.

Planned ignitions would be coordinated with the Arizona Department of Environmental Quality, as well as with adjacent agencies, to ensure that exceedences of State or Federal emissions standards do not result. Additionally, wildland urban interface (WUI) areas would be given high priority for fuel reduction treatments, using mechanical methods and/or domestic animals in lieu of planned ignitions.

Alternative C - Vegetation and Wildlife Emphasis:

Alternative C includes many of the same components of Alternative B, however, it responds to public comments to increase emphasis on vegetation trends within both grassland and ponderosa pine types. This focus improves vegetation conditions within important wildlife habitats and places less emphasis on some vegetation communities and recreational components. In addition, Alternative C includes more management treatment for native fish and other aquatic species and pronghorn habitats; there is much less emphasis on recommendation of potential wilderness areas.

Alternative C would emphasize a higher range of prescribed fire and a lower range of thinning activity compared to Alternatives A and B. Planned ignitions would range from 15,500 to 22,800 acres per year on average and would be focused in grassland and ponderosa pine vegtation. Thinning treatments would range from 750 to 4,000 acres per year on average.

Response to smoke emissions in Alternative C is the same as that described in Alternative B.

Alternative D – Dispersed Recreation Emphasis:

Alternative D includes an emphasis on providing increased dispersed recreation opportunities. Vegetation treatments would be similar to those in Alternative B or slightly reduced. Emphasis on pronghorn and native fish would be identical to Alternative B. Within recreational opportunities, there would be reduced emphasis on developed recreation, such as campgrounds, and increased emphasis on dispersed recreation such as adding trails, improving trailheads and adding designated dispersed sites. This alternative also includes recommendation of the highest number of potential wilderness areas.

Alternative D would emphasize less prescribed fire than Alternatives B and C, and similar or less thinning activity. Planned ignitions would range from 10,600 to 18,800 acres per year on average. Thinning treatments to forests and woodlands would range from 750 to 4,000 acres per year on average (the same as Alternative C).

Response to smoke emissions in Alternative D is the same as that described in Alternative B.

Alternative E – The Preferred Alternative:

Alternative E was developed between draft and final versions of the proposed plan and EIS in response to issues and concerns heard during the public comment period. Alternative E is similar to alternative B in most elements, but with a reduced emphasis on developed recreation and trail maintenance and more clarity of direction for watersheds, forest access, and land acquisitions. This alternative recommends fewer acres for wilderness designation than alternatives B and D.

Alternative E proposes the same amount of thinning and prescribed fire occurring across the landscape as Alternative B. Prescribed fire and wildfires managed for resource objectives would range from an about 10,600 to 25,300 acres per year on average. Thinning treatments would range from about 750 to 6,500 acres per year on average.

Response to smoke emissions in Alternative E is the same as that described in Alternative B.

Table 2 displays the range of proposed treatment activities by alternative.

Table 2: *Proposed Average Annual Treatment Activity*

	Alt A	Alt B/E low	Alt B/E high	Alt C low	Alt C high	Alt D low	Alt D high
Rx Fire	7,835	10,600	25,300	15,500	22,800	10,600	18,800
Rx Thin	1,027	750	6,500	750	4,000	750	4,000
Totals	8,862	11,350	31,800	16,250	26,800	11,350	22,800

Assumptions

Air quality is not expected to be a primary driver in selecting one alternative over another, as predicted impacts between alternatives are not dramatically different. The reasons large differences do not exist include:

- Smoke is a by-product of restoring fire adapted ecosystems. Fire is a necessary part of the equation, and therefore air quality impacts are part of all alternatives.
- All alternatives are expected to achieve the desired conditions for air quality in the proposed Plan.
- During windows of opportunity, whenever fire weather and fire effects are favorable, fire managers strive to treat as many acres with wildland fire as possible, yet still remain within **legal, climatological, social,** and **logistical** limits. In other words, the number of acres treated with wildland fire per year, under all alternatives, is likely to be the same, due to limitations imposed by these constraints. This is true under the current Plan, and expected to continue under all alternatives to the revised Plan.

- **Legal** limits to smoke emissions from prescribed fires are imposed by Federal and State Law. Therefore, there is an upper limit to the number of acres that can be treated with wildland fire imposed by regulation. Wildfire emissions, including those from unplanned ignitions that are being used to meet resource objectives, are not regulated by Law. However, fire managers are guided to include smoke management objectives on all fires. Strategy and tactics are greatly influenced by smoke sensitive receptors.

- Impacts of smoke from planned and unplanned ignitions on the Prescott NF, as well as on other federal and state lands, are cumulative. Therefore wildland fire activities on other agency lands may further limit the ability to utilize wildland fire on the Forest.

- **Climatological** limits are set by weather and fuel moisture, which profoundly affect fire behavior and fire effects. As weather varies from year to year so does the risk of high severity fires and the ability to use planned and unplanned ignitions to achieve resource objectives. The number of days of opportunity varies widely from year to year, creating huge fluctuations in the number of acres treated with wildland fire. Running averages over many years are needed in order to observe trends in the use of wildland fire or to observe undesirable fire effects.

- Meteorological conditions also limit how much smoke the airshed can absorb at any point in time without violating NAAQS, or visibility thresholds.

- Public tolerance for smoke, though not law, regulation, or policy, effectively sets the **social** limit to the number of acres treated with wildland fire. Community public relations and education coupled with pre-burn notification greatly improve public acceptance of fire management programs. The general public will tolerate several days in a row, and several weeks a year, but even the most supportive and educated have tolerance limits. In order to maintain public support for the use of wildland fire, land managers must be responsive to the public's tolerance thresholds.

- Public acceptance of smoke varies greatly from year to year. Acceptance of smoke from planned and unplanned ignitions is high following seasons with high profile, high severity events, and during extremely dry years when the threat of large, high severity incidents is elevated. Conversely, acceptance wanes during wetter years when the threat of uncharacteristic fires is low. This is unfortunate because, climatology in milder years is the most favorable for achieving desired fire effects, especially in areas highly departed from reference conditions.

- **Logistical** limits are also set by the capacity of firefighting resources available. Capacity varies from year to year due to congressional funding, or resources absorbed by other wildfire activity in the region, or nationally.

This analysis uses the running averages of acres treated by wildland fire from the objectives for each alternative as a fixed number per year in order to make broad comparisons between

alternatives. In reality, the climatological, social, and logistical limits discussed above, create wide fluctuations in the number of acres treated each year.

Fuel model, fuel loading and fuel moisture are highly variable over time and distance. For making broad comparisons between the alternatives of "least", "more", and "most" air quality impacts, these inputs are greatly simplified. For site-specific projects, fuel loadings are more precisely estimated, and emissions are predicted in accordance with Arizona Statutes, and ADEQ regulations.

This analysis does not attempt or pretend to predict the actual total emissions that would be produced under each alternative. Rather it aims to present a rationale for which alternatives are likely to produce more or less emissions. It assumes that, over time, there is some degree of correlation between total emission production, and total air quality impacts; while impacts are measured as the concentration of emissions, not the total amount of emissions, over the course of ten, twenty, forty or eighty years, the alternative that produces the most *emissions* is likely to have the most air quality consequences. Though meteorological conditions vary immensely by time of day, and from one weather system to the next, over the course of years these varying conditions should have an averaging effect over time, allowing a correlation between total emissions and total impacts.

Methodology and Analysis Process

Comparison of air quality effects was analyzed using outputs from the Vegetation Dynamics Development Tool (VDDT).

VDDT is a Windows-based computer tool which provides a modeling framework for examining the role of various disturbance agents and management actions in vegetation change. The interaction of human activity, fires, insects, pathogens, growth and competition is complex, and the combined effects are difficult to predict over long periods. The development tool allows for testing of the sensitivity of the ecosystem to a multitude of activities and agents of disturbance, to compare alternatives. With the tool a vegetation type is assigned various states, some of which are seral states found within the historic range of variability, and others that are uncharacteristic states not present in the historic range of variability. Inputs to the model are agents of disturbance, such as number of acres mechanically treated to restore stand structure, or acres that are burned by fire under low to moderate fire weather conditions; outputs are the transition of the vegetation, by percent, from one state to another. For example, a thinning or prescribed fire input would move a percentage of dense states to more open states. Each vegetation type is described by its own set of states and transitions. For a full discussion of the development, calibrations, and assumptions used in the VDDT models for the Prescott NF, as well as all outputs from the model, refer to the Vegetation and Fire Ecology Specialist Report (USFS 2011).

VDDT models for ponderosa pine-gambel oak, ponderosa-pine evergreen oak, piñon-juniper evergreen shrubland, and juniper grassland were developed by the Forest Service at the Regional level to be used specifically to compare alternatives for Forest Land Management Plans in Region 3. The development process for these models is documented at

http://fsweb.r3.fs.fed.us/eap/nfma//vddt/preside/index.shtml. Each model provides a base comparison of the relative progress Plan alternatives are predicted to make toward desired conditions; outputs are then supplemented by other extra-model information. VDDT models for interior chaparral, semi-desert grassland, and Great Basin grassland were developed by the Forest Service at the Forest level and reviewed at the regional level prior to use.

Each state within a VDDT model is classified as either "open" or "closed" based on the amount of expected vegetation canopy cover. Open states are defined as 30% or less canopy cover and closed states are defined as greater than 30% canopy cover. The piñon-juniper models recognize three open states, the pine-evergreen oak model recognizes two open states and the pine-gambel oak model recognizes six open states. The grassland models recognize one or two open states.

The percent of open states achieved among the PNVTs over time for each alternative is the indicator used to compare air quality impacts across alternatives. Higher proportions of open state conditions influence future fire behavior and indicate reduced particulate emissions over the long-term.

Environmental Consequences

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions) there can be no *direct* effects. However, there may be implications, or longer term environmental consequences, related to management of the Prescott NF under this programmatic framework.

Transient impacts to air quality from wildland fire are present in all alternatives. Most of the Prescott NF is occupied by fire adapted vegetation types (USFS 2009b), and smoke from fires, regardless of ignition source or combustion stage, is inevitable.

All alternatives are expected to achieve the Prescott NF desired conditions for air quality stated on page 9 of this report.

For planned ignitions, the Smoke Management Group, housed at ADEQ, greatly facilitates the Forest's ability to implement the Arizona SIP, and adhere to Federal and State regulations. This condition is true for all alternatives.

Smoke from unplanned ignitions also contributes to air quality impacts. Emissions from wildfires are considered to be natural events, and are excluded from determinations of exceedances and (NAAQS) violations. On most wildfires, however, fire managers can greatly influence the emission production by suppressing fires when small, checking or redirecting the growth of the fire, or through emission reduction techniques, such as performing burn-out operations when ventilation conditions are optimal, or limiting acreage burned when ventilation is poor. Other wildfires burn with rates of spread and intensity levels that are largely outside the control of fire managers; in these cases a change in weather or fuel conditions is usually necessary before

firefighters can contain or control the incident. These wildfires burn outside the historic range of variability, outside of proposed desired conditions for the vegetation type, and produce large quantities and concentrations of emissions. This condition is true for all alternatives.

Some comparison in air quality can be made between alternatives by looking at the condition of the vegetation through time and its effects on future fire behavior and particulate emissions. Vegetation management activities that involve thinning and removal of trees and shrubs to restore structure and composition have indirect beneficial effects on air quality because they alter future fire behavior. Forest and woodlands with higher proportions of open states, are more likely to exhibit surface fire behavior, even under elevated fire weather conditions. Where closed states are mechanically thinned, the crown bulk density is lower, and gaps and interspaces in the canopy inhibit the spread of active crown fire from group to group (Friederici 2005, Rothermel 1991, Scott and Reinhardt 2001). Less biomass is consumed during a surface fire, because primarily only litter, debris, and living herbs on forest floor are consumed, but not the crown fuels of the trees and shrubs.

The amount of tree and shrub thinning and prescribed fire proposed under each alternative, as modelled in VDDT, influences the attainment of open states, which in turn influences the relative amount of emissions from subsequent planned and unplanned ignitions.

In other words:

Higher percentage of stands in open states = more surface fire = reduced particulate emissions

Figure 5 shows the percent of open states achieved across PNVTs for each alternative for the current, 10-year, 20-year, 40-year, and 80-year time intervals. **The proposed treatment activities result in observable changes in open state proportions for the grassland and ponderosa pine PNVTs, but not for the piñon-juniper communities.** Chaparral vegetation was excluded from this analysis due to the closed-canopy character of this vegetation type. See the Vegetation and Fire Ecology Specialist Report (USFS 2012) for additional discussion on chaparral.

The alternative with the least predicted air quality consequences is Alternative C: Vegetation and Wildlife Emphasis. Focused application of thinning and prescribed fire to move vegetation towards desired conditions increases the percentage of open states in the grassland and ponderosa pine dominated communities. Future fire behavior is expected to produce the lowest particulate emissions among the alternatives.

The second best alternative from the air quality perspective is shared equally between Alternative B: Proposed Revised Plan and Alternative D: Dispersed Recreation Emphasis. These alternatives have fewer proposed thinning and prescribed fire treatments than Alternative C and as a result less open state conditions are created over time. Compared to Alternative A, these alternatives show a measurable increase in open state proportions for the ponderosa pine-gambel oak and semi-desert grasslands. Future fire behavior is expected to produce particulate emissions that are more than Alternative C and less than Alternative A.

The alternative with the greatest predicted air quality consequences is Alternative A: 1987 Forest Plan Direction. This alternative proposes the least amount of thinning and prescribed fire to move vegetation towards desired conditions. The estimated outcome is higher proportions of closed states and a lower liklihood of future surface fire behavior and associated reduced particulate emissions.

Figure 5. Percentage of Open State Conditions Achieved by PNVT by Alternative

Semi-desert Grass

Open States = B Desired Amount = 80%

	Percentage of Open States Over Time		
Years	Alt A	Alt B/E,D	Alt C
0	20	20	20
10	23	30-44	**44-49**
20	26	41-64	**64-70**
40	33	57-82	**82-86**
80	35	61-84	**84-86**

Great Basin Grass

Open States = B,C Desired Amount = 93%

	Percentage of Open States Over Time		
Years	Alt A	Alt B/E,D	Alt C
0	80	80	80
10	86	86-86	**86-86**
20	87	88-88	**88-89**
40	90	90-91	**91-93**
80	93	94-95	**93-95**

Juniper/Piñon Grass

Open States = B,C,D Desired Amount = 75%

	Percentage of Open States Over Time		
Years	Alt A	Alt B/E,D	Alt C
0	37	37	37
10	43	42-43	42-43
20	47	46-47	46-47
40	53	53-54	53-54
80	60	60-60	60-60

P-J Shrubland

Open States = B,C,D Desired Amount = 95%

	Percentage of Open States Over Time		
Years	Alt A	Alt B/E	Alt C/D
0	24	24	24
10	33	32-33	33-33
20	38	38-38	38-39
40	45	46-46	46-46
80	50	51-52	51-51

Pine-Evergreen Oak

Open States = C,D Desired Amount = 84%

	Percentage of Open States Over Time		
Years	Alt A	Alt B/E,D	Alt C
0	3	3	3
10	24	22-27	**22-29**
20	30	28-34	**28-35**
40	34	29-35	**30-36**
80	32	29-34	**28-34**

Pine-Gambel Oak

Open States = B,C,D,E,J,K Desired Amount = 83%

	Percentage of Open States Over Time		
Years	Alt A	Alt B/E,D	Alt C
0	3	3	3
10	17	18-22	**19-25**
20	23	24-29	**24-32**
40	28	30-34	**30-37**
80	31	32-36	**33-37**

Cumulative Environmental Consequences

Examining cumulative effects from smoke on air quality differs from the evaluation of cumulative effects for many other resources; this is due to the transient nature of air quality impacts from smoke. It is a relatively simple exercise to estimate the total tons per acres of emissions from planned ignitions on the Prescott NF, and other land management agencies, but there is no calculation that correlates total annual emissions to total concentrations of emissions. Again, impacts are measured as concentrations of emissions, whether it's in $\mu g/m^3$ for NAAQS, or in deciviews measuring visibility in Class I Areas. Cumulative effects are not the total emissions produced in a day or a year, but rather the concentration of all fire emissions in a given airshed at a given time. For NAAQS these concentrations have a varying time weighted period depending on the pollutant. For PM_{10} and $PM_{2.5}$, they are measured as a 24 hour average, and as an annual arithmetic mean.

Cumulative effects from planned and unplanned ignitions that are not being actively suppressed on Federal, State, and Tribal lands, are largely mitigated through implementation of the Enhanced Smoke Management Program, in the Arizona SIP, by the previously mentioned Smoke Management Group. When the Federal land managers actively began prescribed fire programs in the 1970s, they became rapidly aware that smoke does not respond to artificial boundaries or delineations, and that a pro-active program for the coordination of prescribed fires would be vital to obtain and continue support of prescribed fire programs by ADEQ and the public. An interagency Smoke Management Group was developed in partnership with the State, and housed in the ADEQ offices in Phoenix. The personnel in the group are funded largely by the Federal agencies, demonstrating the initiative of the agencies to, in some degree, self-regulate emissions production from prescribed fires, across Federal and State boundaries.

This group assists Arizona land managers in not exceeding NAAQS or visibility thresholds through the following services:

- Serves as a central collection point for all prescribed fire requests from the numerous Federal, State, and Tribal land managers who are all competing to produce smoke that will impact the same airsheds during limited windows of opportunity.
- Evaluates potential emissions from individual and multiple, and determines how meteorological forecasts will affect smoke concentrations both during the burn, and during diurnal settling. The Group considers cross-boundary impacts; and weighs burning decisions against possible health, visibility, and nuisance effects.
- Assists in coordinating activities within and between agencies when potential emissions would likely exceed desired conditions.
- Makes recommendations on the approval or disapproval of each prescriebd fire request to ADEQ officials.
- Tracks the use of Best Management Practices and Emission Reduction Techniques used by land managers, to document efforts by land managers to minimize impacts to Air Quality. This information is used promote support from both ADEQ and the public.

- Monitors data gathered from the IMPROVE network to assess visibility impacts in Class I areas, and track progress towards Arizona SIP goals.

While emissions from wildfires are not regulated, Federal, State, and Tribal land managers understand their responsibility to balance the ecological benefits of wildfires with the social impacts of the smoke they produce. The Smoke Management Group also assists land managers in this area through:

- Limiting prescribed fire approvals during periods when wildfires are already impacting an airshed.
- Making recommendations on the timing, or assisting in the coordination between units, of tactical operations such as burn outs, that will produce large amounts of emissions, so that they are done, when possible, when ventilation conditions are most favorable, or spread out over several burning periods to reduce total emissions when ventilation is not as good.
- Assisting land managers in determining the strategy to take on new wildfires. There may be enough fires burning that suppression on a new start is recommended to reduce cumulative smoke impacts even though all other fire effects would be desirable, and move the fire area towards desired conditions as stated in the Land Management Plan.
- Acting as a sounding board for public complaints. In keeping tabs on the type and number of complaints, the Group is able to provide land managers feedback from beyond their local publics on the state of public smoke tolerance. This is vital in maintaining general public support of allowing wildfires to perform their natural role in the ecosystem under the right circumstances in future windows of opportunity.

Through the services of the Smoke Management Group, cumulative effects from wildland fire that are within the control of Federal and State Land Managers, are thus managed to keep air quality across Arizona within desired conditions, including not exceeding NAAQS, protecting visibility in Class I Areas, and additionally promoting general public support of wildland fire management programs.

Unavoidable Adverse Impacts, Irreversible and Irretrievable Commitment of Resources

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Before any ground-disturbing actions take place, they must be authorized in a subsequent site-specific environmental analysis.

For planned ignitions this includes both National Environmental Policy Act analysis, and a prescribed fire burn plan signed by the authorizing line officer. For unplanned ignitions, the analysis, objectives, and courses of action selected for an incident are supported, documented,

and signed in the Wildfire Decision Support System (WFDSS). Because the land management plan does not authorize or mandate any site-specific project or activity, none of the alternatives cause unavoidable adverse impacts, or cause an irreversible or irretrievable commitment of resources.

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