Santa Fe Municipal Watershed
Pecos Wilderness Prescribed
Burn Project—Final
Environmental Assessment

Santa Fe National Forest

Santa Fe County, New Mexico
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CHAPTER 1—PURPOSE AND NEED FOR ACTION

Introduction

The Santa Fe Municipal Watershed Pecos Wilderness Prescribed Burn Project (the Project) is located in the Santa Fe National Forest (SFNF) east of the City of Santa Fe (the City), in Santa Fe County, New Mexico. The analysis area for the project encompasses approximately 8,534 acres of the City’s municipal watershed (the Watershed). Specifically, the project area is located within portions of Sections 4–9, 17–20, 29, and 30, Township 17 North, Range 11 East; and Sections 24 and 25, Township 17 North, Range 10 East, New Mexico Principal Baseline and Meridian (NMPB&M). Portions of the project area also occur within unplatted areas of the Pecos Wilderness (the Wilderness) (Figure 1).

The overly dense mid-elevation Ponderosa Pine and mixed conifer forests of the Watershed were prioritized for restoration and crown fire hazard reduction due to the importance of the Watershed to the municipal water supply of the City of Santa Fe. A crown fire in the Watershed would overload the City's water treatment plant with ash, sediment, and debris, and potentially threaten two dams and reservoirs on the Santa Fe River used for water storage.

The Watershed is, in total, approximately 17,384 acres in size. The City, in cooperation with the Santa Fe National Forest, developed an Environmental Impact Statement (EIS) in 2001 for vegetation management within approximately 7,270 acres of the lower portions of the Watershed. The 2001 EIS did not include vegetation treatment for the mid-elevation portion of the Watershed located within the Wilderness; potential treatments within the approximately 6,520-acre Wilderness portion of the Watershed are the objective of the current project.

Prior to and throughout the 1800s, heavy livestock grazing, homesteading, and logging occurred in the Watershed. Timber was cut for a multitude of uses including firewood, railroad ties, and construction materials. The Watershed was also used for recreational activities such as swimming, fishing, and camping. By the 1920s, the lower slopes were substantially depleted of trees and ground vegetation. Soil erosion was severe, and the water had become polluted. In 1930, the City issued an ordinance prohibiting bathing, camping, fishing, picnicking, and grazing in the area. In 1932, the Watershed was closed by the Secretary of Agriculture to public access as a means of further protecting the water supply. Throughout the 1900s, the U.S. Forest Service (USFS) had a policy of aggressively suppressing all wildfires. The combination of intensive historic land uses followed by fire suppression resulted in eliminating the beneficial role of low-intensity surface fires in the analysis area.

This project was developed in part from recommendations made in the Santa Fe Municipal Watershed Plan, 2010–2029. The Plan was developed in collaboration with the Espanola Ranger District of the SFNF, the Santa Fe Watershed Association, the City of Santa Fe Water Division, the City of Santa Fe Fire Department, and the Nature Conservancy. It provides a framework and recommendations for long-term management, public outreach, and funding for the Watershed activities.

Purpose and Need for Action

The City relies on the Watershed for approximately 40 percent of its water supply. Although considerable work has been ongoing in the non-Wilderness portions of the Watershed to protect the
Figure 1. Project overview.
water supply from the adverse effects of wildfires, concerns remain that a wildfire originating above McClure Reservoir in the Wilderness portion of the Watershed could have catastrophic impacts on the City’s water supply. Consequently, the purpose of the project is as follows:

1. Reduce the likelihood of catastrophic fire in the mid-elevation region of the Watershed above McClure Reservoir and the potential for adverse effects to the City’s municipal reservoirs and water treatment plant.
2. Maintain fire severity to naturally occurring levels in order to satisfy the Wilderness goal of keeping ecological processes unaltered from their natural state.

**Proposed Action**

The USFS proposes to perform prescribed burns of between 200 and 2,100 acres at one time, in Ponderosa Pine (*Pinus ponderosa*) and mixed conifer stands within an approximately 2,900-acre, mid-elevation (8,500–10,000 feet above mean sea level) proposed treatment area (Figure 2 in Appendix A). The prescribed burn would occur at seasonally advantageous times and would be ignited aerially under an approved burn plan and under favorable environmental conditions. Following initial prescribed burn treatment, fuel levels in treated areas would be maintained using periodic prescribed burns, also using aerial ignitions.

The Proposed Action would use prescribed burns in stands that historically burned with low- and/or mixed-severity fire regimes and would not include prescribed burns in the 3,620-acre, higher-elevation spruce-fir stands of the analysis area because these stands historically burned at higher severities, demonstrated by the recent Pacheco Fire (2011) and Jaroso Fire (2013).

Because of the limited access to this portion of the watershed, which has steep, rocky terrain within the burn unit, the primary ignition method would be aerial (helicopter) using Delayed Aerial Ignition Devices (DAIDs). The proposal would also be supported by hand ignition near the burn unit boundaries as necessary and where worker safety allows. Fuel and weather conditions would be used to conduct burning of the unit using natural barriers and without constructed firelines. This is accomplished by using the changes in topography (primarily aspect) and associated changes in fuel type that are found along the ridges that make up the burn unit boundary.

Initial burns would take up to 10 years to complete depending on the available burn windows. During some years environmental conditions would be allow for burning more than others. The treatment area would most likely be burned early in the calendar year when snow patches are still present on the ground, but could occur in other seasons if conditions allow. For example, if monsoon rains and other factors provide favorable conditions to achieve burn objectives.

Maintenance burns would occur every 5-10 years with a rotational treatment, meaning that the area that was treated last would be treated first on the next burn. The maintenance treatments would have lesser fuel loading than that of initial burns, and more acreage could be treated at one time, under the right conditions.

Prior to any ignitions, a burn plan must be approved. This burn plan includes several emission-reduction techniques to reduce smoke impacts. These include burn fuel concentrations, isolate fuels, high moisture in large fuels, moist litter/duff, burning before precipitation, burning before large fuels cure, burning before green-up, backing fire, aerial/mass ignition, and high moisture non-target fuels. These and other mitigations would keep smoke impacts to a minimum (see Chapter 2 for more detail about mitigation measures).
**Forest Plan Direction**

This assessment is tiered to the EIS and Record of Decision for the SFNF Plan (Forest Plan), adopted by the SFNF in 1987 and amended in 2010 (USFS 2010).

According to the Forest Plan, the analysis area is located in Management Area H and O. Management Area H, the Wilderness, is 292,329 acres in size, and Management Area O, the Watershed, is approximately 17,500 acres in size, of which approximately 6,495 acres (H/O) are located in the Wilderness (Figure 3). The management emphasis for Area H is to preserve Wilderness character and values, while management direction for Area O is to maintain quality water production.

**Wilderness Requirements**

The National Wilderness Preservation System was created by an act of Congress (Public Law 88-577) on September 3, 1964. The Wilderness Act defines wilderness as an area “where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain” (Sec. 2(c.)). An area of wilderness is further defined as “an area of undeveloped Federal land retaining its primeval character...which is protected and managed so as to preserve its natural conditions...” (Sec. 2(c.)).

The Wilderness Act prohibited uses, such as temporary roads, motorized equipment or motorboats, landing of aircraft, other forms of mechanical transport. It also does not allow structures, or installations within wilderness areas (Sec. 4(c)). An exception for prohibited uses is given in Sec. 4(c) of the Wilderness Act, which states “…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act...”

Approximately 6,520 acres of the analysis area were added to the Wilderness in 1980 by the New Mexico Wilderness Act of 1980 (Public Law 96-550). Therefore, the project is subject to the Wilderness Act of 1964 (PL 88-577), regulations for the Wilderness Act found in 36 CFR 293, and USFS wilderness management guidelines found in Forest Service Manual (FSM) 2320, which require that wilderness values are maintained during project implementation.

In order to determine if an action meets the minimum requirement of the Wilderness Act, as well as Forest Service regulation and policy for management of wilderness, a minimum requirement decision guide (MRDG) was used (see Appendix B for draft). The MRDG provides a process similar to the environmental review process to identify, analyze and select management actions that are the minimum necessary for wilderness administration. It applies this direction from the Act and incorporates a two-step process.

- Step 1 determines whether administrative action is necessary. If action is found to be necessary, then
- Step 2 provides guidance for determining the minimum activity. Step 2 has been referred to as determining the minimum tool buy could include any type of activity, method, or equipment.

Applicable actions include, but are not limited to, scientific monitoring, research, recreational developments (trails, bridges, signs, etc.), and activities related to special provisions mandated by the Wilderness Act or subsequent legislation (such as grazing, exercising mineral rights, access to inholdings, maintenance or water developments, and commercial services).
As noted in the Overview of the Minimum Requirement Decision Guide (Appendix B):

The National Wilderness Preservation System was established, in part, to designate lands as wilderness to guard against a “growing mechanization” and to provide for areas to be managed “in contrast” to other lands. The Wilderness Act contains no provision that mandates use of ‘quicker, cheaper, and easier’ as criteria for authorizing any of the prohibited uses. The only criteria is to determine that it is the minimum necessary requirement. Agency policy further defines or adds to this decision criteria. Habits that make us think that motorized equipment is the best choice can be changed and the MRDG can help if it is used as an analysis tool and not a justification statement or approval form.

The MRDG drafted for this project is attached as Appendix B. The justification for this project in this context is provided there:

“Special provisions” in section (4.d.1) of the 1964 Wilderness Act (PL 88-577) state that the Secretary of the USDA is to decide whether such measures may be taken to control fire, diseases, and insects. According to FSM 2324.21, prescribed burns may occur within designated wilderness if at least one of the two wilderness fire management objectives is met along with all four of the conditions specified in FSM 2324.22 (6).

The objectives are to (1) “permit lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness,” and (2) “reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness”.

The conditions for this proposal are

(a) the use of prescribed fire or other fuel treatment measures outside of wilderness is not sufficient to achieve fire management objectives within wilderness: In this project, the Proposed Action would meet this conditions because fuel treatments occurring in the lower Watershed, while limiting the chances of a wildfire reaching the treatment area from the south, have not adequately reduced the risk of a wildfire starting in the proposed treatment area and spreading to the west, north, and east. In addition, the post-fire effects from a high severity fire would impact the Santa Fe Municipal watershed as a water supply, and so management action inside the wilderness is necessary because actions intended to reduce the risk to the water supply have been conducted outside the wilderness already.

(b) an interdisciplinary team of resource specialists has evaluated and recommended the proposed use of prescribed fire. The proposed action meets requirement (b) because the analysis represented in this document and the MRDG (Appendix B) has been developed by an interdisciplinary team that considered several aspects of the project.

(c) the interested public has been involved appropriately in the decision. The public has been appropriately involved with the Project through the scoping and public comment process in compliance with 36 CFR 215.

(d) lightning-caused fires cannot be allowed to burn because they will pose serious threats to life and/or property within wilderness or to life, property, or natural resources outside of wilderness.

The natural ecological role of lightning-caused fires (Objective 1) has been limited in the proposed treatment area because of the danger of a catastrophic fire resulting from such an ignition. Because of the existing high vegetation densities in the proposed treatment area and the danger of lightning-caused fire escalating to a catastrophic fire, Alternative B and USFS fire suppression practices in the analysis area are in compliance with FSM 2324.22.6 (d), the fourth condition described above for using prescribed fire in wilderness.
In addition to these specific requirements, the Proposed Action would meet the second wilderness fire management objective because it would reduce the chances of wildfire in or escaping from the proposed treatment area.

FSM 2324.22 (7) states that prescribed fire can’t be used in wilderness to enhance other non-wilderness resource values, such as wildlife, maintenance of vegetation type, or forage production; however, additional effects to non-wilderness resources may result from a decision to use prescribed fire in wilderness.

In other Wilderness areas, watershed condition would be a non-wilderness resource and would not be a factor on its own for supporting the need for prescribed burn. However, the provision of the 1980 Wilderness Act creating this portion of the Pecos Wilderness Area provides for actions necessary for the management of the municipal watershed.

Comparison of alternative ways to accomplish this is located in Chapter 3, Wilderness (page 3737). The MRDG is located in Appendix B of this environmental assessment. It provides both rationale for the need for the project, as well as comparison of alternatives, including those considered but not analyzed in detail. Only the Regional Forester has the authority to make the minimum requirement determination for a prescribed burn in wilderness. Therefore, the MRDG will be signed in concert with the decision for this proposed action.

**Decision to make**

Based on this analysis, comments from the public, and contributions from the interdisciplinary team, the responsible official will decide:

- Which alternative best meets the purpose and need for this project.
- Whether the selected alternative would likely result in significant environmental impacts to the quality of the human environment and whether preparation of either an EIS or a Finding of No Significant Impact (FONSI) is warranted.
- Whether the decision meets all applicable Federal, State, and local laws and policies, including consistency with the Forest Plan.
Figure 2. Analysis area.
Figure 3. USFS Management Areas related to the analysis and proposed treatment areas.
Public Involvement

Public involvement is a vital component of the National Environmental Policy Act (NEPA), and Forest Service regulation and policy. In addition to facilitating the dissemination of information, effective public involvement vests the public in the decision-making process and provides a means for full environmental disclosure.

Scoping is a public process designed to determine the scope of issues and develop alternatives to be addressed in a NEPA document. Scoping helps ensure that potential issues are identified early and that they are properly studied, that issues of no concern do not consume time and effort, and that the Proposed Action and alternatives are balanced, and able to be implemented.

The scoping process for the proposed Santa Fe Municipal Watershed Pecos Wilderness Prescribed Burn Project Environmental Assessment (EA) began on September 1, 2011, when the project was listed in the SFNF Espanola Ranger District Schedule of Proposed Actions (SOPA), which notified the public of USFS’s intent to use prescribed fires in the Wilderness portion of the Watershed. In order to inform interested parties of the proposal, the location of scoping meetings, and the opportunity to comment, a directed mailing was sent to over 100 interested parties appearing on the distribution list.

Several newspaper and radio announcements were made to notify the public of the project following issuance of a public scoping news release (PR 87), to announce the public scoping meeting, to request public comments, and to provide contact information. The news release was also posted on the SFNF website.

A public scoping meeting was held at the Santa Fe Public Library in Santa Fe, New Mexico, on September 20, 2011. This meeting provided an opportunity for the public to receive information, ask questions, and provide input. The format of the meeting was an informal “open house”. Handouts describing the project were distributed, and comment forms were provided for attendees that wished to provide comments at the time of the meeting. Approximately 20 people attended the scoping meeting, including members of the public, USFS, and City of Santa Fe personnel. Ten members of the public provided their contact information on the sign-in sheet that was made available at the meeting. A total of 33 verbal comments were recorded during the public meeting, and 19 written comments from 17 individuals were received during the 30-day scoping period.

Following project scoping, a Comment Report was developed and used by the interdisciplinary team (IDT) to determine potential issues with and alternatives to the Project (see following section of the EA). Comments were considered during refinement of the proposed action, then developed and made available to the public for review and comment on September 7, 2012.

Following provisions of 36 CFR 215, a Notice of Proposed Action was issued on September 7, 2012 (PR 151) to start a 30-day public notice and comment period. During this period a second public meeting was held on September 20, 2012. At the meeting, informational presentations were given and the public was invited to ask questions about the project and provide comments.

Comments were considered during the subsequent analysis, which has occurred from the public notice and comment period of 2012.
CHAPTER 2—ISSUES AND ALTERNATIVES

This section of the environmental assessment:

- Describes the potential issues for the Project that arose through the interdisciplinary process.
- Shows how the SFNF used these issues to modify the Proposed Action and develop a third alternative.
- Provides descriptions of the three alternatives to be analyzed in detail in Chapter 3 and three alternatives that were considered, but not analyzed in detail.

Development of Issues and Alternatives

The analysis team separated potential issues raised during scoping into two categories: substantive and non-substantive. Substantive issues were defined as those potential impacts that may be a result of implementing the Proposed Action. Non-substantive issues were identified as those: 1) outside the scope of the Proposed Action; 2) already decided by law, regulation, the Forest Plan, or other higher-level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence.

The CEQ NEPA regulations, in Sec. 1501.7, require this distinction in order to “…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…”

A list of non-substantive issues and reasons regarding their categorization as non-substantive may be found in the project record [PR 132].

The analysis team identified three issues raised during the scoping process:

1. Without pre-treatment, a prescribed fire in the project area would have a relatively smaller window of opportunity for burning without making the prescribed burn more difficult to control because of the high tree densities that are present. Pretreatment provides fuel conditions (such as dry slash—piled or scattered) that allow burning in wet conditions.

2. Because the project area is located within the Pecos Wilderness, wilderness character must be considered within the context of the 1964 Wilderness Act as well as the specific Wilderness Act that designated this area as wilderness (New Mexico Wilderness Act of 1980). Actions proposed within the wilderness must be compliant with law, regulation policy, specifically, be justified as the “minimum requirements” provisions of the Wilderness Act. 1

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1 As noted in Chapter 1, the Wilderness Act of 1964 mandates that any proposals for actions in a wilderness area meet a “minimum requirement” threshold. Section 4(c) of the Wilderness Act of 1964: “Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.” The Watershed, including the current project area that is now part of the Wilderness, was closed to the public in 1932. The project area, along with a 3,616-acre area to the north and 48,500 acres in other areas of the SFNF and Carson National Forest, were added to the Wilderness system in 1980 by the New Mexico Wilderness Act, which included a provision that nothing in the Act interfere with management of the Watershed.
3. Prescribed burning in the project area would produce smoke that could have adverse impacts on the air quality of the surrounding communities.

**Alternatives Considered but Eliminated from Further Study**

Three alternatives were considered but eliminated from further study because they would not meet the purpose and need of the project or for safety reasons.

**Mechanical Thinning Using Chainsaws/No Prescribed Fire**

This alternative was eliminated because it does not meet the purpose and need of the project. Hand thinning in the steep and difficult terrain found in the Watershed would be impractical, would present an unacceptable level of risk to forest workers, and would not be cost effective. Additionally, downed trees and slash produced by hand thinning would be extremely difficult to remove because there are no roads in the Watershed. Leaving these fuels in the Watershed would do little to reduce the likelihood of catastrophic fire, which is the purpose of the proposed project, and would in fact increase the risk of fire.

**Non-Mechanical Thinning Using Crosscut Bow Saws/No Prescribed Fire**

This alternative was eliminated because it does not meet the purpose and need of the project for the same reasons described above for mechanical thinning. In addition, thinning with crosscut saws would be very expensive, time-consuming, and would not likely be practical at the scale needed.

**Hand-ignited Prescribed Fire**

This alternative was because it is infeasible, given that the terrain makes hand ignition creates risks to worker safety that cannot be mitigated. Because of steep, rocky terrain in the project area, escape routes and safety zones for workers are limited. Because of these safety concerns, USFS personnel would not be able to reach most of the project area, which would not meet the purpose and need.

**Alternatives Considered in Detail**

**Alternative A—No-Action**

The No-Action Alternative provides a baseline from which to compare the effects of the action alternatives. Under the No-Action Alternative, current management plans would continue to guide management of the project area. No prescribed fire would be implemented in the proposed treatment area to accomplish project goals, and the Wilderness portion of the Watershed would remain at risk for a catastrophic crown fire.

**Alternative B**

Alternative B, the Proposed Action, is described in Chapter 1, page 3.

**Alternative C**

This alternative was developed in response to the issues raised during the scoping period, including a concern with the risk of escaped prescribed fires. Although the proposed action would be designed to minimize risk of escape, an alternative that provides for vegetation pretreatment widens the burn window by creating cured, dry fuels on the ground, which allows prescribed fire to be effective in wetter conditions. These wetter conditions also reduce the risk of escape.

Prescribed fires are designed to be manageable and are subject to detailed burn plans describing where, when, how, and under what set of circumstances fires may occur. Because of the project
area’s close proximity to the City of Santa Fe and the values at risk, including the forest-urban interface, recreation, and the City’s water supply, the proposed prescriptions must be conservative to minimize the risk of escaped fire.

This alternative includes mechanical pre-treatment as a way to provide more flexibility when managing the prescribed fires, providing longer duration opportunity to burn. Mechanical pre-treatment would also allow smaller, more numerous prescribed burns to occur over a longer time period than prescribed fires without pre-treatment.

Pre-treatment (thinning with chainsaws) of the entire 2,900-acre treatment area would not be necessary to create the desired fuel conditions. Instead, thinning would occur in strategic locations in order to reinforce fire lines and help contain the prescribed burns within their designated perimeters. Most of the prescribed fire would be ignited aerially; hand ignitions would only occur in places where personnel are able to safely move along the fire perimeter.

Under Alternative C, hand thinning would precede prescribed fire, as described above, in areas where topography allows. The hand thinning would be followed by a treatment of the activity fuel before the prescribed fire. Limited access to the proposed treatment area and the steep, rocky slopes within it preclude the use of hand thinning on most of the treatment area.

Where thinning slash is light, it could be treated before the prescribed fire by lop-and-scatter. Moderate thinning slash could be treated by creating jackpots, or concentrations of fuels, that will burn during the prescribed fire. Where heavy concentrations of thinning slash exist, hand-piling and burning before the aerial prescribed fire would mitigate the potential for undesirable fire behavior.

Mechanical pre-treatment, while expanding the window of opportunity for burning, would be limited to a relatively small fraction of the prescribed fire unit. The portion of the unit where hand thinning is possible due to access and terrain occurs, coincidentally, in the vegetation type most favorable for obtaining a good outcome from burning alone.

**Resources/Issues Effects Analysis Summary**

A summary of the effects analysis for the three alternatives is presented in Table 1. A detailed analysis is presented in Chapter 3.
Table 1. Comparison of Alternatives

<table>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forest Vegetation, Fuels, and Fire Behavior</strong></td>
<td>A catastrophic crown fire would have an adverse impact on forest vegetation, fuels would be eliminated, and fire behavior would be uncontrolled.</td>
<td>Beneficial impact on forest vegetation, fuels would be reduced, and fire behavior would return to a more natural regime.</td>
<td>Fire behavior the same as for Alternative B, with the added benefit of providing for a wider range of burning opportunities.</td>
</tr>
<tr>
<td><strong>Soil and Water Resources</strong></td>
<td>Following a catastrophic crown fire, the erosion potential for soils would be high, soils would be lost, and the Santa Fe River would be subject to high levels of sedimentation.</td>
<td>Minimal impacts to soils and low risk for sedimentation in the Santa Fe River.</td>
<td>Same as Alternative B.</td>
</tr>
<tr>
<td><strong>Riparian Ecosystems and Jurisdictional Wetlands</strong></td>
<td>High risk of adverse impacts.</td>
<td>Minimal risk for impacts, no treatments would occur in riparian areas, and buffer zones between treated and riparian areas would be established.</td>
<td>Same as Alternative B.</td>
</tr>
<tr>
<td><strong>Terrestrial Habitat and Associated Wildlife</strong></td>
<td>High risk of adverse impacts.</td>
<td>Temporary reduction in habitat following treatment. Beneficial impact as increased ground cover develops.</td>
<td>Same as Alternative B.</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------</td>
<td>------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Special Status Species</td>
<td>High risk of adverse impacts.</td>
<td>No impacts from treatment. Beneficial impacts from more favorable tree densities, an increased number of snags in open areas, and development of increased groundcover.</td>
<td>Same as Alternative B.</td>
</tr>
<tr>
<td>Wilderness</td>
<td>A catastrophic fire, either originating in the Wilderness or spreading from non-Wilderness areas into the Wilderness, would have an adverse impact on the Wilderness.</td>
<td>Beneficial impact because fire conditions would return to a more natural fire regime and ecological processes would be restored. Both Alternative B and Alternative C would involve dropping materials from aircraft into the Wilderness.</td>
<td>Same as Alternative B, except longer term impacts to wilderness values because of the thinning proposed as pretreatment. In addition to aerial ignition, Alternative C would involve using mechanized equipment within the Wilderness. Mechanized equipment, dropping materials from aircraft.</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------</td>
<td>--------------------------------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Air Quality/Smoke</td>
<td>The No-Action Alternative (Alternative A) has the potential to have the most impact on air quality because a catastrophic fire would not occur under conditions specified in a burn plan. A catastrophic crown fire would have a long duration and smoke production that would have a severe adverse impact on air quality.</td>
<td>Any burning in the project area has the potential to impact air quality in surrounding communities, including the Class I Pecos Wilderness airshed adjacent to the analysis area. Mitigation measures have been developed for Alternatives B and C to address smoke reduction and to ensure that the project would be in compliance with laws, regulations, and public expectations. Prescribed fire treatments would follow an approved burn plan and would comply with New Mexico State Air Quality Standards.</td>
<td>Similar to Alternative B with slightly less smoke production and the added benefit of providing for a wider range of burning opportunities.</td>
</tr>
<tr>
<td>Economics</td>
<td>Fighting a catastrophic crown fire, removing sediment from reservoirs, and Watershed restoration would be far more expensive than both Alternatives B and C.</td>
<td>Least expensive, depending on amount of hand ignitions.</td>
<td>Similar to Alternative B, with added expense from labor-intensive mechanical pre-treatment.</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>Heritage Resources</td>
<td>High risk of adverse impacts.</td>
<td>Minimal chance of impact because heritage sites would be avoided.</td>
<td>Same as Alternative B.</td>
</tr>
<tr>
<td>Recreation and Scenery</td>
<td>Adverse impacts if a crown fire started in the Watershed and spread to surrounding areas open to recreation.</td>
<td>No impact to recreation because the Watershed is closed to the public. Moderate and temporary impacts to scenery.</td>
<td>Similar to Alternative B with long-term impacts from mechanical thinning.</td>
</tr>
<tr>
<td>Facilities</td>
<td>A catastrophic crown fire would have adverse impacts on municipal reservoirs and the water treatment plant, as well as monitoring facilities.</td>
<td>Beneficial impact because facilities would be less at risk.</td>
<td>Same as Alternative B.</td>
</tr>
</tbody>
</table>

**MITIGATION AND MONITORING**

The mitigation and monitoring measures contained in this section are common to all action alternatives unless otherwise noted. Mitigation measures are prescribed to avoid, minimize, or compensate for adverse environmental effects that may occur from project implementation. Monitoring is used to determine whether the treatments and mitigation measures were implemented as planned, effects were consistent with those predicted in the EA, and treatments were effective in moving towards desired conditions.

**Prescribed Burning and Fire Behavior Mitigations**

- Burn when fuel conditions are not conducive to fire spreading in short-needle fuel beds due to higher moisture content. This typically occurs in fall and winter. Short-needle fuel beds generally occur in mixed conifer sites having northern aspects.
- Fuel moisture content shall be within the following ranges: 1 hour = 4–15%; 10 hour = 5–50%; 100 hour = 6–50%; 1,000 hour = 7–50%; and live fuel moisture = 80–200%.
- Burn when there is an opportunity for good nighttime recoveries. Such opportunities are typified by higher relative humidity, lower temperatures, and low wind speeds.
Soil Mitigations

- Burn when soil moisture content is moderate to high. This means moisture should be felt in the soil after a few inches of digging.

Water Quality, Wildlife, and Migratory Bird Mitigations

- In order to protect riparian areas, aquatic habitat, water quality, Outstanding Natural Resource Waters, and the USFS-listed-Sensitive Water Shrew, no prescribed fires are to occur within 50 feet of the Santa Fe River.
- All prescribed fires are to occur in late winter (before April 30), thereby eliminating potential adverse impacts to migratory birds and avoiding the May–June spawning season of the Rio Grande Cutthroat Trout.

Air Quality Mitigations

- Emission-reduction techniques shall be used during prescribed burning and will be coordinated with the State of New Mexico in compliance with its Smoke Management Program. Smoke monitoring shall be performed in compliance with New Mexico Environment Department guidelines (see examples above in prescribed burn mitigation measures).
- Prescribed fires shall occur only under suitable weather conditions for wind and ventilation.
- In order to minimize potential for smoke intrusions into the City of Santa Fe, burn when westerly transport winds are predicted to last for the day after ignitions.
- Implementation must consider emission-reduction techniques to reduce smoke impacts. These include but are limited to:
  - burning in concentrations (jackpot burning) of isolate fuels,
  - burning when there are high moisture in large fuels, moist litter/duff,
  - burning before precipitation (rain or snow) events,
  - burning before large fuels cure,
  - burning before green-up,
  - burning with backing fire rather than head fires,
  - burning with aerial/mass ignition, and
  - burning with high moisture non-target fuels.

Heritage Resources Mitigations

- Impacts to the historic Elk’s Lodge Cabin site must be avoided. Avoiding any burning nearby is preferred, but if necessary, a low-intensity burn may be conducted across the site only if an archeological monitor is present.
- Any new heritage resources encountered during project implementation must be reported to the USFS Espanola District Archaeologist.
- Site-flagging and archaeological monitoring should be implemented during mechanical pre-treatment to avoid negative impacts to the heritage resources.
Outstanding Natural Resource Waters Mitigations

- A “No-Fire Streamside Management Zone Filter Strip” extending 15 m (50 feet) from each side of the Santa Fe River will be maintained during all prescribed fires to prevent ash and sediment transport into the river, which would degrade water quality (Alternatives B and C). Handlines will be constructed for control (Alternative C only).

- In Alternative C, where feasible, control handlines are to be constructed at Spruce/Fir/mixed conifer boundaries, and at the Streamside Management Zone. Where constructed these control lines must be water-barred using appropriate fire line construction/rehab standards.
CHAPTER 3—ENVIRONMENTAL CONSEQUENCES

This section of the environmental analysis summarizes the physical, biological, social, and economic environments of the affected project area and the potential changes to those environments due to implementation of the alternatives. It also presents the scientific and analytical basis for the comparison of alternatives summarized in the chart above.

Social and Economics

The purpose of this proposed action is to avoid the impacts to the City of Santa Fe’s water supply that would result from a large wildfire occurring in the Santa Fe Watershed. The following discussion describes what those social and economic impacts are expected to be.

Affected Environment

Economic data used in this section were obtained from the 2011 Census data and is based on the demographic information of the City and County of Santa Fe.

In 2011, Santa Fe had a median household income of $52,610 annually. This compares with the national average of $50,502 and New Mexico's average of $44,631. The average annual rate of change for per capita personal income was −3.1%, just slightly more than the national average of −3.7%. Among the 34,687 civilian workers aged 16 and over in Santa Fe, 66% are private wage and salary workers, 20.7% are government workers, and 13.1% are self-employed. By income, the largest industry in Santa Fe is educational services, health care, and social assistance (20.2%), followed by professional services (16.6%); arts, entertainment, and accommodation (15.1%); retail (12.4%); public administration (9.7%); and construction (5.8%) (U.S. Census 2011).

Historically, Santa Fe has a low unemployment rate (between 2–5%) and is generally 1–3% lower than the state average. In December 2012, the unemployment rate for Santa Fe was 5.1%, as compared to the state unemployment rate of 6.6% and a national rate of 7.8% (U.S. Department of Labor 2013).

Facilities

The facilities in the analysis area are limited to remote weather sensors and water flow data collectors. Immediately adjacent and downstream of the analysis area there are water storage and treatment facilities, maintenance roads, and additional environmental monitoring facilities.

Water Storage and Treatment Facilities

McClure Dam and Nichols Dam impound Santa Fe River water within the Watershed. McClure Reservoir is located at an elevation of approximately 7,900 feet above mean sea level, 2.2 miles upstream of the Canyon Road Water Treatment Plant. It has a storage capacity of 3,257 acre-feet. Nichols Reservoir is located at approximately 7,500 feet above mean sea level, 0.2 miles upstream of the Canyon Road Water Treatment Plant, and has a storage capacity of 685 acre-feet. Water from McClure Reservoir is released into the Santa Fe River, and under normal operation, flow is controlled using manually operated sliding gates on the reservoir’s intake tower. Water from Nichols Reservoir is released into the Santa Fe River and/or diverted through the reservoir's intake tower into a 24-inch, concrete-lined steel pipe, which conveys the water to the Canyon Road Water Treatment Plant. Both reservoirs have emergency spillways, which allow the reservoirs to safely pass excess water to the Santa Fe River when the reservoirs are at their maximum storage capacity.
Environmental Consequences of the Alternatives

Alternative A—The No-Action Alternative

Based on average costs per acre for fire suppression and Burned Area Emergency Response (BAER)\(^2\) associated with these recent, nearby wildfires, a 10,000 to 40,000 acre wildfire impacting some portion of the Municipal Watershed above McClure Reservoir would likely incur fire suppression costs of approximately $6.4M to $25.7M and BAER rehabilitation costs of approximately $5.5 to $22.3M.

Table 2. Fire Suppression and BAER Costs of Recent Wildfires

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cerro Grande Fire(^a) (48,000 acres)</th>
<th>Pacheco Fire(^b) (10,250 acres)</th>
<th>Las Conchas Fire(^b) (156,593 acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Suppression</td>
<td>$33.5M</td>
<td>$10M</td>
<td>$40M</td>
</tr>
<tr>
<td>Average ($/acre)</td>
<td>$643</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAER Actions</td>
<td>$72M</td>
<td>$1.6M</td>
<td>$2.6M</td>
</tr>
<tr>
<td>Average ($/acre)</td>
<td></td>
<td>$558</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Fire suppression and rehabilitation costs for the Cerro Grande Fire estimated by the Western Forestry Leadership Coalition, “The True Cost of Wildfire in the Western U.S”, 2010.

\(^b\) Costs associated with the Pacheco Fire and Los Conchas Fire provided by USFS, SFNF, Sandy Hurlocker, Espanola District Ranger, in 2012 and Jon Boe, District Fire Management Officer, in 2013.

Water Supply Infrastructure Repair Costs

In the event of a catastrophic wildfire in the Watershed, impacts to the reservoirs may result that would limit the City’s ability to utilize the Santa Fe River as a critical water supply for the community. Siltation of the reservoirs and ash accumulation that would result from heavy rains following a severe fire would reduce the capacity of the reservoirs and thus reduce the City’s water supply. Most of the water supply stored in the reservoirs is captured during spring runoff and is highly dependent on year-to-year fluctuations in the snowpack.

The amount of sediment produced at the inflow to McClure Reservoir following such a catastrophic fire is dependent on the severity and duration of storm events within the first three years after the fire. Estimates of the volume of sediment range from 415 acre-feet from a 100-year event up to 11,000 acre-feet or higher for the maximum 500-year storm event for the first year following a severe wildfire. This would result in loss of more than 50 percent of the reservoir capacity. The sediment loading would not only reduce the capacity of the reservoirs, but the turbidity and suspended ash of the water would impair use of the water for an extended period until the Watershed and erosion rates decreased to near-normal levels.

\(^2\) Burned Area Emergency Response (BAER) activities include only those necessary to reduce fire damage to life and property within the first year and so do not include all rehabilitation and stabilization costs. For example, post fire flooding did extensive damage to the Nambe Reservoir, costs absorbed by the Nambe Pueblo and other agencies, and not included in the BAER cost estimates.
In order to restore capacity of the reservoirs, the City has estimated costs to dredge, haul, and dispose of 2,000 acre-feet of sediment and ash from McClure Reservoir would likely be between $80M and $240M. These costs exclude increased water treatment costs, increased water utility operating costs associated with production of water from different water sources, and impacts to the local economy from loss of tourism income.

Since expanding its sources of water to include Buckman Direct Diversion (BDD) water from the Rio Grande, the City has more flexibility in terms of being able to meet peak summertime water demand in the event that Santa Fe River Water is unavailable on a short-term basis. If Santa Fe River water quality is impacted or storage capacity is lost on a longer-term basis as a result of a catastrophic fire, it is likely the City would institute severe water demand restrictions, such as prohibiting all outdoor watering, until the reservoir(s) storage capacity can be restored and turbidity returns to normal.

In the event of a wildfire, additional traffic would be carried by Upper Canyon Road for a limited period during firefighting operations as light-duty trucks, fire engines, and other fire-suppression-related vehicles would need access to the Watershed. In the event that the City’s reservoirs filled with sediment and ash following a wildfire, the City would have to expend additional effort to dredge the reservoirs and limit further impacts from continued erosion. This work would take place over several years and would come at great expense to the City and the community, to say nothing of the loss of the water supply for an extended period of time. This work would create additional traffic on Upper Canyon Road and the Watershed service road for an extended period of time to allow for construction access to the Watershed.

It is likely that a wildfire coupled with post-fire flooding would render inoperable water quality, water quantity, and other environmental monitoring infrastructure in the Watershed. High debris flows above McClure Reservoir would destroy the stream gauge. In the case of the open channel stream gauges, increased debris flows and subsequent stream deposits of sediment and ash would necessitate stream surveys and development of new ratings/gauge recalibration. A wildfire could also damage electric measurement and telemetry instruments such that they would need to be replaced.

**Alternative B/C**

Compared to the potential cost associated with a 10,000–40,000-acre wildfire impacting some portion of the Watershed above McClure Reservoir, projected costs associated with forest treatments intended to prevent a catastrophic wildfire under both Alternative B and C would be substantially less. The total cost of the Proposed Action in the wilderness area under Alternative B would be approximately $768,000 through 2029, which is the last year considered in the 20-year management plan. This total cost assumes the USFS would conduct first-entry prescribed burns on approximately 300 acres per year for five consecutive years at a cost of $160 per acre. Thereafter, treated areas would be re-treated with prescribed burning about every five years to maintain fuel levels. Through a collection agreement, the City of Santa Fe will continue to share annual project costs with the USFS, which would be $384,000 through 2029. Excluding costs for forest treatments under Alternative B, other Watershed Investment Program expenses through 2029 would be approximately $4.3M for ongoing work, including: 1) forest treatments in the non-Wilderness portion of the Municipal Watershed, 2) education and outreach, 3) stream habitat assessment/restoration, and 4) water quantity/quality monitoring.

In contrast to the total cost of the Proposed Action in the wilderness area under Alternative B, cost estimates under Alternative C would be higher due primarily to increased labor costs resulting from
the longer time frame needed to accomplish the work and the more labor-intensive nature of the work. Under Alternative C, treatment costs would be approximately $190 per acre, resulting in a total cost of $912,000 through 2029, assuming the USFS would perform first-entry treatments on 300 acres per year for five years and then re-treat about every five years to maintain fuel levels.

**Indirect Effects from Both Alternative B and C**

There are many indirect effects that would enhance Santa Fe’s economy, but because forestry is such a small entity, employment income from these jobs is relatively small. Indirect effects include the environmental, nonmarket benefits following the proposed fuel reduction treatments. Reducing the risk of catastrophic fire in the analysis area would limit the serious damage to soil, water, air, wildlife habitat, and forest vegetation that a large crown fire could have in this area. Thus, there are many positive non-market benefits to the local public expected to result from this project, including restoration of sustainable Watershed conditions and protection of the water supply. There are positive financial benefits as well. As a result of reducing the chance of a catastrophic crown fire in the Watershed, there would be a major financial savings to public taxpayers in implementing this project compared to the costs associated with experiencing a catastrophic fire.

Another indirect effect is related to worker safety and labor-time efficiency (which is better under Alternatives B than under Alternative C) that would require more labor working in difficult terrain. Prescribed burning is substantially safer on steep slopes, and production rates are much higher than manual thinning and piling.

**Cost Estimates**

- The administrative costs of each alternative are estimated to be 15% of the total cost; this figure was not included in the analysis or the planning cost. Only treatment costs were used.
- Broadcast burn costs per acre were assumed to be higher than most other broadcast burns on the National Forest due to the higher level of complexity, sensitivity, and monitoring involved in wildland-urban interface areas, particularly when burning within untreated stands and on steep slopes.

**Cumulative Effects of Alternatives B/C**

Impacts to the service road in the Watershed and local neighborhood streets would result from implementation of any of the action alternatives combined with ongoing City, County, USFS, and private activities. This includes vehicles on the service road for security patrols, public tours, and regular maintenance. Future increases in traffic would result from immediate and also more long-term research and monitoring projects, as well as from routine management activities such as maintenance burns. The effect of increased vehicles, some of them particularly heavy trucks, during project implementation would combine with existing routine use and other increased uses to result in accelerated deterioration of these roads.

During the last 10 years, about $7 million in Federal funding has been spent on the thinning project in the lower non-wilderness portion of the watershed, resulting in more than 6,000 acres being treated from 2003–2009. Since 2012. The City of Santa Fe, with support from the New Mexico Finance Authority Water Trust Board, has spent more than $1 million in environmental monitoring infrastructure improvements, education and outreach, and forest treatments. To date, no forest treatments have been conducted in the wilderness portion of the Watershed above McClure Reservoir to address critical fuel loads which pose a risk the City’s water supply.
Beyond the costs related to mitigating damage to water utility infrastructure in the Municipal Watershed, increased turbidity following a fire would increase water treatment costs at the Canyon Road Water Treatment Plant. The increased water treatment costs would result in more chemicals being added to facilitate treatment and disinfection processes, increased residence times, higher sediment handling and disposal costs, and increased cost for equipment repair/replacement.

It is assumed that after a large wildfire, water quality would be too impaired to make use of the water source, but that within a year after a wildfire, at least some Santa Fe River water could be used for municipal supply. Even after treating about half of the normal amount of water, it is estimated that overall annual water treatment costs at the Canyon Road Water Treatment Plant would double after a large wildfire.

While not quantified here, a large wildfire in the Santa Fe Municipal Watershed could also adversely impact the local economy by decreasing tourism industry income. For example, significant smoke impacts to air quality from wildfires often causes prospective visitors to Santa Fe to either cancel their vacation plans or chose other destinations, resulting in decreased revenues to arts, entertainment, recreation, accommodations, food services, and retail businesses.

*Forest Vegetation, Fuels, and Fire Behavior*

**Affected Environment**

**Forest Vegetation**

Existing vegetation types (EVTs) present in the proposed treatment area were obtained from Landscape Fire and Resource Management Planning Tools (LANDFIRE) GIS data. The most recent dataset was used, Version 1.1, which is also called “Refresh 2008”. Fuel and vegetation characteristics in Version 1.1 account for disturbance and fuel management activities through 2007. Because no disturbances or fuel management activities have occurred in the analysis area from 2007 to present, the dataset reflects the current landscape conditions without need for further updates (Scott 2012).

There are a total of 14 EVTs in the proposed treatment area, although only eight cover more than 10 acres (Table 2). Approximately 75% of the EVTs are comprised of mixed conifer, either mesic or dry-mesic.

**Table 3. Existing Vegetation Types in the Proposed Treatment Area**

<table>
<thead>
<tr>
<th>EVT</th>
<th>Proposed Treatment Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky Mountain Aspen Forest and Woodland</td>
<td>233</td>
</tr>
<tr>
<td>Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland</td>
<td>656</td>
</tr>
<tr>
<td>Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland</td>
<td>1,432</td>
</tr>
<tr>
<td>Southern Rocky Mountain Ponderosa Pine Woodland</td>
<td>178</td>
</tr>
<tr>
<td>Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland</td>
<td>75</td>
</tr>
</tbody>
</table>
### Table 4. SWReGAP Vegetation Types in the Analysis Area but Outside the Proposed Treatment Area

<table>
<thead>
<tr>
<th>Location</th>
<th>Vegetation Type</th>
<th>Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North of Treatment Area</strong></td>
<td>Rocky Mountain Aspen Forest and Woodland</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Subalpine Montane Limber-Bristlecone Pine Woodland</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland</td>
<td>294</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland</td>
<td>1,351</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Southern Rocky Mountain Montane Subalpine Grassland</td>
<td>1,671</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>3,619</strong></td>
</tr>
<tr>
<td><strong>South of Treatment Area</strong></td>
<td>Rocky Mountain Cliff and Canyon</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Aspen Forest and Woodland</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland</td>
<td>892</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland</td>
<td>415</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Ponderosa Pine Woodland</td>
<td>573</td>
</tr>
<tr>
<td></td>
<td>Rocky Mountain Gambel Oak-Mixed Montane Shrubland</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Southern Rocky Mountain Montane Subalpine Grassland</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Open Water</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2,041</strong></td>
</tr>
</tbody>
</table>

The Southwest Regional Gap Analysis Program (SWReGAP) provides plant community and native wildlife species GIS data and modeling for use in land management planning. These data were reviewed to determine the types of vegetation present within the analysis area but outside of the...
proposed treatment area. Vegetation present north of the treatment area consists primarily of subalpine grassland and dry-mesic mixed conifer forest. South of the treatment area, the dominant vegetation is dry-mesic mixed conifer and Ponderosa Pine forest (Table 3).

The analysis area contains stands of trees primarily consisting of Ponderosa Pine, mixed conifer, and spruce-fir, and. The spruce-fir stands are concentrated in the higher-elevation portion of the Watershed north of the proposed treatment area. Within the treatment area, mixed conifer and Ponderosa pine form a complex intermingled pattern, with the pine being more prominent on the south slopes, with the shorter needle fir on the cooler slopes facing north.

**Fuels and Fire Behavior**

Geospatial fuel and vegetation data acquired from the LANDFIRE project served as the basis for the fuels and fire behavior assessment. LANDFIRE (www.landfire.gov) is a vegetation- and fuel-mapping project that provides nationally consistent and seamless geospatial data products for use in wildland fire analysis and modeling. Geospatial data layers of elevation, aspect, slope, fire behavior fuel model, canopy cover, canopy height, canopy base height, and canopy bulk density are used together to make up the “landscape” file (LCP) required by the FlamMap fire-behavior modeling system (Finney 2006) used in this assessment. The most up-to-date version of available LANDFIRE datasets—Version 1.1—were used. Fuel and vegetation characteristics in Version 1.1 account for disturbance and fuel management activities through 2007. No disturbances or fuel-management activities took place in the analysis area from 2007 to present, so this dataset reflects the current landscape condition without a need for further update.

Geospatial data regarding existing vegetation type (EVT), cover (EVC), and height (EVH) form the basis for mapping surface and canopy fuels. These layers were also obtained from the LANDFIRE project, Version 1.1. Existing vegetation type is classified using NatureServe’s terrestrial ecological systems of the United States. A total of 14 EVT's are present in the proposed prescribed fire area, but only 8 cover at least 10 acres. Mixed conifer EVT's represent 75% of the area; the remainder of the EVT's include Aspen, Ponderosa Pine, spruce-fir, White Fir, and riparian vegetation types (Figure 4, Table 4).

As depicted in Figure 4, current Vegetation Type (EVT) in the Santa Fe Municipal Watershed Prescribed Burn Project Treatment Area. In total, 73% of the prescribed fire project area is within a mixed conifer EVT (mesic or dry-mesic).
Figure 4 LANDFIRE Existing Vegetation
Table 5. Area by EVT and Fire Behavior Fuel Models in the Proposed Treatment Area—Current Conditions

<table>
<thead>
<tr>
<th>EVT</th>
<th>GR1</th>
<th>GS1</th>
<th>GS2</th>
<th>SH1</th>
<th>SH2</th>
<th>TU1</th>
<th>TU5</th>
<th>TL1</th>
<th>TL3</th>
<th>TL8</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspen Forest</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>231</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>233</td>
</tr>
<tr>
<td>Dry-Mesic Mixed Conifer Forest</td>
<td>163</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>465</td>
<td></td>
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<td>656</td>
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<tr>
<td>Mesic Mixed Conifer Forest</td>
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<td></td>
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<td></td>
<td>83</td>
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</tr>
<tr>
<td>Dry-Mesic Spruce-Fir Forest</td>
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<td>23</td>
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<td>228</td>
</tr>
<tr>
<td>Montane Riparian Systems</td>
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<td></td>
<td>38</td>
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<td></td>
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<td>38</td>
</tr>
<tr>
<td>White Fir Forest Alliance</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>&lt;1</td>
<td>186</td>
<td>-</td>
<td>-</td>
<td>306</td>
<td>2,081</td>
<td></td>
<td>197</td>
<td>91</td>
<td>2,875</td>
</tr>
</tbody>
</table>

Key: These are the 40 fuel models for BEHAVE model: GR = grass; GS = grass-shrub; SH = shrub; TU = timber understory; TL = timber litter, numbers indicate increasing levels of fire spread rate and flame length.

LANDFIRE fuel and vegetation data are developed separately for each mapping zone. The landscape area surrounding the proposed prescribed fire includes portions of mapping Zones 25 and 28. To avoid data discontinuities (seam lines) along mapping zone boundaries, data layers for this assessment were custom built by applying fuel mapping rules for Zone 28, the dominant mapping zone in the project area as well as the mapping zone where the prescribed fire is proposed, to the whole fire modeling landscape. This was accomplished using the LANDFIRE Total Fuel Change (LFTFC) Toolbar (www.niftt.gov), a custom Toolbar for use in ArcMap. The LFTFC Toolbar permits, if necessary, adjustment of baseline fuel mapping rules to meet local conditions and is also used to update the landscape to reflect disturbance and fuel treatment. The baseline fuel mapping rules were not adjusted for this assessment, but the disturbance-modeling feature of LFTFC was used to create the post-prescribed fire landscape.

The primary fuel characteristics that determine fire behavior potential are fire behavior fuel model, canopy base height (CBH), and canopy bulk density (CBD). A fire behavior fuel model is a set of fuelbed inputs used to predict surface fire behavior when using Rothermel’s spread model. Surface fire behavior affects the transition from surface to crown fire. CBH is the height above the ground above which fire can propagate vertically through the canopy fuel stratum. The lower the CBH, the greater the propensity for a surface fire to transition to some kind of crown fire. CBD is the mass of foliage and fine twigs per unit of bulk canopy volume (kg/m$^3$). Higher values of CBD—typically greater than 0.10 kg/m$^3$—are commonly associated with greater propensity for active crown fire.

Nearly 75% of the proposed prescribed fire area is comprised of mesic and dry-mesic mixed conifer forests and woodlands (see Table 4). Similarly, nearly 75% of the area is mapped as fuel model TU5,
which is characterized by a heavy load of both live and dead surface fuel components and is capable of producing intense surface fire behavior, frequently resulting in transition to crown fire.

Canopy base height and canopy bulk density values in the proposed prescribed fire area are such that transition to crown fire and sustained active crown fire can occur under even moderate wind speeds (Table 5). Median CBH where TU5 occurs is 0.6 m (2 feet), which leads to crown fire even without wind. Mean CBD in those same areas is 0.112 kg/m$^3$, which results in active crown fire if the 20-foot wind speed is above 22 miles per hour [MPH]). The result of these surface and canopy fuel characteristics is a strong propensity for intermittent and active crown fire.

**Fire Behavior Potential**

Potential fire behavior is determined by the combination of fuel, topography, and weather across a landscape. The FlamMap fire modeling system was used to assess the distribution of headfire potential of these characteristics in the project area. Specific characteristics assessed were fire type (surface, passive crown, or active crown) and fire intensity, which is expressed as flame length.

Surface fire is fire that burns in the surface fuels (grass, shrubs, litter, dead and downed branch wood, and short trees in contact with the ground surface). Crown fire refers to fire burning in the tree canopy. Two types of crown fire can be modeled in geospatial fire behavior modeling systems. Passive crown fire, also referred to as torching or intermittent crown fire, burns individual or small groups of trees. Active crown fire, also referred to as continuous or running crown fire, involves the entire surface and canopy fuel complex and spreads from tree to tree through the canopy fuel stratum. Crown fires are more difficult to control and have more severe and lasting effects than surface fire due to the increased rate of spread, increased intensity, and likelihood to start spot fires long distances ahead of the fire front due to lofted embers.

The assessment used the Fire Intensity Level (FIL) classification of potential flame length (Table 6), with the addition of FIL7 to better account for the high intensity of active crown fires.

**Table 6. Canopy Fuel Characteristics within the Proposed Treatment Area—Current Conditions**

<table>
<thead>
<tr>
<th>Pre-treatment Fuel Model</th>
<th>Canopy Base Height (m)</th>
<th>Canopy Bulk Density (kg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Mean</td>
</tr>
<tr>
<td>TU1</td>
<td>0.10</td>
<td>8.63</td>
</tr>
<tr>
<td>TU5</td>
<td>0.10</td>
<td>0.60</td>
</tr>
<tr>
<td>TL3</td>
<td>0.20</td>
<td>0.42</td>
</tr>
<tr>
<td>TL8</td>
<td>0.60</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Key: TU = timber understory; TL = timber litter
Table 7. Classification of Flame Length by Fire Intensity Levels

<table>
<thead>
<tr>
<th>Fire Intensity Level</th>
<th>Flame Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIL1</td>
<td>0–0.6 m (0–2 feet)</td>
</tr>
<tr>
<td>FIL2</td>
<td>0.6–1.2 m (2–4 feet)</td>
</tr>
<tr>
<td>FIL3</td>
<td>1.2–1.8 m (4–6 feet)</td>
</tr>
<tr>
<td>FIL4</td>
<td>1.8–2.4 m (6–8 feet)</td>
</tr>
<tr>
<td>FIL5</td>
<td>2.4–3.6 m (8–12 feet)</td>
</tr>
<tr>
<td>FIL6</td>
<td>3.6–18.3 m (12–60 feet)</td>
</tr>
<tr>
<td>FIL7</td>
<td>&gt;18.3 m (&gt;60 feet)</td>
</tr>
</tbody>
</table>

* FIL7 was added to the standard six-category classification to better display crown fire intensity.

Fine dead fuel moisture content is an important factor affecting potential fire behavior. Fine dead fuel moisture content is primarily a function of temperature, relative humidity, and solar radiation. Temperature and relative humidity vary with elevation, and solar radiation varies with cloud cover and forest canopy cover. The prescribed fire area spans a relatively narrow band of elevation, but forest canopy cover varies throughout the project area. To account for variability of the factors affecting dead fuel moisture content across the prescribed fire area, the fuel moisture conditioning feature of FlamMap was used. The conditioning feature requires a summary of weather variables (temperature, relative humidity, precipitation, cloud cover) spanning several days. The “average worst” fire season conditions defined in the Santa Fe Municipal Watershed Project Final Environmental Impact Statement (USFS 2001) were used for this assessment:

- Temperature = 87° F
- Relative humidity = 17%
- Cloud cover = 0%

After conditioning fuels for several days with the above characteristics, the 1-h moisture content varied from near 3% in the very small portion of the project area with little or no forest canopy cover to just above 5% under a dense forest canopy (75% cover). Conditioned 1-h moisture content in the bulk of the project area was approximately 4.5% under a canopy cover of 50–60%.

FlamMap3 was used to estimate fire type and flame length across the project area for 20-foot wind speed values ranging from 0–50 MPH. Wind direction was assumed to be upslope to reflect a worst-case scenario. The results of the simulations were compiled into charts showing the fraction of the project area in each fire type and each Fire Intensity Level.

At wind speeds less than 20 MPH, only 20% of the project area is expected to exhibit surface fire; passive crowning is the norm (Figure 5). Passive crown fire, also called intermittent crown fire, encompasses a wide range of behavior from individual tree torching to nearly active crown fire. Headfire flame lengths less than 1.2 m (4 feet) (FIL1 and FIL2) would occur on less than 20% of the area. Moderate flame lengths would be uncommon; instead, flame lengths exceeding 3.6 m (12 feet)—and in some places exceeding 18.3 m (60 feet)—would be the norm. FIL7 would occur on at least 80% of the project area at wind speeds greater than 30 MPH. Therefore the potential for sustaining an active crown fire would be exist.
Environmental Consequences of the Alternatives

Three alternatives were considered in the Fuel and Fire Behavior assessment: the No-Action (Alternative A), prescribed-fire only (Alternative B), and hand thinning (where topography allows) followed by prescribed fire (Alternative C). Each alternative and how they specifically relate to fuel and fire behavior is described below.

Alternative A—The No-Action Alternative

Under the No-Action Alternative, no prescribed fires would occur in the treatment area and the existing wildfire hazard in the middle reaches of the Watershed, as described in the Existing Conditions section above, would continue unabated. It is assumed that a high intensity wildfire would occur due to the existing conditions and trends. The predominantly steep slopes and south to southwest aspects would help increase fire spread and intensity. Active crown fire with flame lengths ranging from 12-60 feet or more, depending on wind speed. After an active crown fire, the potential for a subsequent crown fire would be reduced for at least 10-15 years. The wildfire would reduce the average surface fuel load in ponderosa pine from 35 to 9 tons per acre. However, because of the likely widespread high intensity of the wild fire, the soil impacts and water impacts would be sever. See page 41 for a description of post-fire effects to soil and water resources.

Alternative B

The prescribed-fire-only alternative involves the intentional burning of a designated portion of the Watershed under prescribed conditions. The vegetation type in the upper reaches of the burn unit changes from Ponderosa Pine woodland and dry mixed conifer to wet mixed conifer and subalpine forest. During much of the year, fire will carry in the Ponderosa Pine woodland and dry mixed conifer forests, but not in the wet mixed conifer and subalpine forests, meaning that a burn prescription may be identified that does not require constructed firelines in the upper reaches of the burn unit.

The fuel and topography vary considerably within the burn unit. It is unlikely that a prescription window can be identified that will result in uniform coverage of fire across the entire unit. Instead,
only a portion of the unit would actually experience the prescribed fire, primarily the lower-elevation portions in which Ponderosa Pine is a significant component. The prescribed burning would occur over many years and several entries. The first phase of initial treatments would likely start in this area and continue to work off of previously treated areas to utilize the black area. The treatment area would eventually cover most of the terrain.

Where fire occurs during the prescribed fire, a range of first-order effects could be expected to occur, including crown scorch and tree mortality (Photo 1, page 34). These effects are desirable in order to achieve the desired reduction in canopy bulk density and increase in canopy base height.

The disturbance simulation feature of LFTFC was used to estimate post-treatment fuel characteristics for a 2–5-year period following the prescribed fire. Surface fuel model was mapped by applying the moderate-severity wildfire rules to the proposed fuel treatment area. Those rules result in a range of post-fire fuel models dominated by GS1 and TL1 (Table 7). The GS1 model represents fuels consisting of a light loading of litter, grass, and regenerating shrubs; fireline intensity is 10 times lower for GS1 than TU5, the typical pre-treatment fuel model where GS1 occurs post-treatment. TL1 represents a light load of timber litter with no additional grass or shrub component. TL1 produces very little fireline intensity or spread rate.

Post-treatment canopy fuel characteristics were estimated by reducing EVC, then generating CBH and CBD. The result is that CBH is increased (primarily due to crown scorch) and CBD is moderately reduced. These three fuel characteristics changes combine to greatly reduce the incidence of crown fire. (Table 8, Figure 6)

<table>
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<tr>
<th>EVT</th>
<th>GR1</th>
<th>GS1</th>
<th>GS2</th>
<th>SH1</th>
<th>SH2</th>
<th>TU1</th>
<th>TU5</th>
<th>TL1</th>
<th>TL3</th>
<th>TL8</th>
<th>Sum</th>
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<td></td>
<td></td>
<td>233</td>
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<tr>
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<td>567</td>
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<td></td>
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<td>178</td>
</tr>
<tr>
<td>Dry-Mesic Spruce-Fir Forest</td>
<td>53</td>
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<td>&lt;1</td>
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<td>22</td>
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<td>24</td>
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<tr>
<td>Montane Riparian Systems</td>
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<td></td>
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<td></td>
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<td></td>
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<td></td>
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<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td>1</td>
<td>483</td>
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<td>871</td>
<td></td>
<td></td>
<td></td>
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<td>2,875</td>
</tr>
</tbody>
</table>

Key: GR = grass; GS = grass-shrub; SH = shrub; TU = timber understory; TL = timber litter, numbers indicate increasing levels of fire spread rate and flame length.

Reduced average fuel loads are shown by comparing tables 4 and 7 (pre and post conditions). Post treatments shows that fuel model TU5 (very high load, dry climate, timber shrub with an average live fuel load of 3 tons/acre) shifts to a TL1 (low load compact conifer litter with average live fuel
load of 0 tons). The tables also show that GS2 (moderate load, dry climate grass shrub with fuel bed depth at 1.5 feet) shifts to a GR1 (short sparse dry climate grass with fuel bed depth to 0.4 feet). Overall comparison of the tables shows the treatments would reduce the continuity of the smaller diameter fuels.

Post-treatment values of CBH and CBD (Table 8) are such that transition to crown fire and sustained active crown fire are unlikely to occur under even very high wind speeds. Mean CBH where TU5 now occurs is more than 1.4 m (6.4 feet), an increase from 0.6 m (2 feet) before treatment. Mean CBD in those same areas is 0.065 kg/m$^3$, which results in active crown fire only if the 6-m (20-foot) wind speed is above 33 MPH. The result of these factors is a propensity for surface fire and low-grade intermittent crown fire.

The propensity for passive and active crown fire is greatly reduced following the prescribed fire treatment. Surface fire is expected over more than 90% of the project area at wind speeds less than 20 MPH (Figure 6). Active crown fire is not expected to occur over any significant portion of the project area unless wind speeds exceed 40 MPH. Similarly, fire intensity is also greatly reduced following treatment. FIL7 (flame lengths exceeding 18.3 m [60 feet]) does not occur unless wind speeds exceed 35 MPH. At wind speeds less than 20 MPH, roughly 90% of the project area is expected to generate flame lengths less than 1.2 m (4 feet) (FIL1 and FIL2).

### Table 9. Post-treatment Canopy Fuel Characteristics within the Prescribed Fire Area

<table>
<thead>
<tr>
<th>Pre-treatment Fuel Model</th>
<th>Canopy Base Height (m)</th>
<th>Canopy Bulk Density (kg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Mean</td>
</tr>
<tr>
<td>TU1</td>
<td>0.30</td>
<td>8.68</td>
</tr>
<tr>
<td>TU5</td>
<td>0.30</td>
<td>1.44</td>
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<tr>
<td>TL3</td>
<td>0.60</td>
<td>1.42</td>
</tr>
<tr>
<td>TL8</td>
<td>1.80</td>
<td>2.82</td>
</tr>
</tbody>
</table>

* Fuel model is for the pre-treatment condition, so these results can be compared with Table 2.

**Alternative C**

Wherever hand thinning occurs, the effects would be similar to what has taken place lower in the Watershed, outside the Wilderness. That is, canopy bulk density would be decreased by the removal of mid-sized trees less than nine inches diameter at breast height (DBH), and canopy base height would be increased by the removal of small trees (ladder fuel). (Photo 2, page 35 and Photo 3, page 36).

Regardless of how the activity fuel is treated before the prescribed fire, the effects would be substantially the same (Photo 4, page 36). Hand thinning followed by prescribed fire would produce effects similar to the moderate-severity prescribed fire expected under Alternative B—the Ponderosa Pine woodland. For these reasons, Alternative C would result in substantially the same potential fire behavior effects as Alternative B, the prescribed-fire-only alternative.
Figure 6. Fire type and fire intensity for the post-treatment condition within the proposed treatment area.
Photo 1. Prescribed fire adjacent to the Watershed resulting in the desired moderate severity effects, which reduce canopy bulk density and increase canopy base height, limiting the potential for future high-severity crown fires.
Photo 2. A Ponderosa Pine woodland within the lower-elevation portion of the proposed burn unit that is accessible for hand thinning before burning.
Photo 3. Illustration of hand thinning treatment with hand piling of heavy concentrations of activity fuel, which may be required to reduce activity fuel before the prescribed fire in places where existing tree density is high.

Photo 4. Illustration of hand thinning followed by broadcast burn.
Cumulative Effects
Within the last decade, a large amount of fuel reduction work has been accomplished in the lower (non-wilderness) portion of the Santa Fe Watershed (Figure 7). Previous treatments, totaling approximately 5,285 acres, in the lower Watershed have reduced the potential spread rates and of wildfires there, so such fires are less likely to reach the upper Watershed. Likewise, a wildfire originating in the spruce/fir area north of and spreading into the proposed treatment area would burn with less intensity once in the treated area.

Continued thinning and prescribed burning as well as maintenance treatments are ongoing. These treatments would help in the severity of the burning and would probably have moderate burns as opposed to the severe burns in a densely vegetated wildfire.

In 2011, the Pacheco Fire burned approximately 10,000 acres northwest of the Santa Fe Watershed. In 2013, the Jaroso Fire burned approximately 11,000 acres within the Pecos Wilderness. These fires provide a partial fuelbreak for the Santa Fe Watershed from fires within the Pecos Wilderness starting north and west of the Santa Fe Watershed. At the same time, these fires provide examples of the post-fire flooding that is likely to occur in the Santa Fe Watershed as a result of fire effects to vegetation and soils.

Wilderness

Affected Environment
The Pecos Wilderness was one of the original areas designated as a part of the National Wilderness Preservation System in the Wilderness Act (PL 88-577) of 1964. At that time, the 2,876-acre proposed treatment area and the 3,619-acre area north of the proposed treatment area were not part of the Wilderness. The Santa Fe Watershed was added to the wilderness system, along with 48,500 acres in other areas of the Santa Fe and Carson National Forests, in 1980 by the New Mexico Wilderness Act (NMWA) (PL 96-550). A provision was included in the NMWA specifying that “nothing in this Act shall interfere with the management of, or rules, regulations, and law applying to the Santa Fe Municipal Watershed [PL 96-550 Sec. 102(9)].”

The analysis area, including the proposed treatment area, has been subject to past human influences which have affected its wilderness character. Historically, the portion of the Santa Fe Watershed in wilderness was logged, grazed by sheep, used for recreation, and contained homesteads. For public health reasons, in 1932, the Secretary of Agriculture closed the area for public use. The city of Santa Fe has a similar closure, which closed for public use the two reservoirs, which were privately held at that time (they are now owned by the City of Santa Fe).

After the closure, the National Forest lands in the watershed were subject to fire suppression as the main management action. Consequently, dense stands of trees, primarily consisting of mixed conifer and Ponderosa Pine are present in the area proposed for treatment in the analysis area. Spruce-fir stands are concentrated in the less accessible higher-elevation portion of the Watershed.

3 Approximately 27 million acres, or 35% of the total land in New Mexico, is administered by Federal agencies, and approximately 1.7 million acres, or 6%, of this Federal land is managed as wilderness. The Pecos Wilderness is approximately 222,300 acres in size and accounts for 13% of the wilderness in New Mexico.
north of the proposed treatment area and would naturally be dense, with a natural high component of dead and down wood.

The topography of the Wilderness portion of the Santa Fe Watershed consists of steep canyons and, in the extreme northern portion of the analysis area, Santa Fe Lake can be found in a cirque at the base of Lake Peak and Penitente Peak. The wilderness portion of the analysis area is undeveloped, and recreation opportunities and solitude as wilderness values are not potentially affected because the Watershed portion of the wilderness is closed to the public.

Lightning-caused fires have started in or in the vicinity of the Watershed on average twice a year since 2006 (Jon Boe, USFS, pers. comm. December 13, 2012). All of these fires were suppressed in compliance with FSM 2324.22.5, which states that lightning-caused fires can only be allowed to burn if prescribed in an approved burn plan and in compliance with USFS management direction for Management Area O (the Watershed).

An approved burn plan for management-ignited prescribed fire exists for the lower Watershed, including the southern portion of the analysis area, but not for the proposed treatment area or the area to the north of the treatment area in the Pecos Wilderness. USFS management direction in the Forest Plan for Management Area H (wilderness) specifies that high-intensity wildfires be limited to 2,000–5,000 acres and that low-intensity fires have no size limitations as long as wilderness resource objectives are met (USFS 2010).

As described in Chapter 1, before an activity involving a prohibited use can be implemented, a determination must be made that such an action is the minimum required. To support this decision-making process, which is separate from the decision making required by NEPA, the Carhart Institute has developed a *Minimum Requirements Decision Guide* (MRDG) to assist land managers in determining whether or not administrative actions involving prohibited uses in wilderness are the minimum necessary requirement to meet project goals. The following five qualities are used during this analysis as described in the 1964 Act:

- **Untrammeled:** In wilderness, the "earth and its community of life" are essentially unhindered and free from modern human control or manipulation, "in contrast with those areas where man and his own works dominate the landscape." This quality is important because it helps insures that wilderness is managed with the utmost humility and restraint, respecting the autonomy of nature that allows a place to be wild and free. However, it is unlikely that action is necessary to preserve this quality, unless the decision is to *stop* taking action. In fact, to preserve this quality it may be necessary to cease actions that manipulate "the earth and its community of life" that are not needed to preserve some other quality of wilderness character.
- **Undeveloped:** Wilderness retains its "primeval character and influence," and is essentially "without permanent improvements" or modern human occupation. Preserving this quality keeps areas free from "expanding settlement and growing mechanization" and "with the imprint of man’s work substantially unnoticeable" as required by the Wilderness Act. To preserve this quality, it may be necessary to remove existing structures or installations which are unnecessary for the administration of the area as wilderness or otherwise are not features of the area’s wilderness character.
- Natural: A wilderness area is to be "protected and managed so as to preserve its natural conditions." Wilderness ecological systems are substantially free from the effects of modern civilization. Preserving this quality ensures that indigenous species, patterns and ecological processes are protected and allows us to understand and learn from natural features. To preserve this quality, it may be necessary to take action to correct unnatural conditions even if they were present at the time of designation., and

- Outstanding opportunities for solitude or primitive recreation.: The Wilderness Act defines wilderness as having “outstanding opportunities for solitude or a primitive and unconfined type of recreation.” This quality is about the opportunity for people to experience wilderness. The opportunities provided by wilderness include the chance to experience primitive recreation, natural sights and sounds, solitude, freedom, risk, the physical and mental challenges of self-discovery and self-reliance, and to use traditional skills free from the constraints of modern culture.

- In addition to the four qualities of wilderness character listed above, which are required of every wilderness, the Wilderness Act says these areas “may also contain ecological, geological, or other features of scientific, educational, scenic, or historical use” that reflect the character of this wilderness. Some of these features, such as the presence of threatened and endangered species, are also part of the Natural quality of a wilderness and could be evaluated for effects to that quality unless the specific species or habitat is unique to the wilderness area. Other features, however, such as the presence of important geological formations, cultural resources, historical sites, or paleontological localities, do not fit easily into one of the other four qualities. While many different types of features could be included, the intent is to include those that are significant or integral to the wilderness. Features mentioned in wilderness enabling legislation or legislative history would likely qualify. The Other Features of Value that are present must be just as rigorously protected as the other qualities of wilderness character, and so you should account for these separately in this section of the MRDG. To preserve this quality, it may be necessary to take action to protect these features even if they were already at risk or degraded prior to the date of designation.

The following section summarizes the full analysis found in the MRDG in Appendix B.

Environmental Consequences of the Alternatives

Alternative A—The No-Action Alternative

A 40,000-acre catastrophic fire originating either in the proposed treatment area and spreading into adjacent areas or starting outside of the treatment area and moving into the treatment area could have devastating impacts in a relatively small portion (18%) of the 222,300-acre Pecos Wilderness. As seen in the recent nearby fires (Pacheco and Jaroso) trees would be eliminated and burn scars would remain for decades. Areas not subject to severe erosion could contain soils turned hydrophobic by high heat exposure, which would slow vegetative recovery. Although this type of fire is a natural phenomenon, the ecological processes in the analysis area as a wilderness value such as soil productivity would take decades to recover.
Alternative A (No Action) would have no direct impacts to the untrammeled and natural wilderness values by letting this natural event take place. However, fire suppression over the last 100 years has interrupted the natural fire cycle of low intensity, high frequency fires, and so the size and severity of the fire expected to occur would be uncharacteristically high. This practice has interrupted the natural fire regime and has created dense overgrown forest vegetation that is not natural. The interruption of the fire regime would be the impact to the untrammeled values by interfering with the natural process in the ecosystem. [more from the decision guide]

**Alternative B**

Alternative B would involve the use of a helicopter, which is mechanized equipment that would produce noise and have a temporary adverse impact on wilderness values, and the dropping of materials (DAIDs) in the Wilderness. Both of these are prohibited uses according to the Wilderness Act (4.c) and 36 CFR 293.6 and can only be used if they are the minimum requirements necessary to meet the purpose and need of the Project. FSM 2326.1.5a, b specifies conditions under which prohibited uses, including motorized equipment or mechanical transport, in wilderness may be approved by the Regional Forester:

5. To meet minimum needs for protection and administration of the area as wilderness only as follows: a. A delivery or application problem necessary to meet wilderness objectives cannot be resolved within reason through the use of non-motorized methods. b. An essential activity is impossible to accomplish by non-motorized means because of such factors as time or season limitations, safety, or material restrictions.

Aerial ignition is necessary because crews using drip torches to ignite prescribed fire in the proposed treatment area would be subject to unsafe conditions from the difficult terrain in the area. While some areas would be safe to access using this method, the majority of the proposed treatment area is not safely accessible, and the purpose and need of the project would not be met. 4

Alternative B would also have a beneficial impact on wilderness character and values because ecological processes, including a more natural fire regime, would be restored in the proposed treatment area. In addition, once a natural fire regime has been established in the proposed treatment area, lightning-caused fires may be allowed to burn as a natural process. Prescribed fires in the treatment area would burn as a mosaic, which would create openings and an increase in edge habitat and a diversity of habitat favorable for wildlife. Because more of the ground surface would be exposed to sunlight, ground cover and understory vegetation would also increase.

Alternative B (Proposed Action) would maintain the wilderness characteristics, but would have impacts to untrammeled and natural values. Although fire is a natural process in the ecosystem it would be introduced through prescribed burning. The beneficial impacts would be to the natural value and the Santa Fe Watershed. This alternative would also benefit the protection of the watershed. This alternative rated at a [-2] for the MRDG. [explain MRDG and where it can be found in draft—appendix?]

**Alternative C**

Alternative C would have essentially the same beneficial impacts on wilderness as Alternative B, although additional minimum requirements would have to be met for the use of mechanized

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4 The minimum requirement provision of the Wilderness Act has been analyzed in a document referred to as the “Minimum Requirement Decision Guide” found in Appendix B
equipment (chainsaws). Use of chainsaws in the wilderness could disturb wildlife or other forest users in the wilderness. Thinning would also leave tree stumps from the cut trees that would be visible for many years. This would have an impact on the untrammeled and natural character of wilderness for decades.

Alternative C would have the most impacts to wilderness values. Because this alternative includes the use of chainsaws it would impact the untrammeled and natural values. The use of mechanized equipment interferes with the natural process in the ecosystem. Chainsaws would also result in stumps that could be seen for decades and impact scenic qualities. This alternative also has positive impact to natural value and the Santa Fe Watershed. This alternative rated at a [-4] in the MRDG.

Cumulative Impacts

Direct effects from Alternative A would be the continued unnatural fuel buildup in a portion of the watershed wilderness. Although fires are naturally occurring in the ecosystem the unnatural buildup has caused overdense vegetation and more catastrophic fires as opposed to the natural fire regime or high frequency-low intensity burns evident in ponderosa pine.

Direct effects from Alternatives B from prescribed burning would be the intrusion in the wilderness. The use of helicopters and introduction of fire in the wilderness have short term impacts on the wilderness. Direct and indirect effects from Alternative C are the intrusions in the wilderness and the cumulative effect of stumps. The stumps would have long term impacts to the natural and scenic characteristics of wilderness. Both of these alternatives can have short term impacts on opportunities for solitude during implementation.

Recent wildfires in the Pecos Wilderness have occurred in close proximity the project area. The Pacheco Fire of 2010 burned approximately 10,000 acres north of the project area and the Jaroso Fire of 2013 burned approximately 11,000 acres east of the project area. Each of these fires left burn scars within the Pecos Wilderness. Also, each of these wildfires used some degree of suppression techniques to fight the fire. Each fire also had associated rehabilitation efforts. Examples of the suppression techniques include helicopters either for observation, hauling equipment, etc. Rehabilitation techniques used in the Pacheco Fire used helicopter use for aerial straw/hay mulching.

Soil and Water Resources

Affected Environment

The soil and water resource issue associated with the project involves the potential for erosion and sedimentation of the reservoirs, floods, and impacts to water quality and associated flows into McClure Reservoir and the City of Santa Fe’s water supply. To address potential uncertainty in methods for assessing erosion and peak flows, several methods were used to predict impacts.

Soil loss rates were estimated for each of the alternatives using the Water Erosion Prediction Project (WEPP) Watershed Interface (Elliot et al. 2010), the Erosion Risk Management Tool (ERMit) model, the Revised Universal Soil Loss Equation (RUSLE), and empirical methods, which estimate soil loss based on observed losses in other watersheds following catastrophic fires. The analysis area was divided into 21 catchments ranging in size from 23–1,374 acres for analysis (Figure 8). Each catchment was modeled for the predicted soil erosion and peak flow under existing conditions and a catastrophic fire.
Figure 7. Map showing the 10-year history of fuel treatments in the lower portion of the Santa Fe Watershed.
Catchments within the proposed treatment area were modeled for the impacts of a prescribed fire to represent Alternatives B and C. The WEPP model calculates the soil loss for areas within each watershed based on the climate, topography, soil, and vegetation management and provides an annual sediment yield. The ERMiT model uses WEPP technology to provide the probability of soil erosion rather than just an annual yield. RUSLE is a very simplistic evaluation of the potential soil loss assuming no vegetation cover.

Peak flow rates were estimated using USFS Peak Flow Calculator and an empirical method. The Forest Service Peak Flow Calculator estimates peak flows for slope and soil conditions and a 24-hour storm event predicted to occur once every 100 years. The empirical method compares the ratio of post-fire to pre-fire peak flow rates in watersheds throughout New Mexico and Arizona.

**Soil and Sediment Yield**

The soils present in the proposed treatment area are course-grained, well-graded, and have low runoff potential based on the Terrestrial Ecosystem Survey for the Watershed (SFNF 2009). The percentage of the surface area that has rock fragments ranges from 40–70%, and the average slope for the proposed treatment area is 46%. The soils within the Wilderness but outside the treatment area are also described as course-grained and well graded with low runoff potential, but the percentage of surface rock fragments is less, ranging from 20–70% with an average slope of 44%.

For the current conditions of the mature forest in the Santa Fe Watershed, the WEPP model shows very little sediment production. Given the existing mature forest in the 8,500 acres above McClure Reservoir, the WEPP model predicts that the average volume of sediment produced annually from each catchment is 0.055 tons/acre, about 396.5 m$^3$ (14,000 cubic feet) of sediment or about 0.3 acre-feet. This is consistent with observed sediment yield rates. In the 65 years since McClure Reservoir was constructed, the total yield would amount to 21 acre-feet, about 0.6% of the storage capacity. A recent bathymetry survey of McClure Reservoir in 2011 estimated the volume of sediment in McClure Reservoir at 44 acre-feet (including fine sediment that accumulated prior to construction of the dam).

**Water Quality and Peak Flows**

Forest conditions can impact peak flows, particularly following a catastrophic fire. McClure and Nichols Reservoirs are relatively small and thus offer little flood protection. To estimate the potential peak flows, the historic record is key to first assessing the validity of the modeled estimates and for using empirical techniques to predict peak flows. Stream flow in the Santa Fe River has been measured since 1913 at a location downstream of McClure Reservoir (the SFnrSF gauge) and at a location above McClure since 1998 (Figure 9). The construction of McClure Reservoir in 1926 and the subsequent increase in dam height have impacted the measured peak flows.

The Santa Fe River Watershed was identified in New Mexico Unified Watershed Assessment as a Category 1 Watershed: that is one of the state's watersheds in most urgent need for restoration. The reason for such designation is that the river provides about 40% of the City of Santa Fe's water supply from reservoirs located in the Sangre de Cristo Mountains east of town. Another 30% of the City's water comes from a group of wells mostly adjacent to the Santa Fe River west of St. Francis Drive.

The Santa Fe River Watershed is a sub-basin of the Rio Grande, with its headwaters at Santa Fe Lake, below Lake Peak in the Sange de Cristo Range. The watershed at the Santa Fe River from its headwaters to its confluence with the Rio Grande is approximately 285 square miles, and the river course is approximately 46 miles long.
Ground surface elevations in the Santa Fe River Watershed range from 12,408 feet above mean sea level at the top of Lake Peak to 5,220 feet at the Rio Grande. Slopes are extremely steep (often 40 degrees or greater) in the rocks of the Sangre de Cristos are overlapped by the deep sediments or the Santa Fe Group. Most of the rest of the watershed is gently rolling, except in the deeply incised basalt canyon of the Santa Fe River between La Cirneguilla and La Bajada, where the canyon walls are nearly vertical.

The highest recorded peak flow was 1,500 cubic feet per second on August 14, 1921, and the second highest was 600 cubic feet per second on September 23, 1929, at the SFnrSF gauge. The U.S Geological Survey (USGS) reported that the peak inflow during the 1929 storm may have exceeded 1,500 cubic feet per second without the regulation of McClure Dam.
Figure 8. Modeled catchments in the Watershed above McClure Reservoir.
Figure 9. Location of McClure Reservoir and Stream.

Figure 10. Annual peak instantaneous flows measured at two gauges on the Santa Fe River.
Comparison of recent peak flows and mean daily flow measured at the two gauges shows that, other than in 2007, the maximum mean daily and peak flows at the Above McClure gauge were greater than the peaks at the SFnrSF gauge. The peak at the Above McClure gauge has been more than twice the peak at the SFnrSF gauge due to the controlled releases from McClure Reservoir. As such, the peaks observed at SFnrSF after 1947 were multiplied by two to estimate what the historic annual peak may have been without McClure Reservoir. Table 9 summarizes the return frequency of the estimated peak flow record for the return period.

Table 10. Return Interval for Peak Instantaneous Flow in the Santa Fe River above McClure Reservoir (estimated for 1913–2010)

<table>
<thead>
<tr>
<th>Return Period (years)</th>
<th>Modified Historic Peak Flows Representing Inflow to McClure Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>270 cubic feet per second</td>
</tr>
<tr>
<td>5</td>
<td>150 cubic feet per second</td>
</tr>
<tr>
<td>10</td>
<td>220 cubic feet per second</td>
</tr>
<tr>
<td>50</td>
<td>550 cubic feet per second</td>
</tr>
<tr>
<td>100</td>
<td>700 cubic feet per second</td>
</tr>
</tbody>
</table>

**Outstanding Natural Resource Waters**

The portion of the Santa Fe River located in the Wilderness is designated as an Outstanding Natural Resource Water (ONRW) in New Mexico, which provides the highest level of protection under New Mexico's Water Quality Standards. Santa Fe Lake, located in the northern portion of the analysis area but outside the proposed treatment area, is also designated as an ONRW. Designation as an ONRW triggers the Tier 3 Antidegradation water quality standard (the most stringent of the antidegradation standards). The objective is to maintain the highest water quality possible in these streams.

The Water Quality Control Commission approved the statewide designation of wilderness waters on December 15, 2010, which included the Santa Fe River and Santa Fe Lake. In total, there were 29 lakes, 192 perennial streams, and approximately 5,000 acres of wetlands listed in the designation (NMED 2009).

Three criteria are used for ONRW designation (NMED 2009):

1. The water is a significant attribute of special trout waters, National or State park or State monument, National or State wildlife refuge or designated wilderness area, or is part of a designated wild river under the Federal Wild and Scenic Rivers Act; or
2. The water has exceptional recreational or ecological significance; or
3. The existing water quality is equal to or better than the numeric criteria for protection of aquatic life uses, recreational uses, and human health uses, and the water has not been significantly modified by human activities in a manner that substantially detracts from its value as a natural resource.
The New Mexico Antidegradation Policy Implementation Procedure (20.6.4 NMAC) allows for temporary “degradation in surface water of the state when such activities will result in restoration or maintenance of the chemical, physical or biological integrity of the water”. The USFS is tasked with assessing the potential impact of the proposed actions on the water quality of the Santa Fe River and Santa Fe Lake. The guidance for non-point source discharges in ONRW specifically states that “forest management projects specifically directed at Watershed restoration or maintenance, or reducing fuel loads that can lead to catastrophic fires and degradation of water quality” are “encouraged and should not be delayed or prohibited as a result of ONRW designation (NMED 2009).

Environmental Consequences of the Alternatives

Table 11 summarizes the results from the soil and water effect analysis for the alternatives evaluated.

Table 11. Summary of Soil and Water Effect Analysis for the Alternatives Evaluated

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Sediment Yield in First Year (acre-feet)</th>
<th>Peak Flow (cubic feet per second—CFS)</th>
<th>Water Quality</th>
<th>Soil Nutrient Cycling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low(^a)</td>
<td>High(^b)</td>
<td>500-Year Event</td>
<td>Relative to Existing Conditions</td>
</tr>
<tr>
<td>Existing Conditions</td>
<td>2</td>
<td>145</td>
<td>600</td>
<td>NA</td>
</tr>
<tr>
<td>Alternative A, No Action with Catastrophic Fire</td>
<td>20</td>
<td>415</td>
<td>11,000</td>
<td>Adverse impact</td>
</tr>
<tr>
<td>Alternatives B and C</td>
<td>2</td>
<td>145</td>
<td>1,500</td>
<td>Negligible impact</td>
</tr>
</tbody>
</table>

\(^a\) WEPP prediction for 1/25 year event (Elliot et al. 2010).
\(^b\) Empirical Equation, 1/100 year event (Gartner et al. 2007).

Alternative A—The No-Action Alternative Soil and Sediment Yield

Sediment yields under Alternative A, while partially within the range for those predicted for the existing conditions of the analysis area without catastrophic fire, could be as much as nearly three times higher if a catastrophic fire were to occur. This level of sediment yield, carried by the predicted peak flow at least 18 times higher than that currently expected under the existing conditions, would have adverse impacts on the analysis area. Water quality and soil nutrient cycling would also experience adverse impacts under Alternative A.

Numerous studies have documented the impacts of high-intensity fires on the landscape, which leave hydrophobic soils that are more susceptible to erosion and increased runoff. Gartner et al. (2007) described the processes that result in catastrophic floods and debris flows following high-intensity rainfall events. Not only is the infiltration rate reduced by the impact of the intense heat on the soil, but the progressive bulking of sediment that erodes from the hill slopes is also incorporated into the runoff. Although no model can perfectly predict all impacts, the runoff and erosion after the Pacheco, Viveash, Cerro Grande, and Las Conchas fires in the Santa Fe area over the past decade
provide clear evidence of the likelihood of debris flows occurring in the analysis area following a catastrophic fire.

Using the tools to predict potential erosion, sedimentation in McClure Reservoir in the first year following a catastrophic fire could likely be higher than 140 acre-feet. The erosion models do not include the amount of woody material and ash that would accompany the sediment. A single debris flow of 500 acre-feet is estimated using the highest rainfall intensity (500-year storm event), though it may be as high as 2,000 acre-feet. If such an event were to occur during the first few years after a fire, it could significantly reduce the reservoirs’ storage capacities and impair water quality. The soil loss rate caused by the 25-year event is projected to exceed the soil-loss tolerance rates in some parts of the Watershed, making ecosystem recovery very slow after a catastrophic fire.

**Water Quality and Peak Flows**

Peak flows following a catastrophic wildfire would depend on the rainfall events that occur during the first 5 years after a fire. In the worst case scenario, a once-in-500-year event, the predicted peak flows could exceed 11,000 cubic feet per second. This is more than three times the predicted peak discharge for a 500-year event, according to the Federal Emergency Management Agency (FEMA), for the Santa Fe River at the confluence of Arroyo Saiz of 3,550 cubic feet per second (FEMA 2008), which is for a drainage area about 2.5 times the area above McClure Reservoir. Using empirical results for the relationship between pre- and post-fire peak flows, a peak flow of 200,000 cubic feet per second is possible. This is more than 20 times the 500-year event predicted by Gant and Shoaff (2007) in their analysis of the Santa Fe River. Gant and Shoaff predicted that a 500-year event could result in a peak flow of 10,500 cubic feet per second at the Camino Alire Bridge.

High-intensity fires have potential impacts on water quality, including increased water temperature and dissolved ions, such as nitrogen and phosphorus. The removal of riparian vegetation can cause stream temperatures to rise. This can impair aquatic habitats by increasing biological activity, which puts a greater demand on the dissolved oxygen content. Additionally, the pH of the water can be affected by ash deposition after a fire, and this, too, can impact aquatic habitats. A high-severity fire, has the potential to impair the Santa Fe River’s status as a high-quality cold-water fishery by increasing suspended solids and by nutrient loading. Furthermore, nutrient loading and suspended ash could create algal blooms and impair operations of the water treatment plant.

Another potential water quality impairment following a high-intensity fire is an increase in surface water nitrate concentration. Nitrate increases are associated with reduced plant demand and the accelerated mineralization and nitrification of organic nitrogen. Nitrate is toxic to infants and is difficult to remove from a water supply source. Phosphorus concentrations, which can contribute to algae blooms, can also increase. After the Rodeo-Chediski Fire, a water quality analysis of stream flow showed increased concentrations of dissolved nutrients (including nitrogen and phosphorus), some of which may have originated from the fire retardants dropped to slow the fire.

**Outstanding Natural Resource Waters**

Alternative A would have an adverse impact on the ONRW designation status of the Santa Fe River and of Santa Fe Lake because the increased sediment transport following a catastrophic fire would lead to water quality degradation, criteria 3 for ONRW designation in Section 3.2.1 above.
**Alternative B/C**

Sediment yields predicted for both Alternatives B and C are anticipated to be within the same range as those predicted for the existing conditions of the analysis area and would pose no threat to the water storage and treatment systems or the ecosystem. Likewise, impacts to peak flows are expected to be negligible because flows would be within their recorded historic range. Alternatives B and C would improve and beneficially impact soil nutrient cycling because the prescribed fire intensity would be lower than that of a wildfire.

Where there is prescribed burning, soil nutrient cycling would be expected to improve under this alternative. The low to moderate intensity surface burning would release the nutrients from the fine fuels and organic matter, which would move into the soil. The limited increase in ground vegetation would further enhance soil nutrient status and productivity. Long term site productivity would be maintained or improved under this alternative and soil erosion would remain within acceptable levels.

**Outstanding Natural Resource Waters**

Alternatives B and C would have no impacts on the ONRW designation status of the Santa Fe River because the river’s water quality would be maintained and sediment transport rates would be within the normal range found in the analysis area. Neither alternative would have an impact on the ONRW designation status of Santa Fe Lake because the lake is outside of the proposed treatment area.

**Cumulative Impacts**

Thinning and prescribed burning treatments below the wilderness, in the lower Santa Fe Watershed have been occurring annually for the past ten years. The water quality is exceptional, and no adverse impacts from the thinning and prescribed burns below McClure Reservoir have been observed in the Santa Fe River. Abe Franklin with the New Mexico Environment Department, who monitored water quality and geomorphology of the Santa Fe River before and after the treatments, concluded that “no obvious change in water quality or related parameters attributable to the project were observed” (Franklin 2010).

The absence of natural surface fires has resulted in degrading vegetation, soil, and water conditions. The ONRW’s within and below a wildfire would experience reduced water quality as a result of a wildfire. Wildfires would directly affect ONRWs if there are too much sediment to impact these streams.

Other wildfires and above normal spring runoff (100 year flood event) in the wilderness within the Santa Fe Watershed would directly affect sediment by increasing peak flows. In the lower part of the watershed the sediment and peak flows can be regulated through the facilities and at the treatment plant. It could take longer to for the water to get to consumers by needing more settling time.

**3.3 Riparian Areas and Wetlands**

Riparian habitats are ecotones (i.e., areas of transition) between upland and aquatic ecosystems that are influenced by lateral water flow from adjacent stream channels. Riparian vegetation is that which occurs at or adjacent to drainage channels or their floodplains and which differs in species composition from that of immediately surrounding vegetation (USFS 2001).
Jurisdictional wetlands are habitats regulated under Section 404 of the Clean Water Act (CWA). Sites are subject to the jurisdiction of Section 404 when three criteria are met: 1) vegetation is dominated by hydrophytic species, 2) hydric soils are present, and 3) a regime of wetland hydrology is operative at the site (USACE 1987).

Affected Environment

Riparian zones comprise the vegetation systems adjacent to rivers where dynamic processes of erosion, deposition, and water flow occur. Typically, riparian communities occupy a small portion of the landscape but contain the majority of plant diversity in the landscape. There are approximately 16 km (10 miles) of stream in the analysis area from the headwaters of the Santa Fe River to McClure Reservoir, and 4.8 km (3 miles) of stream between the two reservoirs. The riparian community along the Santa Fe River above Nichols Reservoir is reasonably intact relative to other riparian zones in the Southwest and to the pre-treatment conifer forest of the Watershed. The 1998 Tolisano study of the riparian zone stated that “the overall hydrologic and ecological features suggest a resilient and healthy riparian ecosystem” (Santa Fe Watershed Association 2010).

The Tolisano Report (1998) characterized existing conditions in three stretches of the Santa Fe River: lower, middle, and upper. The upper reach of the river runs through a very steep portion of the Watershed, where canyon walls dip steeply to the river, confining the riparian zone to a narrow strip. This part of the riparian community is fairly undisturbed and likely near historical conditions. The middle reach of the river was defined by Tolisano as the reach from McClure Reservoir to a point within the Wilderness, thus encompassing the reach from McClure to the Wilderness boundary and extending above it. The river in this reach emerges from the steeply cut canyon, and spreads out into a wider floodplain. In this section, the floodplain is recharged with overbank surface flows periodically, has a shallow groundwater table, and supports more species and higher structural diversity (Santa Fe Watershed Association 2010).

The Rocky Mountain Research Station sampled vegetation in the riparian community as part of the monitoring effort that accompanied forest treatments. The data documents that, although the community is fairly diverse, five species account for 90% of the trees found in the sampled riparian community: Aspen (Populus tremuloides) (113/acre—27% of all trees), Ponderosa Pine (Pinus ponderosa) (89/acre—21%), Mountain Alder (Alnus tenuifolia) (70/acre—17%), White Fir (Abies concolor) (64/acre—15%), and Douglas Fir (Pseudotsuga menziesii) (44/acre—10%). Other tree species found on the site in smaller numbers include Narrowleaf Cottonwood (Populus angustifolia) (16/acre), Rocky Mountain Maple (Acer glabrum) (8/acre), Limber Pine (Pinus flexilis) (6/acre), Rocky Mountain Juniper (Juniperus scopulorum) (4/acre), Gambel Oak (Quercus gambelii) (3/acre), Chokecherry (Prunus virginiana) (1/acre), Pinyon Pine (Pinus edulis) (1/acre) and snowberry (Symphoricarpos spp.) (1/acre).

The study documented dead standing trees in the riparian zone, 26/acre for snags larger than approximately 5 inches and 93/acre for snags smaller than approximately 5 inches. Aspen are the most numerous snags (average diameter breast height of 9 inches), Ponderosa Pine (average diameter breast height of 6 inches), Douglas Fir (average diameter breast height of 5 inches), cottonwood (average diameter breast height of 11 inches), and White Fir (average diameter breast height of 7 inches). Most are relatively small size snags, which tend to fall more rapidly than larger snags.

The largest live trees on the site are Ponderosa Pine, with 20% of trees over 16 inches in diameter breast height. Of the other four most common trees, there were few large trees: only 7% of White Fir, 3% of Douglas Fir, and 5% of Aspen were larger than 16 inches in diameter breast height; no Mountain Alder trees were larger than 5 inches in diameter breast height. Nearly 75% of the Aspen
are smaller than 8 inches in diameter breast height. In general, especially in moist sites, size reflects age, and together with what we know about human impacts in the past, the data support the case that most trees in the riparian community established fairly recently (Santa Fe Watershed Association 2010).

The Fish and Wildlife Service (FWS) National Wetlands Inventory (NWI) indicates that freshwater emergent wetlands are present in the vicinity of Santa Fe Lake and that riverine wetlands are present along the Santa Fe River upstream from McClure Reservoir to approximately 0.25 miles north of the Wilderness boundary. Because the NWI is based on remotely sensed data and the Santa Fe River extends all of the way to Santa Fe Lake, it is likely that riverine and possibly palustrine wetlands are present along the entire length of the Santa Fe River in the analysis area.

Environmental Consequences of the Alternatives

Alternative A—The No-Action Alternative
Riparian areas with high percentages of deciduous trees typically burn with less severity than areas dominated with conifer species (USFS 2001). Subsequently, if a catastrophic fire were to occur in the analysis area, portions of the riparian areas along the Santa Fe River with conifers would likely burn completely, while areas with broadleaf trees such as Aspen, Mountain Alder, and Narrowleaf Cottonwood would burn in a mosaic pattern with less severity. During a catastrophic fire, wetland areas along the Santa Fe River would be buffered somewhat in areas having broadleaf trees and compared to areas dominated by deciduous trees. These wetland areas would be expected to recover relatively quickly following a fire because the burned trees would release nutrients into the affected wetlands. All wetlands would be inundated by debris flows from a fire above and all the sediment would be deposited in the more open areas.

Alternative B/C
Alternatives B and C would have no direct impact on riparian areas and wetlands because a 50-foot-wide buffer area would be established beyond the ordinary high watermark of the Santa Fe River and any adjacent wetland areas where no prescribed fires would occur during project implementation. The buffer would keep the root structure of the vegetation and would provide a buffer in case there was flooding upstream after a wildfire. These areas would serve as a fuel break if a catastrophic fire were to occur in the treated areas, there would still be impacts, just less impacts than alternative A with a catastrophic wildfire.

Cumulative Impacts
None of the action alternatives is anticipated to have cumulative impacts on riparian areas and wetlands because these resources are not currently sustaining adverse impacts.

Air Quality and Smoke

Affected Environment
While prescribed fires can be an effective tool to reduce fuel loads and reduce the risk of catastrophic fires, they produce smoke which can result in air quality impacts to both public health and visibility.

Both wildfires and prescribed fires produce smoke that can impact visibility and create unhealthy air quality conditions. These impacts can be both local and regional depending on the amount of smoke produced. Typically, impacts are the greatest nearest to where the smoke is being produced; however, in certain conditions smoke can be transported and have impacts hundreds of miles away.
The area potentially impacted by smoke will vary based on several factors, including the amount of fuel consumed, the rate at which it's consumed, how the smoke is transported, the duration of the fire, meteorological conditions, and topography.

The project area is located in steep, mountainous terrain covered by dense Ponderosa Pine and mixed conifer forest approximately 5 miles west of Santa Fe. During the day, the area is affected by predominately southwesterly transport winds, while surface winds generally blow upslope and up-canyon on sunny afternoons and downslope and down-canyon at night. Historically, the greatest impacts from smoke from prescribed fires in this project area have been the City of Santa Fe, as smoke has settled into and down drainages at night. During the day, the sun's heat creates currents which carry the smoke upslope. At night cooler, denser air from higher elevations flows downslope, carrying any lingering smoke along with it. In the evenings, residual smoke would likely be transported down-canyon in the project area as a result of these types of flows. Because cooler air is heavier and cannot rise above warm air, smoke tends to follow the mountain terrain down drainages towards areas where people reside. During the daylight hours, these inversions tend to weaken and disappear as the sun warms the earth's surface. The smoke then lifts and disperses out of the area. However, depending on the transport winds and how high the smoke rises, many other communities in the area could be affected by smoke, including Las Vegas, Pecos, and many of the communities in the valley between the Sangre de Cristo and Jemez Mountains.

**Baseline Air Quality**

The project area typically has excellent air quality. Santa Fe has been noted by the World Health Organization and the American Lung Association as having some of the cleanest air in the United States and in the world. The entire area meets National Ambient Air Quality Standards (Air Quality Standards) for all criteria pollutants. However, there have been adverse impacts to air quality in this area from wildfires and prescribed fires in recent years.

While smoke is made up of a complex mixture of gases, the main pollutants of concern are particulate matter (PM). There are Air Quality Standards for both PM 10 (particulate matter less than 10 microns in size) and PM 2.5 (particulate matter less than 2.5 microns in size). The greatest concern lies with PM 2.5. Due to its smaller size, PM 2.5 particles can travel deep into the lungs and, at elevated levels, can result in health issues. In healthy people, symptoms of smoke exposure usually include irritation of the eyes, nose, and throat or breathing discomfort. More severe symptoms may include chest tightness, wheezing, shortness of breath, and coughing. Smoke exposure can aggravate the conditions of individuals with asthma, chronic lung disease, or cardiovascular disease. Individuals particularly sensitive to exposure to PM 2.5 are people with existing respiratory and heart conditions and the very young, elderly, and pregnant women.

The New Mexico Environment Department operates two monitoring sites in Santa Fe that measure PM 2.5, one downtown nearest the project area and one at the airport. During prescribed fires, the Santa Fe National Forest also operates monitor to measure particulate matter (PM 2.5) at the mouth of the Watershed. As noted earlier, typical levels of PM 2.5 at these sites is very low when compared to the standard. The standard deemed protective of public health by the State of New Mexico and the EPA is 35 µg/m$^3$ averaged over 24 hours. Typical levels in Santa Fe are usually below 10 µg/m$^3$, with a long-term average below 5 µg/m$^3$.

**Visibility**

The analysis area abuts and lies within the Pecos Wilderness Class 1 airshed. Class 1 airsheds have been designated within the Clean Air Act as deserving the highest level of air quality protection. Congress designated (42 U.S.C. 7472)(CAA 162) 158 areas as Class 1 airsheds, including National
Parks larger than 6,000 acres and national wilderness areas larger than 5,000 acres, on August 7, 1977. These Class 1 areas may not be re-designated to a less protective classification. Other nearby Class I areas are Bandelier, approximately 35 miles west of the analysis area; Wheeler Peak, about 60 miles north; and San Pedro Parks, which is approximately 60 miles west-northwest of the analysis area. As air quality protection is legally mandated for Class 1 airsheds, the impact analysis focuses on potential changes to these Class 1 areas.

The standard measurement to assess air quality in Class 1 areas is visibility. Visibility relates to conditions that allow humans to see and appreciate the inherent beauty of the landscape, which can be greatly affected by the particulate matter and gasses found in smoke. The Regional Haze Rule requires that visibility in Class 1 airsheds be improved over the long term on a region-wide scope and addresses fire emissions as one contributor to regional haze. The goal is to return these areas to natural visibility conditions by 2064.

While the greatest impacts can be assumed to occur in the Pecos Wilderness Class 1 airshed, as the project is located on the area’s boundary, there is no visibility monitoring in the Wilderness. There are visibility monitoring stations at the three other nearby Class 1 areas, Wheeler Peak, San Pedro Parks, and Bandelier. As of 2007, all three of these Class I areas were slightly ahead of schedule, but further improvements will be needed to meet the national visibility goal. Monitoring results showed that in the Bandelier and San Pedro Parks Class I areas, the absolute worst days for visibility were attributed to smoke from the 2000 Cerro Grande Fire.

Environmental Consequences of the Alternatives

Effects Analysis Methodology
The analysis considered past data on impacts from wildfires in the Southwest and prescribed fires in the Watershed. In addition, emissions were estimated using the First Order Fire Effects Model (FOFEM), Version 6. FOFEM is a computer program that was developed to meet the needs of resource managers, planners, and analysts in predicting and planning fire effects, including fuel consumption and smoke production. FOFEM is national in scope and uses four geographical regions: Pacific West, Interior West, Northeast, and Southeast. The FOFEM model for this project used the Interior West region with Ponderosa Pine as the cover type. The geographic regions have regional settings, and some of the settings were adjusted to be more in line with the Southwest region and our normal weather patterns.

The current analysis was based on three scenarios: Alternative A (No Action with Crown Fire), Alternative B (the Proposed Action), and Alternative C (Pretreatment before burning). First-order fire effects are those that concern the direct, indirect, or immediate consequences of fire. While emissions do not signify impacts to air quality, specifically human health, they are one metric to consider that can draw some distinction between alternatives.

The output of the FOFEM model includes seven types of emissions, including PM 2.5 and 10, carbon monoxide (CO), methane (CH₄), carbon dioxide (CO₂), oxides of nitrogen (NOₓ), and sulfur dioxide (SO₂).

Model Assumptions
The FOFEM model was run under three scenarios: very dry conditions, moderate conditions, and moderate conditions after mechanical thinning. The very dry conditions scenario was used to simulate conditions that would be expected during a wildfire, including low moisture levels in the fuel and soil. Moderate conditions simulated what would be required for a prescribed fire, with soil...
and fuel moistures at levels typical during a prescribed fire. Under the two scenarios (very dry and moderate conditions), the same fuel loading and acreage were used. For the third scenario, reduced fuel loading was shown with moderate fire conditions.

The smoke modeling scenarios for the action alternatives were run assuming that the entire treatment area would be burned at once, with fuel loadings as specified above. It is important to note that the emission analysis presented is a “maximum” and that the actual cumulative amounts of smoke produced by the project over its lifetime would be less; this is due to maintenance burns occurring under conditions with lesser fuel loading than that of initial burns.

A summary of the predicted emissions from the alternatives is presented in Tables 11-13. Table 11 indicates emissions in pounds/acre along with the relationship between the alternatives expressed as percentages. The emissions in pounds/acre were then used to calculate the predicted emissions for the actual acreages that would be burned in Tables 12 and 13. It is important to note that the 2,900-acre Alternative 1 emissions indicated in Table 12 are only for the unlikely case that a catastrophic fire would be restricted to the proposed treatment area boundary. A catastrophic fire would likely be much larger, on the order of 10,000–40,000 acres in size, and the amount of emissions predicted from fires of these sizes are indicated in Tables 12 and 13.

### Table 12. FOFEM Daily Burning Emission Estimates in Pounds/Acre

<table>
<thead>
<tr>
<th>Emission</th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>Alternative C</th>
<th>Percentage of Alternative A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alternative A</td>
<td>Alternative B</td>
<td>Alternative C</td>
<td>Percentage of Alternative A</td>
</tr>
<tr>
<td>PM 10</td>
<td>1,705</td>
<td>1,340</td>
<td>880</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>1,445</td>
<td>1,136</td>
<td>746</td>
<td>0.79</td>
</tr>
<tr>
<td>CO</td>
<td>17,261</td>
<td>13,530</td>
<td>8,377</td>
<td>0.78</td>
</tr>
<tr>
<td>CH₄</td>
<td>822</td>
<td>645</td>
<td>409</td>
<td>0.78</td>
</tr>
<tr>
<td>CO₂</td>
<td>193,788</td>
<td>155,094</td>
<td>130,966</td>
<td>0.80</td>
</tr>
<tr>
<td>NOₓ</td>
<td>226</td>
<td>183</td>
<td>177</td>
<td>0.81</td>
</tr>
<tr>
<td>SO₂</td>
<td>127</td>
<td>101</td>
<td>82</td>
<td>0.80</td>
</tr>
</tbody>
</table>

### Table 13. Derived Emission Estimates in Lbs. for Proposed Treatment Area and Catastrophic Crown Fire

<table>
<thead>
<tr>
<th>Emission</th>
<th>2,900 acre Proposed Treatment Area</th>
<th>10,000 acres</th>
<th>40,000 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alternative A</td>
<td>Alternative B</td>
<td>Alternative C</td>
</tr>
<tr>
<td>PM 10</td>
<td>4,944,500</td>
<td>3,886,000</td>
<td>2,552,000</td>
</tr>
<tr>
<td>PM 2.5</td>
<td>4,190,500</td>
<td>3,294,400</td>
<td>2,163,400</td>
</tr>
<tr>
<td>CO</td>
<td>50,056,900</td>
<td>39,237,000</td>
<td>24,293,300</td>
</tr>
<tr>
<td>CH₄</td>
<td>238,3800</td>
<td>1,870,500</td>
<td>1,186,100</td>
</tr>
<tr>
<td>CO₂</td>
<td>562,000,000</td>
<td>450,000,000</td>
<td>380,000,000</td>
</tr>
<tr>
<td>NOₓ</td>
<td>655,400</td>
<td>530,700</td>
<td>513,300</td>
</tr>
<tr>
<td>SO₂</td>
<td>368,300</td>
<td>292,900</td>
<td>237,800</td>
</tr>
</tbody>
</table>

---

Final Environmental Assessment
Santa Fe Municipal Watershed Pecos Wilderness Prescribed Burn Project
Table 14. Derived Emission Percentages of Alternatives Relative to Catastrophic Crown Fire

<table>
<thead>
<tr>
<th>Emission</th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>Alternative C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10,000 acre</td>
<td>40,000 acre</td>
<td>10,000 acre</td>
</tr>
<tr>
<td>PM 10</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
<tr>
<td>PM 2.5</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
<tr>
<td>CO</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
<tr>
<td>CH₄</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
<tr>
<td>CO₂</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
<tr>
<td>NOx</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
<tr>
<td>SO₂</td>
<td>3.45</td>
<td>13.79</td>
<td>0.23</td>
</tr>
</tbody>
</table>

**Alternative A—The No-Action Alternative**

If a large crown fire occurred in the area, it is likely that 10,000–40,000 acres or more could burn in the first day or two, similar to the Wallow and Las Conchas fires that burned in Arizona and New Mexico in 2011 or the Cerro Grande Fire in 2000. Typically, smoke produced from wildfires is two to four times greater than that of prescribed burns when the same acreage is burned (Huff et al. 1995). Wildfires typically consume more fuel and thus produce more smoke. Massive quantities of smoke can be produced in a short period of time, and the smoke often persists for a long time (weeks or months). The higher heat intensities of wildfires will burn through large diameter trees and logs, which can continue smoldering for months.

In extreme events when smoke accumulates over a period of days, levels can be reached that are unhealthy for the general population. Such events are more likely to be associated with a large wildfire than with a prescribed burn because of the cumulative effects of consecutive burn periods. The amount of smoke that is generated from a wildfire (which is uncontrolled fire) is much greater than the smoke produced from a prescribed burn, in which smoke management techniques are employed. In a wildfire scenario, large amounts of pollutants are produced that would likely exceed State air quality standards for particulate emissions.

There could be impairments to visible portions of the Wilderness and scenic vistas of the Scenic Byway that would affect hikers and other recreationists. People living in the area who have pre-existing respiratory conditions such as heart or lung diseases may experience more severe impacts to their health due to the duration of the smoke from an uncontrolled wildfire.

Table 14 below shows examples of smoke impacts from several wildfires in the past decade in the Southwest. In each case, the fires actively burned for over a month before they were contained and continued to put up smoke after containment. Additionally, the smoke they produced resulted in unhealthy and often hazardous levels of particulate matter in communities close to where the fires were occurring and created significant impacts for those downwind of these fires. Although some of the examples refer to levels of PM 10 rather than PM 2.5, it should be noted that PM 2.5 typically makes up to 70–90% of PM 10 and therefore is a reasonable proxy for assessing smoke impacts when PM 2.5 data are not available.

Under this alternative, the potential for smoke to adversely impact human health is the most significant. The FOFEM model shows this alternative would have the highest amounts of emissions out of the three alternatives.
Table 15. Wildfires in the Southwest and their Duration and Smoke Concentrations

<table>
<thead>
<tr>
<th>Wildfire Name (year)</th>
<th>Duration</th>
<th>Acres Burned</th>
<th>Measured PM Concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerro Grande (2000)</td>
<td>2.5 months</td>
<td>48,000</td>
<td>&gt;13,000 µg/m³ (PM 10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Several days of high levels of PM 10 (µg/m³) in Holbrook, Snowflake, and Heber, Arizona; levels were in the unhealthy (150–400), very unhealthy (400–500), and hazardous levels (&gt;500).</td>
</tr>
<tr>
<td>Rodeo-Chediski (2002)</td>
<td>1 month</td>
<td>468,638</td>
<td>Several days of PM10 &gt; 100 µg/m³</td>
</tr>
<tr>
<td>Aspen Fire (2003)</td>
<td>1 month</td>
<td>84,750</td>
<td>&gt;1,000 µg/m³ PM 2.5 in several communities near the fire. Impacts were measured as far as 483 km (300 miles) away in Los Alamos and 563 km (350 miles) away in Taos with values of 248 and 103 µg/m³ PM 2.5, respectively. Excesses of air quality standards were measured in several New Mexico cities over several days, including Albuquerque and Santa Fe.</td>
</tr>
<tr>
<td>Wallow (2011)</td>
<td>1 month</td>
<td>538,048</td>
<td>Hazardous air quality conditions were measured in Los Alamos and several Pueblos over several days, with value exceeding 1,000 µg/m³ in several instances.</td>
</tr>
<tr>
<td>Las Conchas (2011)</td>
<td>1 month</td>
<td>&gt;156,000</td>
<td>Several days of PM10&gt; 100 µg/m³</td>
</tr>
</tbody>
</table>

Alternative B

The potential for air quality impacts under Alternative B would be expected to be less than that of the No-Action Alternative with a crown fire. In addition, the potential for impacts are further reduced under this alternative because of required mitigation measures that would limit burning to days with good ventilation conditions, as well as the use of other emission-reduction techniques in accordance with the State Smoke Management Program (see page 17).

Smoke is an unavoidable effect of prescribed burning. Based on typical daytime winds in the area, smoke from the burn area would likely move toward the northeast and dissipate during the periods of active burning. In this case, a prescribed fire would likely last for 5–7 days. During the daytime, the amount of smoke would tend to be greatest for a few hours in the late afternoon when the fire is the hottest. People in the surrounding areas and in Albuquerque and Santa Fe would likely see smoke in the air, although at a considerable distance. In the evenings during the burn and for a few days afterward, residual smoke would be most noticeable when it settles into local canyon bottoms such as the Santa Fe River valley and the City of Santa Fe. To reduce smoke emissions during the evening, mass ignitions are particularly effective when used during good ventilation because the fuel burns hotter and is better consumed so that there is less smoldering overnight. The heat of the fire also helps lift the smoke into transport winds. Mitigation measures listed in Chapter 2 would reduce the risk of smoke intrusions as well (page 16).

According to the FOFEM model, Alternative B would have about 20% fewer emissions than Alternative A.
Alternative C

Although Alternative C reduces the effects of catastrophic fire in the project area similar to Alternative B, the fuels left on the ground would have a longer impact on air quality by burning over a longer duration (several days). The mechanical treatment under Alternative C would leave a different fuel arrangement and fuel loadings would be heavier. There would be a difference in the live fuels (standing trees) in Alternative B and the dead and cured fuels of this alternative. Fuels would have to be piled for burning and/or broadcast burning among the smaller-diameter trees. According to the FOFEM results for this alternative, there would be almost half of the emissions of Alternative A with the thinning and prescribed burning proposed.

Cumulative Effects

In considering cumulative effects, it was not necessary to analyze all the activities in the entire airshed, which covers a large portion of New Mexico, because smoke from the proposed burn would not affect air quality across the entire airshed. The smoke-sensitive receptors previously listed were primarily emphasized, and consideration was given as to whether emissions from other activities would have similar effects when combined with smoke from the proposed burn. Cumulative effects include those from past, ongoing, and reasonably foreseeable future activities that combine with effects of the proposed project in contributing to the total particulate matter or carbon monoxide load in the same areas. In the affected area, there is no large industry producing significant PM or carbon monoxide. While the other potential sources of these pollutants cannot be accurately quantified, they include vehicle combustion engines, fireplaces and wood stoves, fugitive dust from roads and disturbed land, industry emissions, burning by agencies and private landowners, and wildfires.

Emissions from the smoke from either a wildfire or prescribed fire combined with emissions from the various other sources and the existing PM in the air from past activities would negligibly increase the amount of pollutants that would be distributed to areas downwind. Wildfires, prescribed burning, and fireplace smoke would be the primary contributors of PM to cumulative air quality effects. This area has experienced significant impacts to air quality from wildfires. If one of the options utilizing prescribed fire is selected, no other prescribed burns would likely occur in the vicinity at exactly the same time. However, it is foreseeable that prescribed burning would occur each year on surrounding forested lands based on broader landscape restoration strategies. However, these fuel reductions are expected to diminish potential impacts to air quality from future wildfires. Residential wood burning may occur in the fall and overlap the timing of the prescribed burn. However, because of access and snow, significant burning would not occur in winter when there is an increase in residential wood burning and air inversions.

A number of similar thinning and prescribed burning projects have occurred near the project areas that will have similar effects. The largest of these is the Santa Fe Municipal Watershed Thinning Project, which is taking place to the south and east. Some similar thinning has occurred in the private lands to the west, as well as the Hyde Memorial Park to the north and west of the project area. Finally, the City of Santa Fe has undertaken thinning on parcels of City-owned land several miles to the south of the project area. The additional benefits of past and foreseeable future thinning would be to reduce the risk of crown fires across a larger area.
 Specifically, other activities that have potential to add to the effects of the Santa Fe Wilderness Prescribed Burn Project in respect to air quality and human health are as follows:

- Emissions from the Santa Fe Municipal Watershed Project in the lower Watershed that has performed ongoing burning since 2002 and will continue to pile and broadcast burn to complete the initial and maintenance treatments described in the Santa Fe Watershed EIS (see Figure 7 in Section 3.1.3 above).
- Emissions from similar prescribed burning in the vicinity of the analysis area that is close enough to contribute smoke in a measurable way.
- Emissions from traffic in the Santa Fe Metro as well as the greater traffic network of northern New Mexico.

Over the past 10 years, thinning and prescribed burning has been conducted in the lower part of the Watershed with mostly positive outcomes regarding air quality. During implementation, monitoring is conducted in sensitive receptor areas, and burning is stopped if impacts are occurring. There have been a few days where inversions have affected the Santa Fe area, but overall air quality has been favorable.

Substantial adverse impacts to regional haze are also not expected, but if they do occur, they will be limited in duration. No substantial adverse cumulative air quality impacts would be anticipated. This is due to the timing, coordination between Federal agencies and the State regulatory agency, monitoring during implementation of the burn, and other mitigation measures that reduce emissions. Any prescribed burning will comply with the State’s Smoke Management Program. Current air quality in the affected area is within standards and would be expected to remain within standards even with the additive effects from the prescribed burning in either Alternatives B or C.

**Climate, Greenhouse Gases, and Global Warming**

Greenhouse gases (GHGs) are components of the atmosphere that trap heat relatively near the surface of the earth, and, therefore, contribute to the greenhouse effect and global warming. Most GHGs occur naturally in the atmosphere, but increases in their concentration result from human activities such as the burning of fossil fuels. Global temperatures are expected to continue to rise as human activities continue to add carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and other greenhouse (or heat trapping) gases to the atmosphere.

Certain GHGs are more effective at warming the Earth, or “thickening the blanket”, than others. The two most important characteristics of a GHG in terms of climate impact are how well the gas absorbs energy (preventing it from immediately escaping to space), and how long the gas stays in the atmosphere (EPA 2012).

The Global Warming Potential (GWP) for a gas is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years) compared to carbon dioxide (Solomon et al. 2007). The larger the GWP, the more warming the gas causes. For example, methane’s 100-year GWP is 21, which means that methane will cause 21 times as much warming as an equivalent mass of carbon dioxide over a 100-year time period (Forster et al 2007).

Since 1900, the Earth’s average surface air temperature has increased by about 1.2–1.4°F. The warmest global average temperatures on record have all occurred within the past 10 years, with the warmest year being 2005 (EPA 2007). Most of the U.S. is expected to experience an increase in average temperature. Precipitation changes, which are also very important to consider when
assessing climate change effects, are more difficult to predict. Whether or not rainfall will increase or decrease remains difficult to project for specific regions (IPCC 2007; EPA 2010). The extent of climate change effects and whether these effects prove harmful or beneficial will vary by region over time and with the ability of different societal and environmental systems to adapt or cope with the change. Human health, agriculture, natural ecosystems, coastal areas, and heating and cooling requirements are examples of climate-sensitive systems. Rising average temperatures are already affecting the environment. Some observed changes include shrinking of glaciers, thawing of permafrost, later freezing and earlier break-up of ice on rivers and lakes, lengthening of growing seasons, shifts in plant and animal ranges, and earlier flowering of trees (IPCC 2007; EPA 2010).

In 2010, the total amount of GHG emissions in the U.S. was 6,821.8 Tg (CO\textsubscript{2} eq.). One Tg (teragram) is equivalent to one million metric tons or 1 x 10\textsuperscript{12} g. GHG emissions rose 3.2% from 2009–2010 and have increased 10.5% since 1990 (EPA 2012).

**Effects to Climate, Greenhouse Gases, and Global Warming**

Both wildfires and prescribed fires emit greenhouse gases; however, wildfires typically emit significantly greater amounts than prescribed fires. In addition, after catastrophic wildfires, the forest’s ability to store carbon is greatly diminished due to adverse effects on soil and the loss of organic matter. Under the two scenarios (wildfire vs. prescribed fire), greenhouse gas emissions were calculated for CO\textsubscript{2} and CH\textsubscript{4}; the latter is expressed as CO\textsubscript{2}-equivalent to account for GWP (Table 15).

**Table 16. Green House Gas Estimates of the Alternatives in MetricTons**

<table>
<thead>
<tr>
<th>GHG</th>
<th>2,900-acre Proposed Treatment Area</th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>Alternative C</th>
<th>10,000 acres</th>
<th>40,000 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH\textsubscript{4} (CO\textsubscript{2} equivalent)</td>
<td>1,192 (25,030)</td>
<td>935 (19,640)</td>
<td>593 (12,454)</td>
<td>4,110 (86,310)</td>
<td>16,440 (345,240)</td>
<td></td>
</tr>
<tr>
<td>CO\textsubscript{2}</td>
<td>280,993</td>
<td>224,886</td>
<td>189,901</td>
<td>968,940</td>
<td>3,875,760</td>
<td></td>
</tr>
<tr>
<td><strong>Total GHG</strong></td>
<td><strong>306,023</strong></td>
<td><strong>244,527</strong></td>
<td><strong>202,355</strong></td>
<td><strong>1,055,250</strong></td>
<td><strong>4,221,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

Under the two Alternative A large-acreage wildfire scenarios, between 4 and 21 times more greenhouse gases would be produced than either Alternative B or C. Assuming that the total amount of GHG emissions in the U.S. has increased over the last two years at the same rate as it did from 2009–2010, the current total U.S. annual emissions would be 7,265.4 Tg. Alternative A under the 40,000-acre wildfire scenario would contribute 3.83 Tg to this annual GHG figure, or about 0.05%. Alternative C would contribute 0.18 Tg, or 0.002%, and Alternative B would add 0.22 Tg, or 0.003%. As these small percentages indicate, none of the alternatives, even the worst-case wildfire scenario, would have more than a negligible cumulative effect on global warming and climate.
WILDLIFE

Affected Environment

Special Status Species
A Biological Assessment and Evaluation (BA&E) and a Migratory Birds Effects Analysis (MBEA) has been written for the proposed project (USFS 2012b, c). The BA&E addresses potential impacts the project may have on Federally listed Threatened and Endangered species and USFS Region 3 Regional Forester's sensitive species list, and the MBEA addresses potential impacts the project may have on migratory birds.

Threatened and Endangered Species
In Santa Fe County, two bird species, one fish, and one mammal are listed as Threatened or Endangered by FWS and therefore warrant full protection under the Endangered Species Act (Table 17). A single endangered plant species was mentioned in the BA&E, Holy Ghost Ipomopsis (*Ipomopsis sancti-spiritus*), because it is known to occur on the SFNF; however, the plant is not listed in Santa Fe County.

The Rio Grande Silvery Minnow has been extirpated from Santa Fe County. A 2004 agreement between the USFS Southwest Regional Office and the FWS acknowledges that Southwestern Willow Flycatcher and Black-footed Ferret do not occur on the SFNF. There is no designated Critical Habitat in the analysis area, and there are no Mexican spotted owl (MSO) Protected Activity Centers (PACs).

Table 17. Threatened and Endangered Species in Santa Fe County

<table>
<thead>
<tr>
<th>Species</th>
<th>Status</th>
<th>Project Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexican spotted owl (MSO)</td>
<td>Threatened</td>
<td>Not habitat for the MSO. No PAC. No Critical Habitat.</td>
</tr>
<tr>
<td>Holy Ghost Ipomopsis</td>
<td>Endangered</td>
<td>Not present. No Critical Habitat. This plant is only occurs on Pecos Ranger District.</td>
</tr>
<tr>
<td>Canada lynx</td>
<td>Proposed</td>
<td>Not present. No Critical Habitat. Introduced in San Juan Mountains in CO</td>
</tr>
<tr>
<td>Black-footed ferret</td>
<td>Endangered</td>
<td>Not present. No Critical Habitat. Not in NM</td>
</tr>
<tr>
<td>New Mexico (meadow) jumping mouse</td>
<td>Proposed Endangered</td>
<td>Not present. No Critical Habitat. No habitat present.</td>
</tr>
<tr>
<td>Southwestern willow flycatcher</td>
<td>Endangered</td>
<td>Not present. No Critical Habitat. No habitat present.</td>
</tr>
<tr>
<td>Jemez Mountains Salamander</td>
<td>Endangered</td>
<td>Not present. No Critical Habitat. Outside of species range.</td>
</tr>
</tbody>
</table>
The threatened or endangered species listed in the above Table are not found within the project area and therefore will not be discussed further.

**Region 3 Regional Forester's Sensitive Species**
Species on the 2013 *Regional Forester's Sensitive Animal and Plant Lists* found on the Santa Fe National Forest were evaluated in the BA&E (Tables 18 and 19).

**Table 18. Regional Forester's Sensitive Species Fauna List for the Santa Fe NF**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Habitat in Project Area?</th>
<th>Limiting Factors/Threats to Species or Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Leopard Frog</td>
<td><em>Rana pipiens</em></td>
<td>No</td>
<td>Habitat loss, non-native predators, disease. AZ - Two of the main threats to this species are habitat destruction and pollution. Also they are collected for biological supply houses and fishermen use them for bait.</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td><em>Haliaeetus leucocephalus</em></td>
<td>No</td>
<td>No nesting/breeding/ or wintering habitat.</td>
</tr>
<tr>
<td>Northern Goshawk</td>
<td><em>Accipiter gentilis</em></td>
<td>Habitat present</td>
<td>Wildfire, logging-even age cutting, improper livestock grazing, loss of prey habitat.</td>
</tr>
<tr>
<td>American Peregrine Falcon</td>
<td><em>Falco peregrinus anatum</em></td>
<td>No</td>
<td>Pesticides/chemicals, wind turbines.</td>
</tr>
<tr>
<td>White-Tailed Ptarmigan</td>
<td><em>Lagopus leucurus</em></td>
<td>No</td>
<td>Sensitive to human disturbance and improper livestock grazing. Lives above timberline only in Pecos Wilderness on the SFNF.</td>
</tr>
<tr>
<td>Western Yellow Billed Cuckoo</td>
<td><em>Coccyzus americanus occidentalis</em></td>
<td>No</td>
<td>Lower to mid-elevation floodplain cottonwood forest. Logging clearcuts, improper livestock grazing in riparian zones, pesticides in riparian zones.</td>
</tr>
<tr>
<td>Burrowing Owl (Western)</td>
<td><em>Athene cunicularia hypugae</em></td>
<td>No</td>
<td>Habitat alteration/fragmentation and loss of edge habitat. Dependent on burrows of prairie dogs for nest sites.</td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Species or Habitat in Project Area?</td>
<td>Limiting Factors/Threats to Species or Habitat</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Gray Vireo</td>
<td><em>Vireo vicinior</em></td>
<td>No</td>
<td>Even aged forest management, habitat fragmentation, improper livestock grazing, and cowbird parasitism. Changes in fire regime that bring about an increase in fire extent or frequency may be detrimental.</td>
</tr>
<tr>
<td>Lilljeborg's Pea-Clam</td>
<td><em>Pisidium lilljeborgi</em></td>
<td>No</td>
<td>The restricted population of this unique pea-clam is vulnerable to contaminants, sedimentation, and stochastic natural events (fire, drought). Potential biological threats are posed by introduction and establishment of the Zebra Mussel in Nambe Lake from fish stocking practices and/or accidental bait bucket introduction.</td>
</tr>
<tr>
<td>RUIDOSO SNAGGLE TOOTH</td>
<td><em>Ruidoso Snaggletooth</em></td>
<td>No</td>
<td>Found on bare soil, under stones, and in thin accumulations of grass thatch and juniper litter on mid-elevation carbonate cliffs and xeric limestone grasslands along the eastern slopes of the Sangre de Cristo and Sacramento mountains in eastern New Mexico, where the only extant occurrences are believed to be.” (Nekola and Coles, 2010).</td>
</tr>
<tr>
<td>Rio Grande Chub</td>
<td><em>Gila pandora</em></td>
<td>No</td>
<td>Threats are stream dewatering and habitat modification due to channelization.</td>
</tr>
<tr>
<td>Rio Grande Cutthroat Trout</td>
<td><em>Oncorhynchus clarki virginalis</em></td>
<td>Yes</td>
<td>Habitat degraded by improper livestock grazing and timber harvest; hybridization and competition with various introduced salmonids; dewatering caused by irrigation diversion; poor winter habitat, stream intermittency, and deteriorating water quality resulting from drought; susceptible to habitat loss/degradation resulting from wildfires; highly vulnerable to replacement by non-native trout; more vulnerable to angling than are coexisting trout; and habitat is fragmented, most populations are isolated in headwater habitats, and gene flow among populations is virtually nonexistent.</td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Species or Habitat in Project Area?</td>
<td>Limiting Factors/Threats to Species or Habitat</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Rio Grande Sucker</td>
<td><em>Catostomus plebeius</em></td>
<td>No</td>
<td>Hybridization with the introduced White Sucker is the primary reason for decline in northern New Mexico and southern Colorado. Elsewhere, habitat modifications (elevated sediments and stream dewatering) have contributed to declines. Some populations may have been extirpated by the introduction of predaceous Northern Pike.</td>
</tr>
<tr>
<td>Cinereus (Masked) Shrew</td>
<td><em>Sorex cinereus</em></td>
<td>Unknown. Potential</td>
<td>Highly restricted distribution in Southwest.</td>
</tr>
<tr>
<td>Water Shrew</td>
<td><em>Sorex palustris</em> navigator</td>
<td>Yes</td>
<td>Southwest populations isolated on sky islands; limited to riparian/marshy areas.</td>
</tr>
<tr>
<td>Preble's Shrew</td>
<td><em>Sorex preblei</em></td>
<td>No</td>
<td>Only reported from Sandoval County.</td>
</tr>
<tr>
<td>Spotted Bat</td>
<td><em>Euderma maculatum</em></td>
<td>No</td>
<td>Populations considered vulnerable; threats include recreational climbing, pesticides, improper livestock grazing, and pest control operations.</td>
</tr>
<tr>
<td>Pale Townsend’s Big-Eared Bat</td>
<td><em>Corynorhinus townsendii pallescens</em></td>
<td>No</td>
<td>Disturbance/destruction of roost sites via recreational caving, mine reclamation and renewed mining, etc. Inadequate surveys of abandoned mines prior to closure.</td>
</tr>
<tr>
<td>Pika</td>
<td><em>Ochotona princeps saxatilis</em></td>
<td>No</td>
<td>Narrowly restricted habitat, confined to talus slopes and boulder fields in alpine and sub-alpine habitats. Found only in higher elevation in the Pecos Wilderness on the SFNF.</td>
</tr>
<tr>
<td>Goat Peak Pika</td>
<td><em>Ochotona princeps nigrescens</em></td>
<td>No</td>
<td>Narrowly restricted habitat, disjunct populations, confined to talus slopes and boulder fields in alpine and sub-alpine habitats. Only in the Jemez Mountains around the Valles Caldera National Preserve.</td>
</tr>
<tr>
<td>Gunnison’s Prairie Dog</td>
<td><em>Cynomys gunnisoni</em></td>
<td>No</td>
<td>Vulnerable to poisoning, shooting, agriculture, urbanization, habitat fragmentation, disease. Candidate, Limited to montane population.</td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Species or Habitat in Project Area?</td>
<td>Limiting Factors/Threats to Species or Habitat</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Meadow (New Mexico) Jumping Mouse</td>
<td><em>Zapus hudsonius</em></td>
<td>No</td>
<td>Highly restricted distribution, restricted range, loss of riparian habitat.</td>
</tr>
<tr>
<td>American Marten</td>
<td><em>Martes americana</em></td>
<td>Yes</td>
<td>Habitat loss and degradation, past extensive logging and trapping for pelts.</td>
</tr>
</tbody>
</table>

**Table 19. USFS-listed Sensitive Plant Species**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>County Where Found</th>
<th>Species or Habitat in Project Area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tufted Sand Verbena</td>
<td><em>Abronia bigelovii</em></td>
<td>Rio Arriba, Sandoval, Santa Fe</td>
<td>No. Hills and ridges of gypsum in the Todilto formation (1,737–2,256 m [5,700–7,400 feet] AMSL). Plants are conspicuous on otherwise rather barren gypsum. Not found in the project area.</td>
</tr>
<tr>
<td>Greene Milkweed</td>
<td><em>Asclepias uncialis</em> ssp. <em>uncialis</em></td>
<td>Apache, Santa Cruz, Yavapai, Colfax, Grant, San Miguel, Union</td>
<td>No. Not in Santa Fe County.</td>
</tr>
<tr>
<td>Chaco Milkvetch</td>
<td><em>Astragalus micromerius</em></td>
<td>McKinley, Rio Arriba, San Juan</td>
<td>No. Found in western Rio Arriba County near Chaco Canyon.</td>
</tr>
<tr>
<td>Pecos Mariposa Lily</td>
<td><em>Calochortus gunnisonii</em> var. <em>perpulcher</em></td>
<td>Mora, San Miguel</td>
<td>No. Specimens from high-elevation meadows in the Pecos Wilderness. Not found in the project area.</td>
</tr>
<tr>
<td>Yellow Lady’s Slipper</td>
<td><em>Cypripedium parviflorum</em> var. <em>pubescens</em> (= <em>C. calceolus</em> var. <em>pubescens</em>, <em>C. pubescens</em>)</td>
<td>Apache, Graham, Greenlee, Catron, Colfax, Grant, Otero, San Juan, San Miguel, Santa Fe, Taos</td>
<td>No. Specimens from high-elevation wet meadows in the Pecos Wilderness only. Not found in the project area.</td>
</tr>
<tr>
<td>Robust Larkspur</td>
<td><em>Delphinium robustum</em></td>
<td>Colfax, Rio Arriba (suspected not found), Sandoval, Taos</td>
<td>No. Canyon bottoms and aspen groves in lower and upper montane coniferous forests from (7,200-11,200 ft.) One specimen recorded from Taos county. Not found in the project area.</td>
</tr>
<tr>
<td>Heil’s Alpine Whitlow Grass</td>
<td><em>Draba heilii</em></td>
<td>Rio Arriba and Mora Counties.</td>
<td>High elevation alpine plant.</td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>County Where Found</td>
<td>Species or Habitat in Project Area?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------</td>
<td>--------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Pecos Fleabane</td>
<td>Erigeron subglaber</td>
<td>San Miguel, Taos</td>
<td>No. Found in Pecos Wilderness open meadows. Not found in the project area.</td>
</tr>
<tr>
<td>Wood Lily</td>
<td>Lilium philadelphicum</td>
<td>Los Alamos, Otero, Rio Arriba, Sandoval, San Miguel, Santa Fe</td>
<td>No. Require moist, partially shaded sites. Not found in project area.</td>
</tr>
<tr>
<td>Chama Blazing Star</td>
<td>Mentzelia conspicua</td>
<td>Rio Arriba</td>
<td>No. Conspicuous, large (2-inch) yellow flowers approximately 1 m tall. Specimens recorded in Chama Canyon and Ghost Ranch on sandstone formations. Not found in the project area.</td>
</tr>
<tr>
<td>Springer's Blazing Star</td>
<td>Mentzelia springeri</td>
<td>Los Alamos, Sandoval, Santa Fe</td>
<td>No. Found along road cuts with Bandelier tuff and pumice. Not found in project area.</td>
</tr>
<tr>
<td>Arizona Willow</td>
<td>Salix arizonica</td>
<td>Apache, Mora, Rio Arriba, Taos</td>
<td>No. High-elevation riparian meadows. Specimens found in San Pedro Parks. Not found in the project area.</td>
</tr>
</tbody>
</table>

Migratory Birds

The Migratory Bird Treaty Act (MBTA) of 1918 (United States Code, Title 16, Chapter 7, Subchapter II) prohibits the “pursuit, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof.” The ensuing Executive Order 13186, signed January 10, 2001 by President Clinton, “directs executive departments and agencies to take certain actions to further implement the [MBTA].” Such actions include the responsibility that Federal agencies “taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations … develop and implement, within two years, a Memorandum of Understanding with the Fish and Wildlife Service, that shall promote the conservation of migratory bird populations.”

New Mexico Partners in Flight (NMPIF) identifies physiographic areas and high-priority migratory bird species by broad habitat types (NMPIF 2007). The SFNF is located within Bird Conservation Region (BCR) 16, Southern Rockies/Colorado Plateau. The project area contains both Ponderosa pine and mixed conifer vegetation types. High-priority migratory bird species found in these habitat types include Northern goshawk, Mexican spotted owl, Flammulated owl, Virginia’s Warbler, and Grace’s warbler. Although Greater pewee and Olive warbler are both known to occur in the two vegetation types, these species will not be considered because they do not occur on the SFNF.
Management Indicator Species Habitat

SWreGAP data and Biota Information System of New Mexico database searches were used to determine which general wildlife species would likely be present in the analysis area.

The USFS prepared a Management Indicator Assessment for the proposed project (USFS 2012a). The Forest Plan identifies eight wildlife species as Management Indicator Species (MIS) (Table 20). These species are used to monitor the general health of the Forest’s ecosystems and the effects of planned management activities on viable populations of all fish and wildlife species. MIS species were selected during the development process of the Forest Plan and were chosen because of their ability to respond to habitat changes early or at low levels of stress.

Estimates of MIS populations were evaluated from a number of sources for each species and then ranked into descriptive categories for the SFNF (Table 20). Populations of MIS species would be expected to fluctuate within a category from year to year. However, a species would not be expected to switch from category to category without some long-term change in environmental conditions. For example, a change in ranking from uncommon to rare would be a cause for concern and would warrant intensive evaluation of the species. The ranking system is based on the predicted number of breeding pairs or adult females, and is dependent on which is most appropriate for the species addressed.

There are six dominant SWreGAP vegetation associations in the analysis area, all of which occur in the proposed treatment area. Vegetation associations along with management indicator species occurring by taxonomic group are presented in Table 20. Trend and habitat trend are from the SFNF MIS Report 2012.

Table 20. Santa Fe National Forest Management Indicator Species

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Key Habitat Component</th>
<th>Habitat Trend</th>
<th>Population Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merriam’s Turkey</td>
<td><em>Meleagris gallopavo</em></td>
<td>Ponderosa Pine zone that allows for grass, forb, and mast-producing vegetation to grow.</td>
<td>stable</td>
<td>stable</td>
</tr>
<tr>
<td>Pinyon Jay</td>
<td><em>Gymnorhinus cyanocephalus</em></td>
<td>Foraging habitat and mast-producing species in pinyon-juniper habitat.</td>
<td>declining</td>
<td>stable</td>
</tr>
<tr>
<td>Hairy Woodpecker</td>
<td><em>Picoides villosus</em></td>
<td>Mature forest habitat and snags.</td>
<td>stable to increasing</td>
<td>stable</td>
</tr>
<tr>
<td>Mourning Dove</td>
<td><em>Zenaida macroura</em></td>
<td>Mid and low elevation grasslands, woodlands, and Ponderosa Pine habitats.</td>
<td>stable to increasing</td>
<td>stable</td>
</tr>
<tr>
<td>Mexican Spotted Owl</td>
<td><em>Strix occidentalis lucida</em></td>
<td>Late seral stage mixed conifer.</td>
<td>declining</td>
<td>stable</td>
</tr>
</tbody>
</table>
### Table 21. Management Indicator Species in the Project Area

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merriam’s Turkey</td>
<td></td>
<td>Habitat and species present in area.</td>
</tr>
<tr>
<td>Pinyon Jay</td>
<td></td>
<td>Habitat and species not present in area.</td>
</tr>
<tr>
<td>Hairy Woodpecker</td>
<td></td>
<td>Habitat and species present in area.</td>
</tr>
<tr>
<td>Mourning Dove</td>
<td></td>
<td>Habitat and species present in area.</td>
</tr>
<tr>
<td>Mexican Spotted Owl</td>
<td></td>
<td>Habitat and species not present in area.</td>
</tr>
<tr>
<td>Elk</td>
<td></td>
<td>Species not present in area.</td>
</tr>
<tr>
<td>Bighorn Sheep</td>
<td></td>
<td>Habitat and species not present in area.</td>
</tr>
<tr>
<td>Rio Grande Cutthroat Trout</td>
<td></td>
<td>Habitat and species present in area.</td>
</tr>
</tbody>
</table>

### Environmental Consequences of the Alternatives

#### Threatened and Endangered Species

The only Federally listed species with potential habitat addressed in the BA&E was the threatened Mexican Spotted Owl (MSO). It was determined that the alternatives would have no effect on this species. The determination meets criteria designated in the USDA guidance criteria for a No Effect determination and was based on the following:

- Surveys performed in 2002–2008 by the Rocky Mountain Research Station in the Watershed were negative for Mexican spotted owl. The area is at the upper limits in elevation for MSO and nesting habitat.
- Areas along the Santa Fe River that are identified as restricted riparian are not considered for burning.

MSO Critical Habitat – Not present. No effect.

#### USFS Sensitive Wildlife Species

A summary of the BA&E evaluation of the USFS Sensitive wildlife species that may occur in the analysis area is presented in Table 18.
**Alternative A** would have adverse impacts on all USFS-listed Sensitive species evaluated in the BA&E. Cinereus (Masked) shrew, and American marten would be adversely impacted because a catastrophic fire would not be restricted to forest types of the treatment area, but in fact would spread to spruce-fir stands where they are. Northern goshawk and Boreal owl would be adversely impacted because forest stands providing nesting and foraging habitat would be destroyed. Rio Grande Cutthroat Trout and Water Shrew would be adversely impacted because a catastrophic fire would burn riparian areas and ash flowing into the Santa Fe River would inundate spawning habitat.

**Alternatives B and C** would have no impact on Cinereus (Masked) shrew and American marten because the higher-elevation spruce-fir habitats that these species utilize would not be subject to prescribed fires.

**Alternatives B and C** would beneficially impact Northern goshawk and Boreal owl. Prescribed fires in the treatment area would alter tree densities by removing small trees and creating open areas containing snags that would benefit prey species for Northern goshawk and Boreal owl. Prescribed fires, while temporarily reducing grass cover, would allow more dense grass cover to return, which would benefit prey species.

Alternatives B and C may temporarily impact Rio Grande cutthroat trout and Water shrew if the prescribed fires were to reach riparian areas. No adverse impacts are expected to occur to Rio Grande Cutthroat trout or the shrew because the 50-foot unburned buffer zone will be mitigation to prevent ash from prescribed fire from entering fish habitat.

### Table 22. USFS-listed Sensitive Species Impact Summary

<table>
<thead>
<tr>
<th>Species</th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>Alternative C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Goshawk</td>
<td>May Impact−</td>
<td></td>
<td>May Impact +</td>
</tr>
<tr>
<td>(<em>Accipiter gentilis</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boreal Owl</td>
<td>May Impact−</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(<em>Aegolius funereus</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rio Grande Cutthroat Trout</td>
<td>May Impact−</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(<em>Oncorhynchus clarki virginalis</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinereus (Masked) Shrew</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(<em>Sorex cinereus cinerens</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Shrew</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(<em>Sorex palustris navigator</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Marten</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(<em>Martes americana origenes</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key:** May Impact− = may adversely impact, May Impact+ = may beneficially impact.

Riparian vegetation and ground cover will be able to filter out ash from prescribed fires and will keep it from reaching the river. In addition, no fires are to occur in May or June, thereby avoiding impacts during spawning season for Rio Grande Cutthroat Trout.

**USFS-listed Sensitive Plant Species**

The alternatives would have no impact on USFS-listed Sensitive plant species because the analysis area does contain suitable habitat and/or is outside the known range of these species.
**Migratory Birds**

Alternative A would have a direct adverse impact on migratory nesting birds if a catastrophic fire were to occur during breeding season.

Alternatives B and C would have no impact on migratory birds because prescribed fires would occur in late winter which is outside the breeding season.

**Management Indicator Species**

**Alternative A—The No-Action Alternative**

Alternative A would have an adverse impact on native wildlife species and the four MIS species identified in Table 21 because a catastrophic fire would result in a high level of wildlife mortality and would also destroy wildlife habitat for most species. Acres of standing snags would benefit the woodpeckers.

**Alternative B—The Proposed Action**

Alternative B would have a short-term adverse impact on native wildlife species during prescribed burns. Mobile species, such as birds and larger mammals, would be expected to leave areas being burned and their chances of mortality would be lower than smaller, less mobile species such as rodents, amphibians, and reptiles. Following prescribed burns, a beneficial impact to wildlife habitat is expected as vegetative ground cover would increase.

Alternative B should have a beneficial effect on habitat for Merriam’s Turkey. Although there could be some temporary and minor disturbance to individual turkeys, causing them to move away from the disturbance for a short period of time, this would not negatively affect their ability to reproduce or survive. Turkeys are very mobile, so all the potential negative effects would not impact the population or contribute to a downward trend in the population. This project is likely to have no negative impacts on the overall population trends for turkeys in the project area. The potential for incidental loss of a turkey nest would not likely be measurable above the normal population fluctuations that occur from year to year. Alternative B is not likely to measurably influence the status or trend of this species.

Alternative B would increase the number of snags available to Hairy Woodpecker for feeding and nesting and thus improve overall habitat quantity in the proposed treatment area. A low potential for incidental loss of a cavity nest tree exists because large trees would not be targeted and they would resist burning under the cooler conditions of a prescribed burn. No effects to individual woodpeckers are expected.

This project is expected to have no effect to the overall population trend for Hairy Woodpecker on the SFNF. Alternative B is not likely to measurably influence the status or trend of this species.

Alternative B would result in higher grass and forb ground cover that would produce seed for foraging Mourning Doves. Although there could be some temporary and minor disturbance effects to individual doves, this is highly improbable, as the proposed treatment area would be burned early in the year before nesting season. If Mourning Doves were present, they would move away from the disturbance for a short period of time. Alternative B would not adversely affect Mourning Doves’ ability to reproduce or survive. This project is likely to have no negative impacts on the overall population trends for mourning dove in the project area. The potential for incidental loss of a Mourning Dove nest would not likely be measurable above the normal population fluctuations that occur from year to year. Habitat quantity would not change, but the change in quality would be
beneficial to Mourning Dove habitat. Alternative B is not likely to measurably influence the status or trend of this species.

Alternative B may have temporary and minor impacts on individual Rio Grande Cutthroat Trout, although this is highly unlikely because tspawning takes place in June, when no prescribed burning would occur. The regrowth of forbs and grasses would intercept ash that might reach the Santa Fe River. A 50-foot buffer of unburned area will be left between the slope and the river as mitigation. The prescribed burn would not affect the ability of Rio Grande Cutthroat Trout to reproduce or survive. No impacts are expected on the overall population trends for Rio Grande Cutthroat Trout in the proposed treatment area. The potential for incidental loss of a Rio Grande Cutthroat Trout would not be measurable above the normal population fluctuations that occur from year to year. Habitat would not change. Alternative B is not likely to measurably influence the status or trend of this species.

**Alternative C**

Alternative C would result in the same impacts on wildlife species and the four MIS species as Alternative B; however, it would also have an additional temporary and adverse impact on these species due to the noise produced by chainsaws during thinning operations.

**Cumulative Impacts**

None of the alternatives would have cumulative impacts on Threatened and Endangered Species because the analysis area does not contain suitable habitat for these species nor are they known to occur in the project area.

Likewise, none of the alternatives would have cumulative impacts on USFS Sensitive plant species because the analysis area does not contain suitable habitat and/or it is outside the known range of these species. Alternative A would have adverse and cumulative impacts on the USFS Sensitive wildlife species indicated in Table 22, as well as on migratory birds.

Alternatives B and C are not anticipated to have negative cumulative impacts on USFS Sensitive species or migratory birds because mitigation measures would be implemented to minimize or eliminate impacts to these species.

Alternative A would have an adverse and cumulative impact on native wildlife species and the four MIS species because a catastrophic fire would result in a high level of wildlife mortality and wildlife habitat would be destroyed. Alternatives B and C would result in short term and long term temporary impacts to the habitat because habitat quality in the proposed treatment area would improve following treatment. No other activities are proposed, therefore there are no cumulative impacts.

**Heritage Resources**

**Historic Overview**

The prehistoric occupation of the Santa Fe area has a deep history that dates from as early as the Paleoindian period. Evidence of early prehistoric use of the analysis area is limited and represented by isolated projectile points, flaked stone, and ceramics. Synthetic studies of regional prehistory can be found in Stuart and Gauthier, Elliot, and Shapiro.
The primary occupation and use of the Watershed is confined to the Historic period. The Historic period in New Mexico is usually divided into occupations based on sovereignty: Spanish Colonial (A.D. 1540–1821), Mexican Colonial (A.D. 1821–1846), and the American Period (A.D. 1846–present).

Cattle husbandry was originally the primary subsistence activity in colonial Santa Fe, but this was gradually replaced by farming and sheep herding. By the eighteenth century, an extensive acequia system was in place, and much land north and south of the Santa Fe River was under cultivation. Santa Fe also served as a base for military excursions into surrounding regions to try to prevent raids by Ute, Comanche, and Navajo peoples. Eighteenth-century colonial settlement patterns shifted away from large land grants and haciendas to smaller dispersed farmsteads with associated ranchos established on lands abandoned by the aggregation of the different Pueblo groups. Simmons attributes this shift to a decrease in native population, reduction of the available work force, and an increased colonial population. The result was a loose coalition of farmsteads along the Rio Grande and Santa Fe River.

Many late-nineteenth- and early-twentieth-century homesteads formerly lined the Santa Fe River, but they have subsequently been destroyed by gravelling activities or erosion. Other sites dating to this time period in the area include waystations, line camps, corrals, and reservoirs (Scheick 1979). In the foothills to the north, early mining explorations were made, wood was cut for construction, and building stone was quarried. Numerous nineteenth- and twentieth-century sites have been documented near Agua Fria, including homesteads, line camps, trash scatters, and erosion-control structures.

From the date of its admission into the Union until World War II, New Mexico continued to be integrated as a part of the U.S. political, economic, and social system. The Great Depression of the 1930s curtailed the availability of jobs, but locals were unable to fall back upon the traditional agropastoral economy. Grazing and agricultural lands had become so divided and reduced in size that subsistence farming and local trade were no longer feasible. Many valley residents became dependent on government employment projects such as those provided by the Works Projects Administration (WPA). The City of Santa Fe also saw much New Deal activity in the form of the Civilian Conservation Corps (CCC). The CCC built thousands of rock check dams in arroyos all around Santa Fe in attempts to control erosion brought on by their earlier wood-cutting on hillslopes above the town. Some of these historic features have been documented in earlier project work in the Watershed along the Agua Sarca drainage.

The Watershed itself had been used extensively by residents of Santa Fe up until 1932, when it was closed to the public. Historic uses included firewood gathering, timber harvesting, grazing, agriculture, and recreation. An extensive study of the history of the Watershed can be found in Crawford and Stull (2003a) and project work conducted by SFNF heritage staff. With the establishment of forest preserves and National Forests, the Santa Fe Watershed was home to the early twentieth century Granite Point Ranger Station.

Affected Environment

Known Heritage Resource Sites

Per the National Historic Preservation Act (NHPA) of 1966 (amended through 2006) and its implementing regulations found in 36 CFR 800, a heritage resources survey was conducted in the proposed treatment area given the project's potential to affect cultural resources. Prior to fieldwork, pre-consultation on the level of inventory required was reviewed by the New Mexico Historic Preservation Department (HPD) who provided concurrence of the proposed sample survey. A
sample survey of approximately 50 acres was conducted in areas likely to contain cultural materials. In addition, the conditions of Appendix J, Standard Consultation Protocol for Large Scale Fuels Reduction, Vegetation Treatment, and Habitat Improvement Projects, signed in 2010, of the USFS Region 3 First Amended Programmatic Agreement Regarding Historic Properties were followed.

Three previously recorded sites, a hunting blind, two historic artifact scatters, and one new site, the Elk Cabin Lodge foundation, were identified during the historic resources survey. The three previously recorded sites have already been determined Eligible for listing on the National Register of Historic Places (NRHP). The three previously documented sites, a hunting blind, and two loci of historic artifacts (scatters) may represent historic temporary campsites. For the purposes of this project, the hunting blind is recommended as Not Eligible and the two Historic period scatters are recommended as properties whose eligibility remains undetermined at this time. The Elk Cabin Lodge foundation is recommended as undetermined for listing pending further archival research. These recommendations are considered new eligibility recommendations (Copperstone 2012).

Environmental Consequences of the Alternatives

**Alternative A—The No-Action Alternative**

Under Alternative A, current management plans would continue to guide management of the analysis area. As no prescribed fire would be implemented, there would be no immediate effects to heritage resources, although a wildfire could pose risks to the Elk Cabin Lodge through damage to the exposed foundation or exposure of archaeological features not identified during archaeological survey. Fire suppression tactics may also negatively impact the four sites in question, as the cutting of firelines or the downing of trees may destroy elements of the sites in question.

A 10,000 – 40,000 catastrophic wildfire would have an adverse effect on known historic period heritage resources as it would create an unstable ground surface where existing sites are located and would destroy combustible features such as cabin remains, old wood, and fragile can, glass, and ceramic scatters. Flooding due to denuded slopes would jeopardize in situ artifact and feature locations and possibly bury or conversely wash away surface cultural materials.

**Alternative B**

Alternative B has the potential to affect heritage resources, particularly the Elk Cabin Lodge, which may be sensitive to prescribed fire as unidentified artifacts may be present and could be damaged by the fire. However, this alternative reduces the potential negative impact of wildfires on the resource. The site will be avoided under this alternative. If avoidance is not possible, this site will experience a low-intensity burn with an archaeological monitor present prior to the larger prescribed burn to ensure that any unidentified artifacts are protected.

The three previously documented sites would not be impacted by this alternative. The two historic artifact scatters are outside the proposed treatment area, and therefore would not be affected. The hunting blind is located along the western boundary of the proposed treatment area and would require no mitigation because this site has been re-evaluated as modern.

As no other heritage resources were identified during archaeological survey of the proposed treatment area and no heritage resources are likely to be encountered on the slopes on which much of the prescribed burning would occur, impacts to previously unidentified heritage resources are not expected under this alternative.
Alternative C
Potential impacts under Alternative C would be similar to Alternative B, except that mechanical pre-treatment may inadvertently impact heritage resources through ground-disturbing activities or felling of trees. Site-flagging and archaeological monitoring should be implemented during mechanical pre-treatment to avoid negative impacts to the heritage resources if pre-treatment is to occur in the vicinity of the three previously identified archaeological sites and the newly documented Elk's Lodge Cabin.

Cumulative Effects
The known heritage resources and those that have not as yet been identified in the Watershed have been protected from outside impacts, specifically the potential for human-caused catastrophic fire, since closure of the area in the 1930s. There would be no direct, indirect or cumulative effects to heritage resources.

Recreation and Scenery

Affected Environment
The Secretary of Agriculture closed the Watershed to public entry in November 1932 for the protection of water quality. Because of the closure, the project area is not used for recreational activities. Recreational areas in the vicinity of the project area include the Santa Fe Ski Basin located at the northern end of the analysis area and several campgrounds along Highway 475 which runs parallel to the western boundary. A service road for the communications site located on Tesuque Peak is used by hikers, as is a trail along the northern Watershed boundary. The peak and trail both overlook Santa Fe Lake at the headwaters of the Santa Fe River.

The proposed treatment area is not visible from any key observation points along Highway 475 or trails in the vicinity. However, the northern portion of the analysis area above the treatment area is visible from a trail along the northern Watershed boundary.

Environmental Consequences of the Alternatives

Alternative A—The No-Action Alternative
A catastrophic fire in the analysis area and surrounding areas would have adverse impacts on both the visual resources of and recreational opportunities in the vicinity of the analysis area. Campgrounds along Highway 475 would likely be closed following a large-scale wildfire, as would hiking trails. A catastrophic fire could also have adverse impacts on the Santa Fe Ski Basin if a fire originating in the analysis area spreads into the ski area.

Alternative B/C
Alternatives B and C would have no lasting adverse impact on recreation because the Watershed is closed to the public. Because the proposed treatment area is not visible from Highway 475 or from the hiking trails at the northern end of the analysis area, no impacts to visual resources are expected. Alternatives B and C would also have a beneficial impact on recreation because the chances of wildfire occurring would be reduced.

Cumulative Impacts
If a catastrophic wildfire were to occur in the project area, the fire scars would remain for several decades. The years following the fire there would be regrowth and green-up, but the burned stumps
would remain. This would reduce the scenic quality of the area, until other larger trees are established. Recreational activities such as camping and hiking just outside the project area may be temporarily impacted during prescribed burns through temporary closures of trails and campgrounds if closures are implemented.

Recent wildfires near Santa Fe in the Pecos Wilderness include Pacheco Fire (2011) and Jaroso Fire (2013). These fire areas are closed during suppression and can remain closed for several years following the fire for rehabilitation. These areas include many trails, trailheads, scenic areas that are impacted. Recreationists have to go elsewhere in the Pecos Wilderness because of access to the wilderness or can go to other nearby wilderness areas.

**Environmental Justice/Civil Rights**

**Human Health Effects**

When determining whether human health effects are disproportionately high or adverse, the CEQ instructs agencies to consider the following three factors to the extent practicable (Council on Environmental Quality, 1997):

(a) Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and

(b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and

(c) Whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

**Alternative A**

Under the No Action alternative, no prescribed burning treatments within the Santa Fe Waterhed would occur; thus, there would be no human health effects to any population in the analysis area.

**Alternatives B and C**

There would not be a disproportionately high and adverse effect on minority or low-income populations under these alternatives. Because area has been closed to the general public since the 1930’s and the Emission Reduction Techniques listed in the Burn Plan, permit requirements, and smoke monitoring the risks of exposure to the general public would be negligible.

**Cumulative Effects**

None of the alternatives would cause a disproportionately high and adverse effect on minority or low-income populations; therefore, there would be no cumulative effects.

The No Action would have a negligible effect on low-income and minority populations.

Any of the action alternatives would have a small, cumulatively beneficial effect on the environment used by minority and low-income populations when combined with other fuels reduction projects, such as the Prescribed burning on the Lower Santa Fe Watershed Prescribed Burning and Upper Pecos Roadside Thinning Projects.
CHAPTER 4—CONSULTATION WITH OTHERS

List of preparers

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List of agencies consulted

- Kewa Tribe
- Nambe Pueblo
- New Mexico Department of Game and Fish
- New Mexico Environment Department
- New Mexico State Historic Preservation Office
- Ohkay Owingeh Tribe
- Pojoaque Pueblo
- Pueblo of Cochiti
- Pueblo of Jemez
- Pueblo de San Ildefonso
- Santa Clara Pueblo
- Tesuque Pueblo
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Tolisano, J.

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U.S. Department of Labor

U.S. Environmental Protection Agency (EPA)


U.S. Fish and Wildlife Service (FWS)

U.S. Forest Service (USFS)

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<td>2012b</td>
<td><em>Biological Assessment and Evaluation, Santa Fe Municipal Watershed Pecos Wilderness Prescribed Burn EA.</em></td>
<td>U.S. Forest Service, Espanola Ranger District, Santa Fe National Forest, Santa Fe.</td>
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APPENDIX A. ANALYSIS AREA MAP
Figure A.1. Map of the Project's analysis area.
APPENDIX B. MINIMUM REQUIREMENTS DECISION GUIDE

(SEE SEPARATE DOCUMENT)