Natural History of the
Upper Watershed of the Santa Fe River

ABOUT THE WATERSHED The Santa Fe Municipal Watershed (Upper Watershed) provides water for approximately 34,000 households and businesses within the City of Santa Fe and surrounding communities and comprises 17,384 acres of the 164,350 acres of the Santa Fe River basin. The upper 10,000 acres of the Upper Watershed are within the Pecos Wilderness Area. Two reservoirs, Nichols and McClure, have a cumulative holding capacity of around 4,000 acre-feet (an acre-foot is equal to 325,851 gallons or the amount of water required to cover an acre, one foot deep.) The Santa Fe water system used 3,390 acre-feet in 2022 from these reservoirs, which is around 39% of the water consumed by Santa Fe residents. Over 11,000 acres of mostly Ponderosa Pine within this area have been "treated," that is, mechanically thinned to a density of 60-90 trees per acre. Prior to this, there were up to 1,200 trees per acre, making the forest ripe for a dangerous, hot, catastrophic crown fire that would wreak havoc with the surface water the City of Santa Fe depends upon.

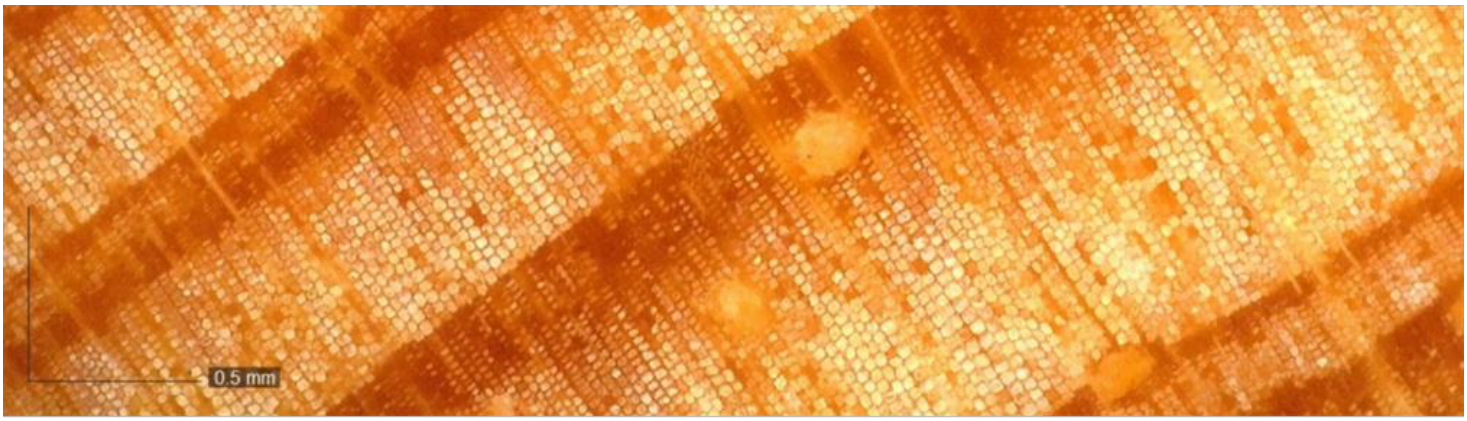
GEOLOGY & HYDROLOGY The Upper Watershed is comprised of foliated metamorphic Precambrian schist and gneiss and Pennsylvanian limestone, shale, and sandstone. The highest peak in the watershed is Lake Peak (12,409 feet.) At the base of the Sangre de Cristo range, the river slope becomes more gradual as it flows through the Tertiary and Quaternary sediments of the Santa Fe Group. The major formations in the Santa Fe Group are the Tesuque (silty sandstone) and the Ancha (unconsolidated, poorly sorted gravels, sands and silts) formations. These formations are Santa Fe's most significant aquifer, and consist of alluvial fans, river channel deposits and interbedded volcanic rocks. Annual mean streamflow (measured at a gauge just below McClure Reservoir) over most of the 20th century ranged from a high of 28 cubic feet per second (cfs) to a low of about 2 cfs.

WEATHER & CLIMATE On average, the Upper Watershed receives 35 inches or precipitation each year. More precipitation falls in the form of winter snowstorms and summer monsoons. Most snow falls in January and February and monsoons are localized thunderstorms that deliver large volumes of precipitation over short durations, occurring between July and September. In contrast, the City of Santa Fe generally sees approximately 14 inches of rain per year.

FLORA & FAUNA The riparian areas in the Upper Watershed are home to willows, cottonwoods, box elder, maple, and the non-native Siberian elm; as well as red-winged blackbirds, canyon towhees, warbling vireos, osprey, and beaver. Vegetation in the lower elevation is characterized by piñon pine, Rocky and one-seeded junipers along with cholla, prickly pear cactus, yucca, Chamisa, mullein, grama grasses, and other flowering plants. At higher elevations, vegetation includes ponderosa pine, Douglas fir, white fir, Englemann spruce, limber pine, and Gambel's oak. This high elevation vegetation provides food and shelter for red squirrels, pygmy nut hatches, and Stellar's jays. The highest peaks of the watershed basin are alpine tundra. Other animals found throughout the Upper Watershed include mule deer, bobcat, black bears, and coyotes.

What is Dendrochronology?

Dendrochronology is the science of dating tree-rings to answer questions about climate, ecosystems, anthropology and more. As trees grow, they record information about the environment that is preserved in the tree rings. By collecting and analyzing wood samples, we can age trees, learn about the history of their environments, and apply this knowledge to answer questions relevant to forest, fire, and watershed management.



Microscopic view of tree rings from a ponderosa pine in northern New Mexico.

Crossdating and the magic of tree rings: The power of tree rings is that they can be dated to the exact year they were formed, sometimes hundreds of years ago, which can tell us that it was dry in the year 1516 or that a fire occurred in the year 1748. How we can know the exact year a tree-ring was formed, especially for dead pieces of wood laying on the ground? The answer is in the pattern of wide and narrow rings, which creates a unique pattern, like a barcode. By collecting many live and dead trees in an area we can build a chronology or timeline of wide and narrow rings that can be used to "crossdate" new samples to the existing record. The tree-ring record in the forests near Santa Fe extends back more than 700 years!

Climate Reconstructions: Variations in tree-ring widths are correlated with the temperature and moisture levels during periods of tree growth. These variations can be measured and analyzed to reconstruct past local climates.

Fire History Reconstructions: Some fires burn hot enough to kill some of the protective bark of a tree and leave a scar. Scarred trees with an open wound are more likely to record scars from the next fire, even if it burns at very low intensity. These records of past fires from tree-ring fire scars can be preserved for hundreds of years and used to understand the history of fire. Fire scars tells us about the year, season, frequency, severity, and size of past fires. This fire history can inform land manager decisions on how to best re-introduce and manage fire in an ecosystem.

Learn more at https://www.usgs.gov/centers/fort-collins-science-center/science/new-mexico-tree-ring-lab

Left: Fire-scarred cross-section of a ponderosa pine from the Santa Fe Watershed, New Mexico. Three fire scars are marked and labeled in the years 1664, 1685, and 1700. *Right:* A fire-scarred southwestern white pine in the Jemez Mountains, New Mexico.

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Upper Santa Fe Watershed History

Prior to the 500's, Pre-Puebloan Oshara people move through the landscape and build temporary camps on the high alpine passes.

Prior to the 1300's, Tano and other Puebloan ancestors build pit houses along the Santa Fe River.

Prior to the 1500's (13th and 14th centuries), Tewa, Keres, and Towa Pueblo people establish numerous villages and trade routes along the middle Rio Grande and its tributaries, including within and around the Santa Fe River Watershed (e.g., Pindi, Arroyo Hondo). Surrounding parts of the landscape serve as migration routes, farmland, hunting grounds, gathering places, and more, including an established access trail to Pecos Pueblo leading up what is now Canyon Road. Major trade partners include other Pueblos, Diné, Apache, Ute, and Comanche.

1598 – First Spanish capital La Provincia del Nuevo Mexico (near Okhay Owingeh Pueblo) is violently established at the northern end of the Camino Real, which passes through the Santa Fe Watershed. Sheep, horses, pigs, and cattle are introduced to the landscape for the first time.

1609 – Don Luis de Velasco Marques of New Spain appoints Pedro de Peralta as governor of the province of New Mexico as a result of Don Juan de Oñate's violent rule.

1610 – Governor Peralta moves the Spanish capital to Santa Fe (named La Villa Real de la Santa Fe de San Francisco de Asis). Partial consideration of the site is due to the presence of a river, springs, and marshes. The Palace of the Governors is built. Water rights are established. The Spanish construct the Acequia Madre (irrigation canal) along with Acequia Cerro Gordo and Acequia de la Muralla, based on Moorish technology. Parts of all three are still in use today.

1640s – The village of Agua Fria is established near Pindi Pueblo, followed by La Cieneguilla, La Cienega, and what would later become La Bajada, all along El Camino Real de Tierra Adentro.

1680 – The pueblo revolt is led by Po'pay of Ohkay Owingeh and other Pueblo leaders. Pueblo people unite to drive the Spanish out of Santa Fe by cutting off the water supply to the Palace of the Governors, resulting in the retreat of the Spanish governor and colonists to northern Mexico.

1680-1692 – A pueblo is established at the Palace of the Governors, in the place known in Tewa as O'ga P'ogeh Owingeh, or White Shell Water Place. The white shells themselves can refer to different varieties of traded shells for different pueblos, such as olivella and abalone.

1692 – Spanish reinvade and recolonize Northern New Mexico under leadership of Don Diego de Vargas, and upper watershed becomes part of the Juan de Gabaldon and Santiago Ramirez Land Grants.

1700s – A crystal clear river and grist mills are recorded.

1750s – Homes are built along Canyon Road that exist today.

1846 – Santa Fe is taken by U.S. troops during the Mexican War.

1847 – A sawmill is built to provide lumber for Ft. Marcy at the current site of the Randall Davey Audubon Center.

1848 – The Treaty of Guadalupe Hildalgo ends the war between the U.S. and Mexico and recognizes the personal and property rights of New Mexicans and Pueblo Indians brought under U.S. sovereignty. Santa Fe becomes part

of U.S. territory. The treaty recognizes the importance of acequias as a century old practice and changes land management practice away from small scale burning and forest management.

1851 - The territory of New Mexico passes its first water laws.

1861 – New Mexico territorial legislature passes an act to investigate increasing water flow in the river.

1879 – Santa Fe Water and Improvement Company submits a certificate of incorporation to the County of Santa Fe. The commissioners of Santa Fe County grant to the Water and Improvement Company the "exclusive right and privilege of erecting dams and reservoirs, and impounding water on the River of Santa Fe."

1880 – Santa Fe Water and Improvement Company is incorporated. Atchinson, Topeka and Santa Fe Railroad reaches New Mexico but does not go into Santa Fe. The arrival of the railroad begins the de facto suppression of fire on the landscape due to overgrazing of the herbaceous understory. The population of Santa Fe is 6,635.

1881 – Santa Fe Water and Improvement Company fails, and Santa Fe City Water Works Corporation purchases assets. Old Stone Dam is constructed by a private company, storing 25 acre-feet and carrying water into town through a 10-inch pipe.

1881-83 – Protests over a private company purchasing public assets stops pipe laying work.

1882 – Santa Fe Water and Improvement Company buys back water assets and sells them to the Water and Improvement Company.

1890s – Benito Borrego and Thomas Catron win title to Santiago Ramirez Land Grant in court, a land area covering over 6,000 acres in the upper watershed.

1891 – Municipal Investment Co of Chicago buys all water assets from Water and Improvement Company.

1892 – Pecos River Forest Reserve is established (later combined with the Jemez Forest Reserve to form the Santa Fe National Forest).

1893 – Two-Mile Dam, named for distance to Santa Fe Plaza) is constructed, storing 587 acre-feet.

1894 – First hydroelectric plant constructed (Santa Fe Hydroelectric Plant) at Upper Canyon Road and Canyon Road. A small concrete reservoir, Talaya Reservoir, is also built on a hill 160 feet above the plant to provide a hydro static head (water pressure) to the plant. Water is brought to Talaya Reservoir by gravity from Two-Mile Reservoir through a 15-inch pipe.

1895 – On April 2, power distribution to the Santa Fe Hydroelectric Plant begins delivering about 100 kilowatts of electricity.

1900s – Railroad across forest preserves and Prisoner's Road (State Route 22) is proposed. The Homestead Act is passed. Forest preserves are named "national forests", and ranger districts are established.

1900 - Water and Improvement Company and its assets are sold to Charles F. Street of New York City. Santa Fe Water & Light Company is incorporated by Charles Street and others, and absorbs the assets of the Santa Fe Electric Company, the Santa Fe Gas and Electric Company, and the Water and Improvement Company.

1902 – Santa Fe Water & Light Company digs a ditch called the High Line into the hillside about 100 feet above Two-Mile Reservoir to tap the river, supplying water to Two-Mile, which then supplies Talaya Reservoir. The High Line extends upstream to the site of what will become Nichols Reservoir.

1904 – Old Stone Dam fills with sediment in a heavy flood event and never again stores surface water.

1910s – Agua Sarca Ranger Station is established and later changed to Granite Point Ranger Station. Ground phone lines are established. Pecos and Jemez Forest Preserves are changed to Santa Fe National Forest.

1910 – Due to catastrophic fires occurring in the west, the U.S. Forest Service "declares war" on forest fires and launches a continued campaign of fire prevention and control.

1912 – New Mexico becomes a state. The population of Santa Fe is 5,100.

1920s – Commercial grazing is prohibited. State Highway 22 is abandoned. Recreation plan for Santa Fe Canyon is proposed.

1926 – Construction of Granite Point Dam, renamed McClure Dam in 1946, is completed. Originally creating a reservoir capacity of 650 acre-feet, it is expanded in 1935 and 1946 to a capacity of 3,257 acre-feet. New Mexico Power Company is formed.

1930s – Pecos Wilderness is established. Pumping station at Santa Fe Lake is built by New Mexico Power Company. All cabin permits expire, and cabins are abandoned.

1930 – The population of Santa Fe is 20,325.

1932 – Upper Watershed closes to the public pursuant by an order from the Secretary of Agriculture due to overgrazing and erosion concerns.

1935 - The "10 a.m. rule" is adopted by the U.S. Forest Service, stating that all wildland fires are to be completely out by 10 o'clock on the morning following the initial report.

1940s – The hydroelectric plant is abandoned.

1943 – Constuction of Four Mile Dam and Reservoir, later named Nichols Dam and Reservoir, is completed, with a capacity of 684 acre-feet. High Line and Talaya ditches are abandoned.

1944 – Sustained Yield Act of 1944 is proclaimed changing the management of forests with the creation of sustained yield timber units in order to stabilize communities, the forest industry, and employment.

1946 – The merger between Santa Fe Water & Light and New Mexico Power forms Public Service Company of New Mexico (PNM), returning the control of water in Santa Fe to a New Mexico corporation. Sangre de Cristo Water Company, a subsidiary of PNM, is charged with managing Santa Fe's water system, including the reservoirs and the treatment plant at the current site of the Water History Park.

1950 – The population of Santa Fe is 28,000.

1960s – Idea for a proposed route from Las Vegas over Elk Mountain to the watershed is abandoned.

1970s – Proposal for new Granite Point Dam by Army Corp of Engineers is set aside.

1975 – Water treatment facility is built on Upper Canyon Road.

1978 – Two-Mile Dam is declared unsafe due to weak spots that have developed.

1980 – The population of Santa Fe is 49,299.

1990s – U.S. Forest Service thinning efforts begin.

1990 – Acequia associations defend their rights in the Santa Fe River Stream System Adjudication. PNM takes the position that it owns all water rights in the stream system and opposes having to release any water to the acequias, which in turn asserts a right prior to that of PNM. A judge finds that acequias have senior water rights and orders Sangre de Cristo Water Company to release water into Acequia Madre and Acequia Cerro Gordo.

1992 – Two-Mile Reservoir is drained.

1994 – Two-Mile Dam is partially breached for safety, but not fully dismantled.

1995 – City of Santa Fe buys Sangre de Cristo Water Company from PNM shifting control of Santa Fe's water from private to public hands. PNM retains 188 acres, including Two-Mile Dam and Old Stone Dam.

1997 – Adam Gabriel Armijo Park (6 acres, now named Cerro Gordo Park) is dedicated. During construction of the park the original Acequia Cerro Gordo is destroyed, and the current small acequia system is built in its place. The Santa Fe Watershed Association (SFWA) is founded.

2000 – PNM donates 188 acres in Santa Fe to The Nature Conservancy (TNC). The tract includes Old Stone Dam and Two-Mile Dam, and is opened to the public in 2002 as Santa Fe Canyon Preserve. The population of Santa Fe is 62,200.

2001 - Santa Fe Municipal Watershed Wildland-Urban Interface Fuels Reduction Project, a project to thin and burn approximately 6,400 acres in the watershed, is approved after completing an environmental impact statement in 2000.

2003 – Four functioning acequias remain in Santa Fe (from over 70): Acequia Madre, Acequia Cerro Gordo, Acequia de la Muralla, and Acequia del Llano.

2004 – SFWA and other partners conduct a paired basin study to monitor the effects of the initial forest treatments in the Upper Watershed with funding from an EPA 319 Clean Water Act grant.

2007 - The Santa Fe River is named America's Most Endangered River by American Rivers due to lack of water flow, downstream gravel mining, and trash dumping. A Santa Fe Municipal Watershed Planning CFRP grant funds local fire history studies by the University of Arizona Tree Ring Lab and the development of a long-term fire history-based management plan for the Municipal Watershed led by Dr. Ellis Margolis.

2010 – The Santa Fe Municipal Watershed Plan – developed in collaboration with SFWA, TNC, and Audubon New Mexico – is adopted by City of Santa Fe and U.S. Forest Service. The plan includes a cost share agreement between City of Santa Fe and U.S. Forest Service to support ongoing forest treatments. SFWA begins the first My Water, My Watershed education field trips into the Upper Watershed.

2011 - The Buckman Direct Diversion (BDD) project is completed, opening the possibility of the Living River Ordinance. The BDD allotments and water rights from the San Juan-Chama Project help the City of Santa Fe reduce its dependence on mined groundwater and surface water from the Santa Fe watershed.

2012 – Santa Fe City Council votes unanimously to pass the Target Flow for a Living River Ordinance on February 29th. With advocacy from community members and SFWA, the city agrees to by-pass 1,000 acre-feet of water into the Santa Fe River on wet or normal years.

2013 – Santa Fe Municipal Watershed Plan is updated. Intake structure at Nichols Dam is rebuilt.

2015 – The U.S. Forest Service approves, through a Finding of No Significant Impact, prescribed burns in the Santa Fe Municipal Watershed Pecos Wilderness after completing an environmental assessment. City of Santa Fe and TNC begin multi-year Aztec Springs Project, thinning and burning on City and TNC lands. Intake structure at McClure Dam is rebuilt.

2015-2016 – The Greater Santa Fe Fireshed Coalition forms; joint City and County Fireshed Coalition resolutions pass.

2018 – The Office of the State Engineer's rating of Nichols and McClure dams drops from "Satisfactory" to "Poor" due to aging pipes underneath both dams.

2020 – A 2019 Pacheco prescribed burn allows firefighters to contain the Medio Fire, a wildfire caused by a lightning strike, before it spread southeast into the Santa Fe watershed.

2021 – The New Mexico Environment Department and City of Santa Fe draft a Source Water Protection Plan. The population of Santa Fe is 88,193.

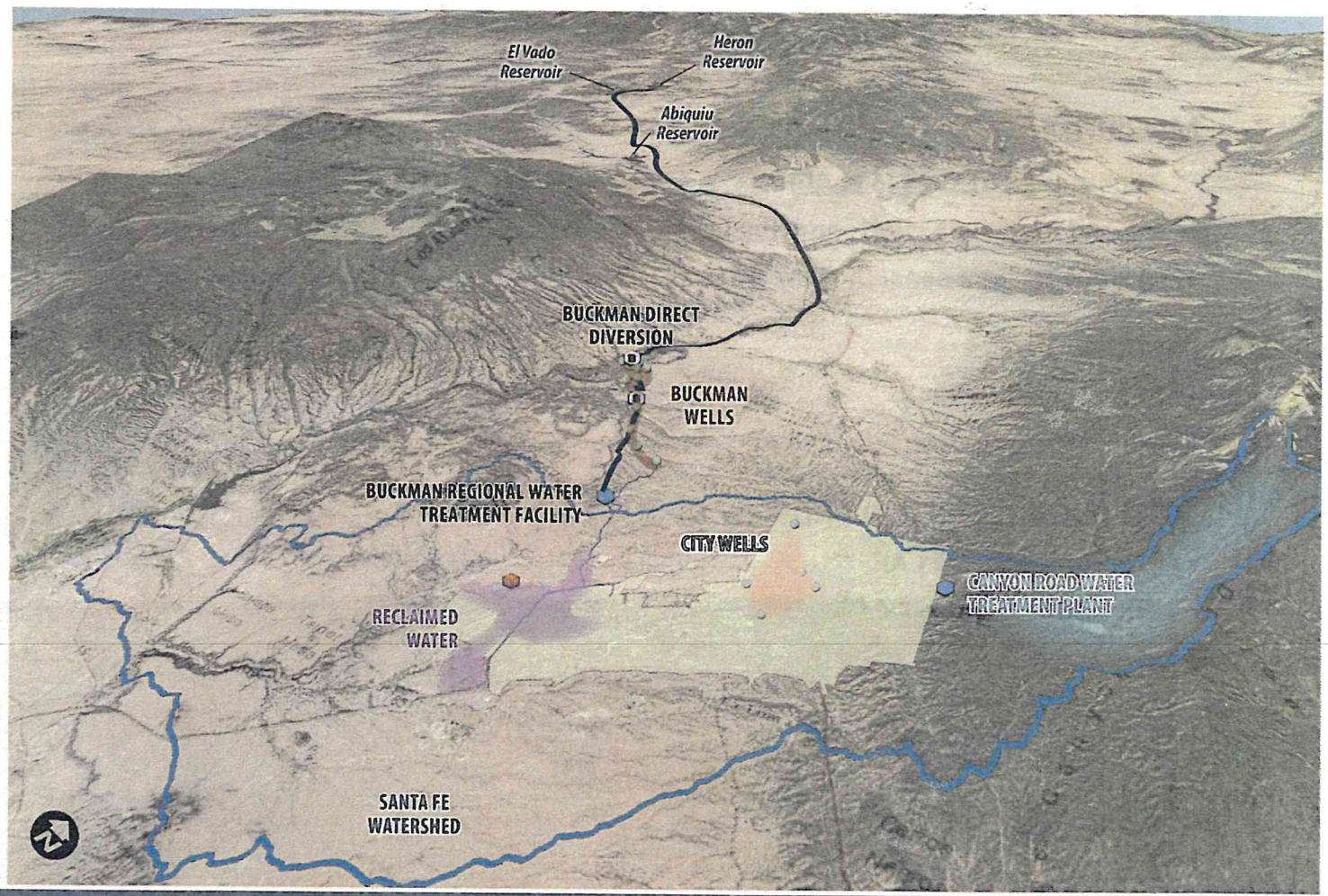
2022 – The Hermit's Peak /Calf Canyon Fire, caused by two escaped prescribed fires, burns over 341,000 acres, reigniting discussion and policy surrounding prescribed burning complexity.

2023 – U.S. Forest Service implements new prescribed burn policies/procedures. U.S. Forest Service approves, through a Finding of No Significant Impact, the Santa Fe Mountains Landscape Resiliency Project to treat about 38,680 acres, after completing an environmental assessment in 2022. Scoping began in 2019.

2024 – Nichols Dam Restoration Project begins.

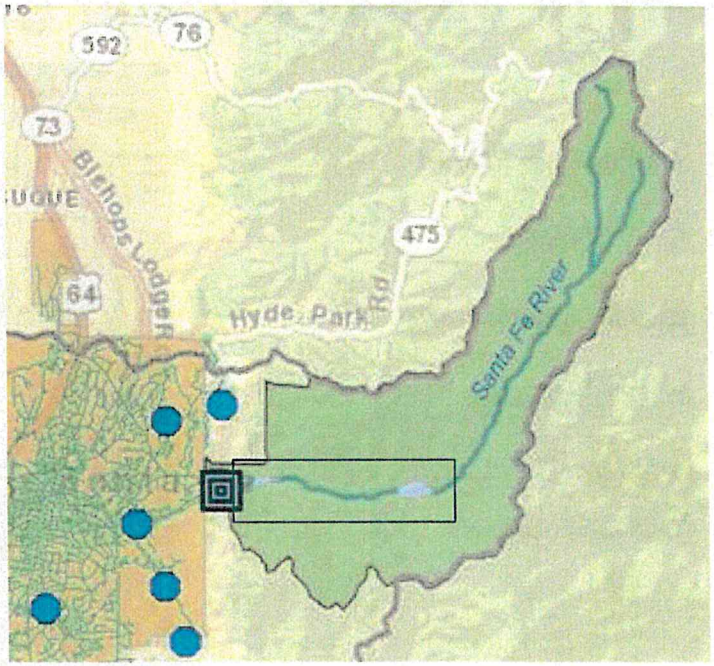
City of Santa Fe Water Supply Sources

- Santa Fe River
- City Wells
- Buckman Wells
- Rio Grande
- Water Reuse & Conservation



Nichols and McClure Reservoirs

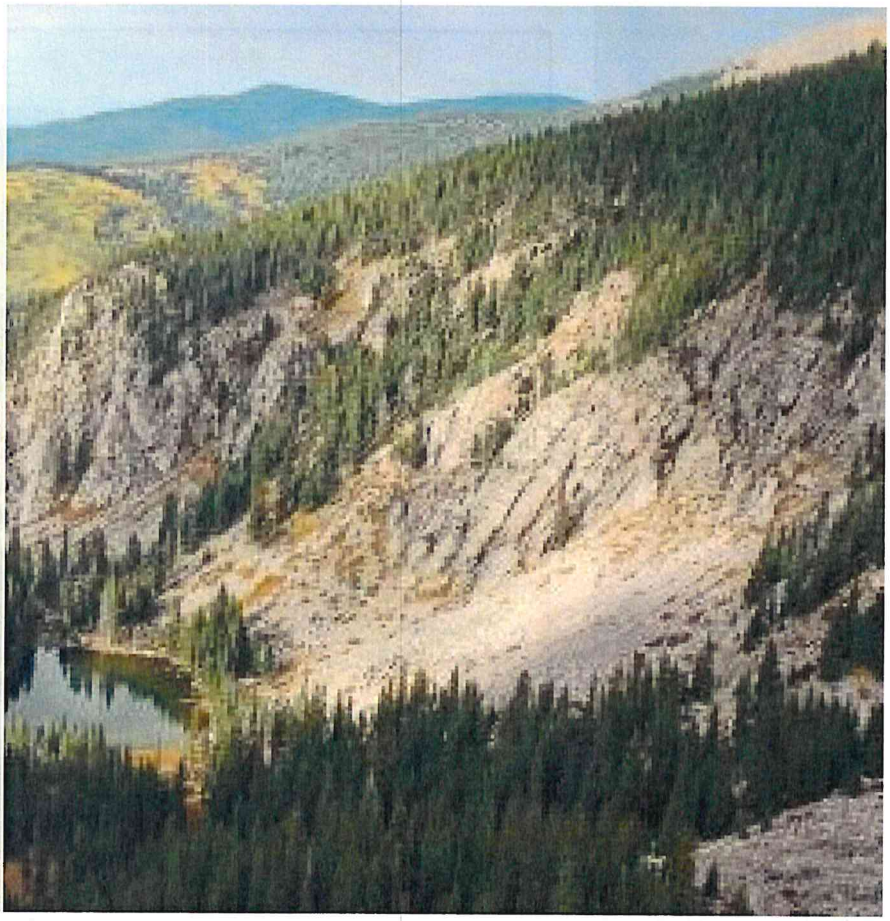
- McClure
  - Constructed in 1926 (561 AF)
  - Expanded in 1935, 1947, and 1990s
  - Current storage capacity 3257 AF
- Nichols
  - Constructed in 1943
  - Current storage capacity 664 AF
- Total current storage capacity of 3921 AF
  - Pre-Compact: 1061 AF



Santa Fe Municipal Watershed Plan, 2010-2029

Prepared with funding from the USFS Collaborative Forest Restoration Program

Revision April 2013



Plan Authors

Vegetation Plan: Ellis Margolis, University of Arizona and Melissa Savage, University of California, Los Angeles

Water Plan: Dale Lyons, City of Santa Fe Water Division

Outreach Plan: Eileen Everett, Santa Fe Watershed Association

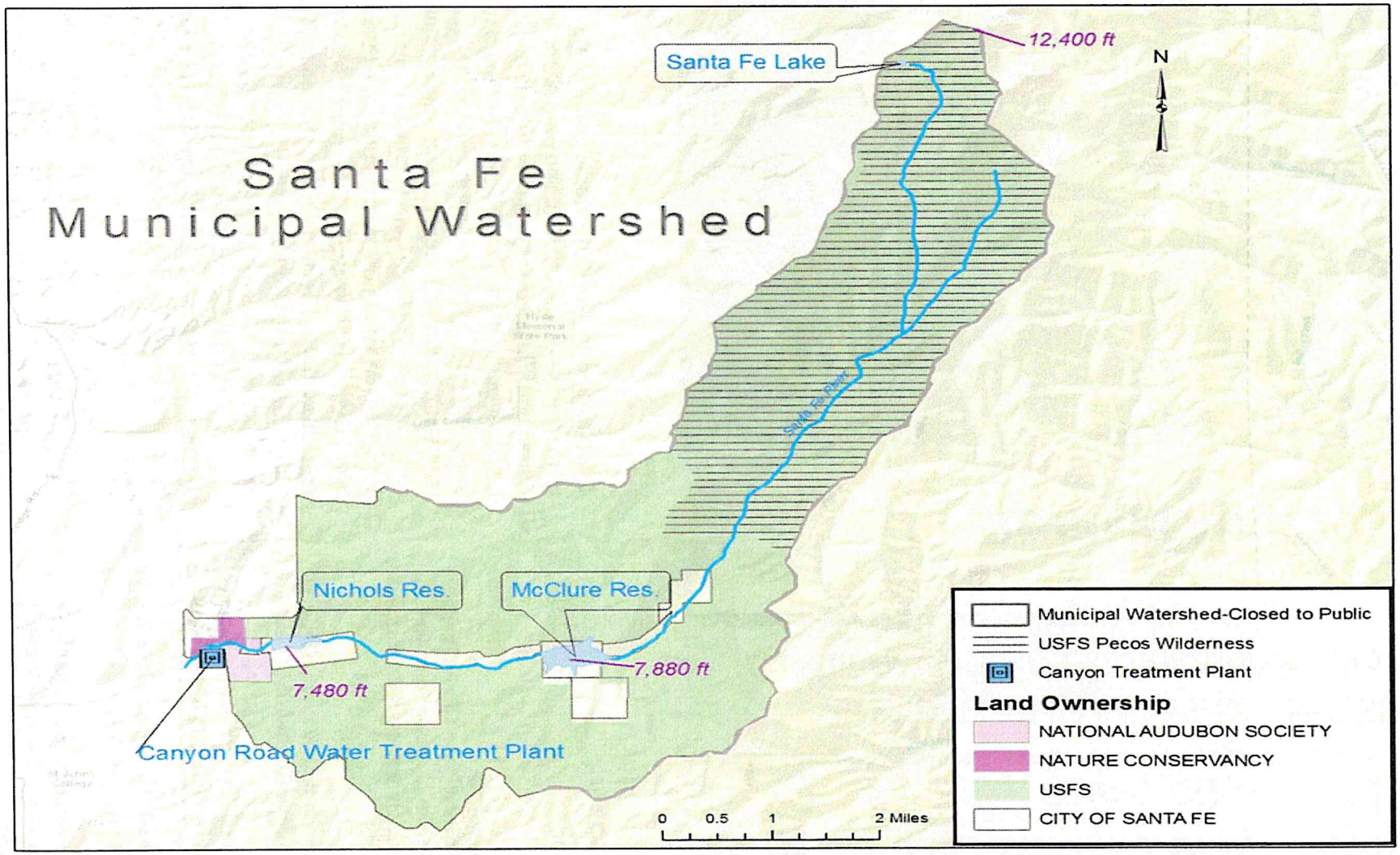
Financial Plan: Laura McCarthy, The Nature Conservancy

Plan Compiled and Edited by Dale Lyons, City of Santa Fe Water Division

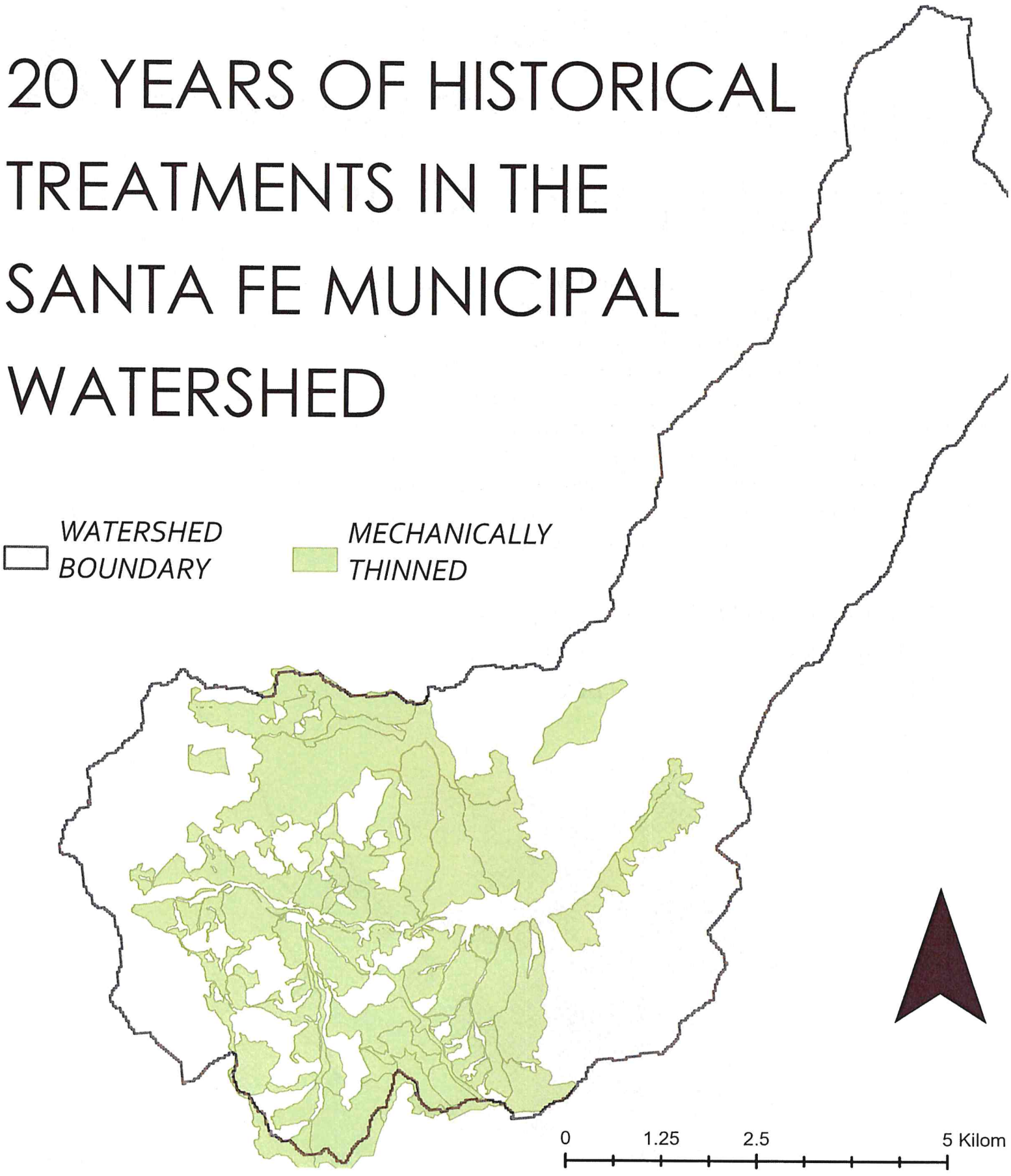
This master plan provides a framework and recommendations for long term management, outreach, and funding for the Santa Fe Municipal Watershed. The ongoing collaborative work in the municipal watershed is known as the Watershed Investment Program. The plan addresses four areas critical to the maintenance of the watershed: (i) vegetation management and fire use; (ii) water management; (iii) public awareness and outreach; and (iv) financial management based on Payment for Ecosystem Services. The cost to retain the restored forest condition over 20 years is estimated at $5.1 million, an average of $258,000 per year. In contrast, Fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash from the City's reservoirs would likely be between $80M and $240M. Without forest treatment, the likelihood of such a wildfire is 1 in 5 in any given year.

Development of the original plan was funded from the USDA Forest Service Collaborative Forest Restoration Program with a collaborative grant (CFRP #27-07) that included the Española Ranger District of the Santa Fe National Forest, the Santa Fe Watershed Association, the City of Santa Fe Water Division, City of Santa Fe Fire Department and the Nature Conservancy.

Santa Fe Municipal Watershed



20 YEARS OF HISTORICAL TREATMENTS IN THE SANTA FE MUNICIPAL WATERSHED



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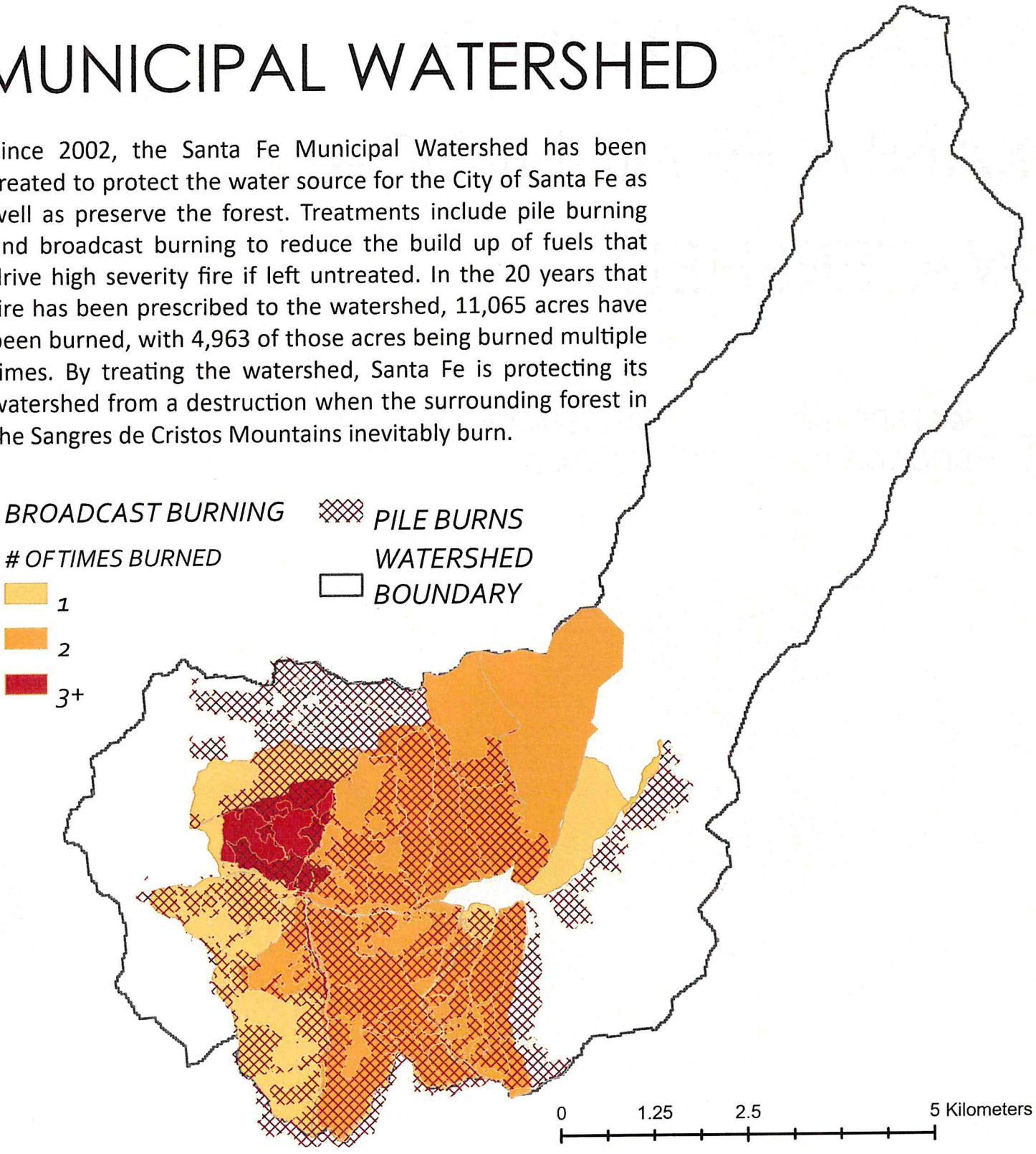
20 YEARS OF HISTORICAL TREATMENTS IN THE SANTA FE MUNICIPAL WATERSHED

Since 2002, the Santa Fe Municipal Watershed has been treated to protect the water source for the City of Santa Fe as well as preserve the forest. Treatments include pile burning and broadcast burning to reduce the build up of fuels that drive high severity fire if left untreated. In the 20 years that fire has been prescribed to the watershed, 11,065 acres have been burned, with 4,963 of those acres being burned multiple times. By treating the watershed, Santa Fe is protecting its watershed from a destruction when the surrounding forest in the Sangres de Cristos Mountains inevitably burn.



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