1. If the proposal would extend the water supply through conservation, or increase the supply through development of new water,

   a. Describe the location and verify the ownership of and legal access to lands related to the proposal.

   Both the Reserve and Luna 7.5-minute quadrangle maps are needed when accessing the research location. From Reserve, New Mexico, drive approximately 6 miles west on New Mexico Highway 12 to the intersection of U.S. Highway 180 (U.S. 180) and turn right or north towards Luna. Travel approximately 7 miles on U.S. 180 on Section 18, Township 5 North, Range 20 West and turn right (east) on Upper Kiehne Road or designated Forest Road 35 (according to the U.S. Department of Agriculture Gila National Forest Map), a two-track legal access to the proposed project area on Gila National Forest administered lands (Figure 1). The entire project is located on the Gila National Forest, Quemado District.

   b. Identify the source of the water to be put to use.

   The source of water to be put to use would be surface runoff and subsurface recharge generated from the proposed project area that drains into the San Francisco River, which is a tributary to the Gila River.

   c. Describe and quantify whether and how the proposal would extend the water supply through conservation, or increase the supply through development of new water in the Southwest Planning Region.

   This proposal would extend the water supply in the San Francisco Basin through conservation by thinning an area of overstock forest. The type of proposed thinning activities would not only increase water yield within the San Francisco Basin, but also help protect the area from catastrophic wildfire, thus enhancing watershed health and function. Past research has shown water yield can be increased significantly when the density of the forest overstory is decreased by at least one-third (Brown et al. 1974; Rich and Thompson 1974; Ffolliott and Thorud 1975). One study in particular was conducted by Ffolliott and Thorud (1975) who reviewed all the available literature on water yield improvements in ponderosa pine forest in Arizona. These researchers were able to determine a relationship between the average annual water yield increase at average conditions and the extent of ponderosa pine forest overstory thinning. They developed a formula to estimate the annual increase of acre-feet of water yield from a watershed. Using the Ffolliott and Thorud (1975) approach, we estimate that this forest watershed thinning project has the potential to increase the watershed yield by 0.15 acre-feet per acre per year, increasing overall watershed yield by 173 acre-feet per year after thinning is completed (Figure 2). The project will be scheduled to continue for seven years following thinning, which would give a total increase of 1,211 acre-feet over the life of the project. If the results of this pilot study are found to be beneficial to the natural environment and increase water yield as estimated, then these forest restoration treatments can be applied in other forest watersheds across the region to provide increased watershed yield to the entire Gila Basin.

   d. Demonstrate how the proposal would meet AWSA and CUFA requirements.

   This project is a water utilization alternative based on the definition in the Arizona Water Settlement Act (AWSA) Evaluation Process, Schedule, and Application, March 23, 2011, which states, “water utilization is a project or activity that does not develop additional water from the
Gila basin above that allocated to New Mexico prior to the 2004 AWSA or does not require exchange of Central Arizona Project (CAP) water for additional depletions by New Mexico in the Gila Basin.” The primary objective of this project is to enhance surface water yield and watershed health in the San Francisco Basin of New Mexico and mitigate the potential development of additional Southwest New Mexico Water Planning Region water resources under the auspices of the AWSA.

2. Describe the proposal and its technical viability.

   a. Include any (or reference publically-available) technical and engineering studies completed and demonstrate how these studies support the proposal.

This proposal complements the Burro/Stiver proposal submitted by the Grant Soil & Water Conservation District (with contractors SWCA and Ellen Soles). The Burro Mountains/Stiver Canyon projects include research in a lower elevation piñon-juniper ecotype (Burro Mountains) dominated by warm-season perennial herbaceous cover and a higher, Ponderosa ecotype (Stiver) supporting cool season perennial herbaceous cover that also supports relict stands of aspen and cottonwood. This Reserve project occurs in a Ponderosa-dominated site at a lower elevation than the Stiver site; the Reserve site supports blue grama, a warm season perennial grass. The three projects represent the Gila National Forest in its entirety with representative topography and geology.

This project will use a paired watershed design, a scientifically sound study approach, to quantify water yield response in the Gila Basin. These watersheds will be located on northwest-facing slopes immediately draining to the San Francisco River. This approach will objectively quantify the effects of forest thinning treatments on watershed runoff, soil moisture, and vegetation cover types. An objective of this management approach is to establish an herbaceous understory capable of sustaining fire return intervals of five to eight years. Current forest conditions, including dense overstory, do not support the herbaceous ground cover species capable of carrying frequent low-severity surface fires. Project methods include measurements of stand structure, herbaceous understory, soil moisture, stream runoff, shallow groundwater levels, rainfall, ambient temperature, and relative humidity. The New Mexico Climate Center will model evapotranspiration levels in the paired watersheds using data from mini-meteorological stations that will be installed in each watershed to accurately record climate inputs. Modified steel piezometers will be used to measure surface water runoff from the watersheds. Shallow groundwater piezometers will be used to measure alluvial groundwater levels in response to the forest thinning treatments. The project will evaluate hydrologic changes and interactions between soil moisture, groundwater, surface water, and climate before and after thinning where vegetation is altered to enhance watershed function and restore a natural fire regime. This multidisciplinary forest/watershed management approach has broad applicability to forested landscape throughout the Southwest New Mexico Water Planning Region to meet growing regional water demands.

Because this area supports domestic livestock grazing it may be difficult to predict recovery time; however, the project proponents have an excellent relationship with the grazing permittee (Tom Paterson; his attached support letter refers to the site as near Luna), who is willing to work with the research team to ensure the carrying capacity of the land is not exceeded. Project managers will be in constant contact with the grazing permittee regarding rest and rotation grazing periods. The project area is preferred by contractor mechanical thinning due to the
proximity to the Reserve Mill. The easy accessibility to the project area on Forest Road 35 will be helpful in reducing ecosystem disturbance, and it is anticipated that no new road construction will be required.

Many technical studies have been conducted in the past that directly relate and support this project. Most water yield studies have used a paired catchment approach (treatment vs. control) to assess the effect of vegetation removal (Hibbert 1967; Burgy and Papazafiriou 1971), which is the method that we are proposing. In a review of 94 catchment experiments, Bosch and Hewlett (1982) found no studies that showed a reduction in water yield relative to a reduction in vegetation. In 1967, Hibbert made the following observations regarding forest disturbance effects on water yield: 1) reduction of forest cover increases water yield, 2) establishment of forest cover (afforestation) decreases water yield, and 3) response to treatment is highly variable. More recent studies (over 94 in number) have shown similar findings (Stednick 1996), with the additional claim that the magnitude of change in water yield is most strongly related to the amount of precipitation and the intensity of the treatment (Troendle et al. 2006). Varying forest cover types have also been found to strongly influence the degree of water yield post-harvest, with the greatest yield of water coming from thinned coniferous forests (40 mm) with a 10% change in forest cover) compared to deciduous forest (25 mm with a 10% change in forest cover) post-treatment (Bosch and Hewlett 1982). The intensity of thinning is believed to govern hydrologic response post-treatment (Troendle and King 1987). The most significant (and more easily measured) increases in water yield in ponderosa pine and mixed-conifer forests were recorded following treatments where forest cover was reduced by more than 20% (Stednick 1996). Troendle et al. (2006) stated that if this threshold in basal area reduction is not met, then effects of thinning on water yield will be negligible with maybe only slight increases observed during wet years. In contrast to the above studies, Ziemer (1986) found increases in water yield are hard to determine and that vegetation management is not necessarily the best approach to increase water yield. The Ziemer (1986) literature review was also conducted primarily on gaged watersheds throughout California. There have not been enough water yield studies conducted in New Mexico to conclude the same occurs.

One of the most researched sites for water yield studies has been the Beaver Creek Watershed, Coconino National Forest, Arizona (Brown et al. 1974; Clary et al. 1974; Baker 1982, 1986). At this experimental forest site, researchers found that thinning of ponderosa pine woodlands (with reductions in basal area up to 120 square feet/acre) generate stream-flow increases of 35% (Johnson 1996). From a review of studies throughout the Southwest, MacDonald and Stednick (2003) also report water yield increases in ponderosa pine following thinning, but they caution that these peaks in forest hydrology are often short lived, decreasing as the forest floor becomes re-established. The persistence of increased water yield observed at Beaver Creek was found to vary by treatment intensity: completely cleared sites had statistically significant water yield increases for seven years, declining with the onset of Gambel oak and herbaceous growth; light overstory removal maintained increased water yields for six years; and heavy overstory removal maintained increased water yields for 10 years.

Changes to water yield following thinning have been attributed to a number of factors. In a study at the Fraser Experimental Forest in Colorado (Troendle and King 1985), 30% of observed water yield increases were attributed to a decrease in interception and a resultant increase in water held in snowpack. Fifty percent of the increased yield was attributed to reduced evapotranspiration during the summer months and the corresponding reduction in melt-water used for soil recharge.
in the spring months. The remaining 20% of yield increase was attributed to reduced evapotranspiration losses during April and May. The results observed by Troendle and King (1985) are closely related to the climatic regime of the site, an observation also made by MacDonald and Stednick (2003). They say, from reviewing studies of paired catchments, that an annual rainfall threshold of 450 to 500 mm (18–19 inches) is required in order to detect an increase in runoff as a result of removal of vegetation (Bosch and Hewlett 1982; Troendle et al. 2006). The proposed research area for this project has an annual average precipitation around 20 inches, which is above the threshold found in order to detect an increase in water yield.

b. Include any (or reference publicly-available) hydrologic, ecologic, or geotechnical studies completed and demonstrate how information included in these studies specifically supports or detracts from the proposal.

Concerns over the degradation of forests throughout the nation and the frequency of major wildfires have led to increased interest in restoring western forests (Stone et al. 1999), a development that has been strengthened by a growing political view that restoration is necessary and urgent (Covington et al. 1997; Kloor 2000; Jenkins 2001; Allen et al. 2002). The U.S. National Fire Plan (2000), the U.S. Ten-year Strategy Plan (2001), the U.S. Healthy Forest Initiative (2002), and the Healthy Forests Restoration Act (2003) are all federal initiatives with a common message to mandate restoration of degraded forests and promote forest health. Millions of acres of public lands have been targeted for restoration by federal, state, and local agencies (U.S. Forest Service [USFS] 2000).

Ecological and hydrological processes are interrelated in water-limited environments (Middleton and Thomas 1997) such as the ponderosa forests of the Southwest. Ludwig et al. (2000) suggest that a positive feedback or self-reinforcing mechanism links water and vegetation in these environments and changes to canopy through different forms of disturbance, which in turn alters the hydrology of the system. Densely forested watersheds, characteristic of the degraded southwestern ponderosa pine woodlands, have been linked to decreasing total stream flows, peak flows, base flows, and overall water yield (Trimble and Weirich 1987; Ffolliott et al. 1989; Madrid 2005). Ponderosa pine woodlands have for the last 20 years or so been the focus of restoration under the auspices of water resource management, where treatments are targeted at restoring pre-settlement hydrology and water yield (Stednick 1996). Many studies have attempted to quantify the hydrologic effects of such restoration, with varying results (Keppeler and Zeimer 1990; MacDonald and Stednick 2003; Ice and Stednick 2004).

Because of the huge variability in climate, it should be acknowledged that water yield studies across states are not always transferable. Most of New Mexico’s runoff is a result of intense summer thunderstorms of short duration (Wilcox et al. 1996; Reid et al. 1999; Wilcox et al. 2003), while Arizona ponderosa pine forests, for example, experiences more winter precipitation and snowmelt (Davenport and Wilcox 1995). The relationship between precipitation, infiltration, storage, and runoff is complex and often site and vegetation specific. Lateral subsurface flow, for example, is rarely found in piñon-juniper communities, in contrast to findings in ponderosa pine communities in adjacent study areas (Wilcox et al. 1996; Wilcox and Breshears 1997). In areas such as New Mexico, where “infiltration excess overland flow” is the dominant runoff process, researchers warn against basing runoff predictions on precipitation measurements, as the relationship between precipitation and runoff is often likely to be poor. Infiltration is also linked largely to forest floor conditions, slash, and debris after thinning, as well as aspect and slope (Gifford 1975; Breshears et al. 1995; Davenport and Wilcox 1995).
MacDonald and Stednick (2003) suggest that changes to water yield from thinning are likely to be short lived in arid zones and that detectable changes would be significant only below the treatment area, becoming diluted in the downstream direction. This effect was also observed by Troendle and King (1987) in a Colorado study where stream flow increased significantly in a sub-basin below a treatment area but was barely detectable a few hundred meters downstream, as the harvest made up only a fraction (5.6%) of the wider watershed.

As can be seen above (including the answer to question 2a), there has been a great deal of research dealing with watershed restoration and water yield improvements; however, there are not many conclusive results that can be drawn outside the study areas. Many of these studies have shown significant increases in water yield following treatment, but how these studies transfer to the Gila Basin is unknown. This is why it is important to gather this information/data within the Gila Basin. This will allow future water planners to make more educated decisions on the best way to increase water supply through restoration.

3. **Quantify estimated costs.**

   a. *Quantify the proposal’s estimated costs, including planning, design, and/or construction, and administration or oversight.*

   The initial cost (Year 1) associated with this project including planning, design, and construction would be $200,000 with an administrative cost at $7,000. The total cost of the project as seen below in Table 2 is $2,270,000 over the course of 10 years.

   b. *If applicable, quantify the proposed project’s on-going administrative, operational, and maintenance costs.*

   Table 1 below shows the expected project costs after initial setup is completed. Initial setup would be scheduled to take place in 2012, Year 1 of the project, if chosen for funding. The yearly operational and maintenance cost will allow the research team to conduct monthly offloads of all equipment to ensure no gaps in data, replace damaged or failing sensors, model streamflow and shallow groundwater movement, model evapotranspiration, conduct yearly vegetation surveys, ensure quality assurance/quality control (QA/QC), manage the data, and write yearly progress reports complete with full data analysis. A more detailed budget can be seen in question 5b below. Maintenance

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<td><strong>$630,000.00</strong></td>
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c. Describe environmental compliance activities, and quantify the costs for environmental mitigation and restoration related to the proposal.

We will work directly with the USFS as the National Environmental Policy Act (NEPA) process is being followed for this and other watershed projects in the region. Through this process, the USFS will be able to identify the potential negative impacts associated with the project. As potential impacts to the natural ecosystem are evaluated during the planning process, mitigation measures will be identified and implemented prior to impacts. Some of the potential short-term negative impacts associated with this project may include the use of mechanized equipment, which has the ability to alter surface soils and hydrology, destroy herbaceous vegetative cover, and introduce exotic weeds. Mitigation measures such as soil surface smoothing, revegetation of the two-track roads, and cleaning of equipment prior to and after use are a few ways to alleviate these impacts. Potential threatened and endangered species in the project area will be evaluated prior to any on-site activities, and if identified, surveys will be conducted prior to on-site activities. If any species of conservation concern are found, mitigation measures will be taken to ensure the restoration is completed in such a way as to avoid any negative impacts to the species and their habitat.

From conversations with the USFS, it is estimated that NEPA clearance will cost around $150,000 for this project area. Once NEPA compliance is completed, the restoration of the forest can begin and will have an expected cost around $1.08 million, which will be used to thin and burn the two proposed sections. If this project is funded, the research team will aggressively pursue other potential funding sources, such as the Collaborative Forest Restoration Program (CFRP) in order to help offset the high costs of NEPA clearance and thinning.

d. Quantify the AWSA funding sought for the proposal and for the pendency of the proposed activity’s or project’s duration.

Table 2 below shows the amount of funding requested annually from the AWSA. The funding below could potential be less if other grants are obtained. The high cost seen in 2014 and 2015 is related to the cost of implementing forest thinning, a per acre quote from the Quemado Ranger District, Gila National Forest.

Table 2. Amount of Funding Requested Annually from the AWSA

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<td>$95,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$2,270,000</strong></td>
</tr>
</tbody>
</table>
4. If proposal impacts, beneficially or adversely, the environment of the Southwest Planning Region, the Gila River, its tributaries or associated riparian corridors, use the best available science to:

   a. Describe and quantify how the proposal might impact the project site and environment, particularly state and federally-listed species.

The selective removal of overstock trees from ponderosa pine forest will beneficially affect half of the project site environment. Forest thinning prescription and procedures will be those used by the USFS, Gila National Forest. Of the total 2,560 acres of forest watershed land, only half (the treatment watershed), or 1,280 acres, will be potentially impacted by the thinning process for a several week period only. The other half (the control watershed, 1,280 acres) will not be impacted at all. Impacts to soils, vegetation other than non-overstock trees, and wildlife will be small, short-term, and recoverable given that heavy equipment will not be used and new roads will not be constructed. An existing dirt road (Forest Service Road 35) at the project area will provide access to approximately 60% of the thinning treatment site (768 acres). Tree thinning will be performed by personnel on foot with chainsaws. Commercial wood (fire wood and lumber) from downed trees will be transported out of the project site by use of a low-impact grapple and four-wheel drive pickup trucks. Branches and small-diameter trees will be cut and spread on the ground and in small drainages for erosion control. Once the majority of the site has been mechanically thinned, prescribed fire will be used to thin another approximately 30% of the site (384 acres). About 10% of the site (128 acres) probably will not be thinned because those areas are on steep rocky terrain and/or comprise stands of mixed-aged trees that will be left in place. Hydrology monitoring equipment (mini weather stations, stream and groundwater piezometers, for example) will have no measurable impact to the environment.

Restoration of the proposed forest area and much of the entire Gila River watershed are needed to reduce overstock trees and improve the environmental health of the watersheds. Ponderosa pine and mixed-conifer communities in the Southwest, like those within the San Francisco Basin, have experienced major changes in ecological structure, composition, and process over the last century (Cooper 1960; Covington et al. 1997; Fulé et al. 1997; Allen et al. 2002). Before Euro-American settlement, southwestern ponderosa pine woodlands were composed of low-density, park-like stands with a dense grass understory and highly flammable leaf litter. Historically these forests experienced frequent low-intensity wildfire, creating heterogeneous forest spatial patterns at local and landscape scales. Disruption to the natural fire regime, harvesting, and intensive grazing practices of these forests has drastically altered their historic structure and has made them extremely vulnerable to unnaturally severe stand-replacing fires, insect outbreaks, excessive soil erosion, and other deviations from historic conditions.

Ecological and hydrological processes are interrelated in water-limited environments such as the ponderosa forests of the Southwest. Densely forested watersheds, characteristic of the degraded southwestern ponderosa pine woodlands, have been linked to decreasing total stream flows, peak flows, base flows, and overall water yield (Middleton and Thomas 1997). Southwestern ponderosa pine woodlands have for the last 20 years or so been the focus of restoration under the auspices of water resource management, where treatments are targeted at restoring pre-settlement hydrology and water yield. Many studies have attempted to quantify the hydrologic effects of such restoration, with varying results (Keppeler and Zeimer 1990; MacDonald and Stednick 2003; Ice and Stednick 2004).
Most water yield studies have used a paired watershed approach to assess the effect of excess tree removal. Time-trend studies have also been completed; however, they are often criticized as having no climatic control to separate vegetal cover effects from climatic effects. Hibbert (1967) made the following observations regarding forest disturbance effects on water yield: 1) reduction of forest cover increases water yield, 2) establishment of forest cover (reforestation) decreases water yield, and 3) response to treatment is highly variable. More recent studies have had similar findings, with the additional claim that the magnitude of change in water yield is most strongly related to the amount of precipitation and the intensity of the treatment.

Based on available information, we believe that watershed forest thinning within the San Francisco Basin will increase surface water yield for agricultural uses downstream, improve water quality, enhance wildlife habitat, reduce the potential for catastrophic wildfires and soil erosion, and improve the environment for human recreation.

Twenty plant species and 58 animal species of conservation concern are listed by the New Mexico Rare Plant Council and the New Mexico Department of Game and Fish, respectively, from Catron County, New Mexico (Biota Information System of New Mexico 2011; New Mexico Rare Plant Council 1999). If this project is funded, we will evaluate the geographic distribution and habitat associations of each of those species to determine if any potentially occur within the actual project area and downstream from the project area. Particular attention will be given to federally listed threatened and endangered species. U.S. Fish and Wildlife Service Section 7 consultation will be performed for the project area during the NEPA process for this project. The project site will be surveyed for any potential species and habitat of conservation concern. Project impacts will be planned to avoid any such species found in the project area.

b. Describe and quantify the proposal’s efforts to mitigate possible adverse impacts on the environment, particularly riparian areas and state and federally-listed species in the Gila Basin and at the specific location of the proposal.

The selective cutting of overstock trees will have minimal negative environmental impacts on the project site, including drainages and riparian areas. Some of the potential short-term negative impacts associated with this project may include altered surface soils and herbaceous vegetative cover. Mitigation measures such as soil surface smoothing and revegetation are ways to alleviate these impacts. Buffer areas will be maintained along any healthy riparian areas, and no impacts will be imposed in those locations. Spreading of small branches and other small woody materials in drainages will reduce the potential for soil and bank erosion following tree thinning treatments. This proposed project is a forest watershed restoration project aimed at improving the function and ecological health of the project area, in addition to increasing surface water yield to the greater watershed. Efforts will be made to improve the environmental condition of the site, not to degrade it. Reducing the potential for catastrophic wildfire will reduce the potential for post-wildfire severe soil erosion and flooding, and will help to improve overall watershed water quality by increasing watershed environmental health.

We will work directly with the USFS as the NEPA process is being followed for this and other watershed projects in the region. Through this process, the USFS will be able to identify the potential negative impacts associated with this project. As potential impacts to the natural ecosystem are identified during the planning process, mitigation measures will be identified and implemented prior to impacts. As stated above, as part of the NEPA process, we will evaluate the potential for and the occurrences of any plant or animal species of conservation concern,
especially federally listed threatened or endangered species. If any such species are found in or adjacent to the project area, the project plan will be adjusted so as not to impose any negative impacts to those species.

c. Describe and quantify how the proposal may benefit the environment, particularly riparian areas and state and federally-listed species in the Gila Basin and at the specific location of the proposal.

This project has the potential to help mitigate new water development activities within the San Francisco Basin by increasing surface water yield to compensate for any increased withdrawals up to the 14,000 acre-feet allowed by the AWSA. New water development projects funded by the AWSA have the potential to negatively impact the San Francisco Basin aquatic and riparian environments and native wildlife species; however, this project has the potential to mitigate those impacts by potentially adding more surface and groundwater to the San Francisco River system.

This forest watershed restoration project will enhance habitat for most species of plants and animals native to the region by increasing diversity of plant production. Reduction of overstock trees will produce a healthier forest watershed and provide historic open stand conditions with a healthy herbaceous understory and increased soil moisture (Allen et al. 2002). Increased surface water yield will provide improved habitats for aquatic and riparian species downstream from the project area.

d. List any environmental statutes, rules, or regulations that may apply to the proposal, and demonstrate how the proposal implementation will comply with such laws, rules or regulations.

The proposed project will take place on federal USFS lands; therefore, NEPA will be the principal environmental regulatory process accounting for laws, rules, and regulations applicable to the project. As part of the NEPA process, all pertinent environmental statutes, rules, and regulations, such as the Endangered Species Act and the National Historic Preservation Act, will be identified and relevance to the project evaluated.

5. Describe any economic or cost analysis information and data for the proposal:

a. Quantify estimated economic benefits including environmental, recreation, value of water itself, value of the water to the regional economy, increased economic growth, protection against loss of jobs, agriculture, ranching, local economic sustainability or growth, or other.

Projects like this one that have the ability to supply merchantable timber to local sawmills, which helps sustain economic growth. For example, wood material from this proposal would benefit K&B Timberworks and Kellar Logging, both located in Reserve, New Mexico, through retention of 15 full-time jobs, utilization of marketable products from forest restoration projects, increase in state and county revenues through gross receipt taxes, and long-term sustainability of supply would allow for expansion of the timber processing facility, therefore, creating more jobs and more local economic growth. The estimated value for 15 full-time jobs would be $300,000 per year, which is based on an average annual salary of $20,000.

This project aims to improve watershed health, which will increase opportunities for recreation. Improved watershed health and surface water yield will provide better habitat for wildlife, supporting recreational activities such as wildlife viewing and hunting. More open forest stands
and better developed understory vegetation will provide better landscapes for mountain biking, hiking, and camping. Increased surface water yield and improved water quality will provide better stream conditions for fishing, boating, and swimming. Ecologically healthy and attractive forest and river landscapes should enhance tourism in the region and provide economic benefits to local communities.

b. Quantify estimated costs including planning, design, and/or construction, environmental compliance, operation, maintenance, repair, and administrative costs or other.

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**Planning**

Internal planning meetings will be held to coordinate project details and finalize the research design and associated methods. Planning meetings will be held on-site with the research team and other project partners to review the final design specifications and location of monitoring equipment. At this time questions and concerns from the project partners about locations of the instrumentation can be discussed and resolved.

**Total labor/travel costs year 1:** $10,000

**Total labor/travel costs years 2–10:** $2,500

**Design/Installation**

Under this task the research team will finalize the study design, purchase all monitoring equipment, and install the monitoring equipment to be used throughout the project. The following would be located and installed:

- Weather stations
- Soil moisture sensors
- Permanent vegetation transects
- Stream piezometers; stream piezometers will be equipped with pressure transducers
  - Shallow groundwater piezometers; piezometers will be equipped with pressure transducers that will measures shallow groundwater fluctuations
- A deep groundwater monitoring well equipped with a pressure transducer to measure changes in depth

**Total equipment cost:** $50,000
Total labor/travel cost: $50,000

**Project Meetings**

Project meetings will be held throughout the course of this project with the research team and associated partners. Meetings for both the NEPA and CFRP process will also need to be attended when necessary. Since we do not know the number of meetings annually, this cost estimate is based on travel to and from four meetings in the Reserve area per year.

Total labor/travel cost: $14,000

**Vegetation Monitoring**

Vegetation measurement and monitoring protocols will follow the methods developed by Herrick et al. (2005). Point line-intercept will be used to characterize the plant species composition and foliage canopy height profile up to 1 m above the ground surface. Gap line-intercept will be used to measure both plant canopy horizontal cover and soil surface cover, including bare soil, rocks, cryptobiotic crusts, leaf litter, and dead and down woody material. Animal (deer, livestock) tracks and scat also will be recorded along the lines. Total plant species lists will be compiled from the line-intercept data to provide species composition and diversity information. Tree seedlings and saplings less than 1 m in height will also be measured along the lines. Monitoring percentage of cover can provide valuable insight on the response of vegetation to thinning practices and can aid in determining if the vegetation is providing (or making progress toward providing) adequate ground cover to protect the soil and/or arroyo banks from erosion.

These surveys will also look for invasive species and noxious weeds and when found they will be mapped with a Trimble XT global positioning system (GPS) unit.

Total labor/travel cost: $30,000

**Data Analysis and Reporting**

All data will be quality checked by senior scientists before being submitted to the database manager. A database manager will be in charge of building a database that will be used for the duration of the project. Senior scientists will perform analysis on a yearly basis looking for data trends. Modeling of both stream flow and shallow groundwater flow will be conducted as well as modeling of evapotranspiration onsite. Once thinning is completed comparison will be made between the treated and controlled watershed. Yearly progress reports with all analysis will be submitted to the New Mexico Interstate Stream Commission (NMISC) on a yearly basis.

Measurement data will be summarized and analyzed using a variety of analytical techniques, depending on the type of data and the desired analysis. Statistical testing will follow analytical procedures found in Krebs (1998), Gotelli and Ellison (2004), McCune and Grace (2002), and Ludwig and Reynolds (1988). We will use SYSTAT (Systat Software Inc. 2002) statistical analysis software to perform most statistical tests of data comparing parameters from treatment and control study plots. Separate paired t-tests will be run for ponderosa pine and piñon-juniper woodland sites. The same analytical statistical approach will be used for all data sets. Linear
regression will also be used to examine relationships between variables or parameters. Both quarterly and yearly progress reports with all analysis will be submitted to the NMISC and associated project partners.

**Total labor: $35,000**

c. *Identify the source of local contributions and demonstrate the commitment and ability to pay any local cost-share for project proposal, including any applicable exchange costs.*

If awarded the project team will aggressively seek funding from the CFRP, which came about in 2000 after Congress passed the Community Forest Restoration Act (Title VI, Public Law 106-393). This act authorized up to $5 million each year for a grant program that would fund collaborative, community-level projects aimed at ecological restoration projects on public lands in New Mexico. Through this program we would apply for $150,000 to help offset the high cost associated with the NEPA process. The CFRP program also allows for implementation funding after the NEPA process is complete. The project team would also seek this funding in the amount of $360,000 to help offset the high cost of thinning and prescribed burning. Other programs including CFRP will be sought in order to help offset the cost of implementation of the thinning and burning operations. If this project is funded through the CFRP process, the percent match could reach 23% of the total cost of the project. Soil moisture sensor replacement will also be matched at a maximum of $1,400 per year which represents a 1% match on the total project.

6. **Describe how the proposal addresses the needs of a particular group or groups or interests on the issues of**

   a. *Historic uses, traditions, cultures, and customs.*

This proposed forest watershed restoration will enhance environmental services for many human interest groups. People have historically used the natural resources of this region for their livelihoods and for recreation. Bringing the forest watersheds back to a more “natural” condition will directly improve ecosystem services such as forest industry, livestock grazing, hunting, and outdoor recreation. Increasing watershed function will enhance surface waters and water quality and will benefit ecosystem services for agriculture, fishing, recreation, and other uses of quality surface waters.

Surface water in the San Francisco Basin has historically been used primarily for agricultural irrigation (Southwest Regional Water Plan 2005). The agricultural communities within the San Francisco Basin are dependent on water for irrigation to sustain their livelihoods; however, population growth and increasing drought conditions across the region are leading toward increased surface water demands and decreased surface water supply. Future anticipated water demand in the Southwest New Mexico Water Planning Region has been projected to continue to be dominated by agricultural irrigation with a projected water balance gap in Catron County to be a 114-acre-foot deficit by 2040 (Southwest Regional Water Plan 2005).

The primary objective of this proposed watershed improvement project is to demonstrate that forest watershed yield or supply can be increased through appropriate forest watershed management practices. Such an increase in water supply could alleviate the projected water balance deficit for the San Francisco Basin and the entire Southwest New Mexico Water Planning Region if adopted on the broader forested landscapes throughout the region. Thus, this
project may demonstrate how surface water supply may be increased in a sustainable way to maintain regional cultures, customs, and traditions by accommodating future water demands. Additionally, an increase in forest thinning management in the region would improve and increase habitat for game wildlife species, such as mule deer, elk, wild turkey, and game fish species, which would lead to increased opportunities for game hunting and fishing. Removal of trees from overstocked watersheds also would lead to employment opportunities in the forest products sector to market trees and other wood products produced through the thinning process. A goal of this watershed management approach is to use prescribed fire as a management tool that can be used cost effectively on a local level without the need for large outside funding sources.

b. **Current and future demands for water in the Southwest Planning Region.**

The principal water demand in the Southwest New Mexico Water Planning Region, especially the San Francisco Basin, is for agricultural irrigation at 80% of total usage (Southwest Regional Water Plan 2004). The most recent water budget for the San Francisco Basin is balanced; therefore, no additional water is currently available for consumptive use (Southwest Regional Water Plan 2004). The purpose of this proposed project is to restore San Francisco Basin watershed health, increase surface water yield or supply, and improve water quality and reduce the potential for catastrophic wildfire. The AWSA allows for additional water development in the San Francisco Basin, and this proposed project aims to increase surface water supply that may mitigate future water development and allocation in the basin.

Increased water yield or water supply should result from forest thinning and/or prescribed burning of select overstory trees. One of the most researched sites for forest water yield studies has been the Beaver Creek Watershed, Coconino National Forest, Arizona (Brown et al. 1974; Clary et al. 1974; Baker 1982, 1986). At this experimental forest site, researchers found that thinning of ponderosa pine woodlands (with reductions in basal area up to 120 square feet/acre) generate stream flow increases of 35% (Johnson 1996).

In order to see if this may occur in the San Francisco Basin as well, a scientifically sound study design using the paired watershed approach will be implemented. This approach will objectively quantify the effects of forest thinning treatments on watershed runoff, alluvial flow/recharge soil moisture, and soil erosion from vegetation management responses. An objective of this management approach is to establish an herbaceous understory capable of sustaining fire return intervals of five to eight years. Current overstock forest conditions do not support an herbaceous understory capable of carrying frequent low-severity surface fires (Figure 3).

Project methods will include measurements of stand structure, herbaceous understory, soil moisture, stream runoff, shallow and domestic/irrigation groundwater levels, rainfall, ambient temperature, and relative humidity. The New Mexico State University Climate Center will model evapotranspiration levels in the paired watersheds (Figure 4) using data from mini-meteorological stations that will be installed in each watershed to accurately record precipitation inputs (Figure 5). Stream piezometers (Figure 6) will be used to measure surface water runoff from the watersheds, and shallow groundwater piezometers (Figure 7) will be used to measure shallow groundwater and a cased monitoring well will measure domestic/irrigation levels in response to the forest thinning treatments. The project will evaluate hydrologic changes and interactions between soil moisture, groundwater, surface water, and climate before and after thinning where vegetation is altered to enhance watershed function and restore a natural fire
regime. This multidisciplinary forest/watershed management approach to forested landscapes throughout the basin will have applicability to the entire Southwest New Mexico Water Planning Region to meet growing regional surface water demands.

c. Flood control.

Flooding is common following catastrophic wildfire in mountainous terrain. Catastrophic wildfire removes vegetation and organic soil surface litter and duff, resulting in elevated runoff and reduced infiltration during heavy rainfall events. A primary goal of this project is to reduce the potential for catastrophic wildfire and, therefore, reduce flooding events in the watershed.

d. Fire protection, prevention, or suppression.

In addition to increasing water yield, another primary objective this proposed project is to reduce the potential for catastrophic wildfire. As stated above, selectively removing trees in overgrown stands is a proven method for reducing the severity of wildfires. Thinning trees eliminates continuous horizontal and vertical fuel supplies, thus preventing the spread and the severity of wildfire. Wildfire in thinned stands tends to burn near the ground surface and remains relatively cool, not killing larger trees. Wildfire in overgrown stands tends to spread rapidly into the tree crowns, becoming very hot and destroying entire stands of trees.

e. Recreation.

This project aims to improve watershed health, which will increase opportunities for recreation. Improved watershed health and surface water yield will provide better habitat for wildlife, supporting recreational activities such as wildlife viewing and hunting. More open forest stands and better developed understory vegetation will provide better landscapes for hiking and camping. Increase surface water yield and improved water quality will provide better stream conditions for fishing, boating, and swimming. Ecologically healthy and attractive forest and river landscapes should enhance tourism in the region and provide economic benefits to local communities.

f. Environmental protection and/or enhancement.

Overall improvement of watershed health will increase the resistance of the watershed environment to perturbations, including climate change, and the resilience of the watershed environment to rebound from perturbations. Forest thinning will reduce competition among remaining trees for limited soil water and nutrients, resulting in physiologically healthier trees (Allen et al. 2002). When trees are less limited by available soil moisture, they are better able to survive drought periods and resist bark beetle attack. Forest thinning will also reduce the potential for catastrophic wildfires, which damage, disrupt, and destroy ecosystem resources. Understory vegetation also will be better able to withstand drought periods by reduced competition from overstock trees.

g. Any others.

This project will produce valuable research information to forest watershed managers and researchers over a broad range of institutions and disciplines. The research will be valuable to the USFS and others in forest sciences and the forest industry relative to evaluating best practices for forest watershed management. This research will produce valuable information to restoration ecologists who are attempting to develop the best approaches to southwestern ponderosa pine forest and watershed restoration. The research will be valuable to hydrologists interested in how
forest thinning affects watershed surface water yield, both locally and downstream to the greater watershed. Very little research has been conducted on the environmental consequences of forest thinning the New Mexico, and this project will provide much needed information to help evaluate the effectiveness of these current proposed methods for future forest watershed restoration.

7. **List those supporting the application, including federal, state, and local government entities; Indian nations, tribes or pueblos; irrigation or conservation districts; non-profit organizations; and other entities. Provide letters or resolutions of support for the application.**

   SEE ATTACHED LETTERS OF SUPPORT

8. **Describe whether the proposal would benefit one or more than one of the counties in the Southwest New Mexico Planning Region – Catron, Grant, Hidalgo, and/or Luna Counties.**

   This proposed project would directly benefit Catron County; however, the indirect benefits of this project could potentially benefit Grant, Luna, and Hidalgo counties as well. A few of the direct benefits to Catron County would include increased water yield, increased habitat diversity, and catastrophic wildfire protection. This project also has the ability for job creation, which in turn would help stimulate the local economy. This project has the potential to indirectly benefit Grant, Luna, and Hidalgo counties because of the increased fire protection from thinning.

9. **Describe whether the proposal would support economic growth or benefit one or more than one of the following interests in the Southwest New Mexico Planning Region – agricultural, ranching, municipal, recreational, or other (specify).**

   1) **Agriculture.** A primary objective of the proposed project is to increase surface water yield from the forest watersheds as a result of forest thinning. Such thinning has been shown to increase water yield by up to 35% in southwestern ponderosa pine forests. Increased surface water yield would increase downstream surface water supply that would be potentially available to supplement agricultural irrigation. Given that climate forecasts predict drying and warming weather conditions in the Southwest, any increases in forest water yield will benefit agriculture in the greater watershed.

   2) **Ranching.** An outcome of forest thinning is an increase in the diversity and cover of understory herbaceous vegetation including perennial grasses. Increased grass and other understory herbaceous vegetation resulting from forest thinning would increase the carry capacity of the land because of the increased forage availability to domestic livestock. Careful measure need to be taken in order to ensure there is enough perennial grass cover to carry a surface fire, which is a primary goal of restoration within the Gila National Forest.

   3) **Municipal.** Municipalities downstream from watersheds restored by forest thinning should directly benefit from increased surface water availability and improved surface water quality. Municipal water use is generally from groundwater wells, and groundwater levels may be enhanced by increased flow in the San Francisco and Gila rivers. Additionally, improved forest watershed health will provide more attractive forest landscapes for recreation and potentially increased tourism for regional municipalities. Reduction of catastrophic wildfire through forest thinning practices will allow for the growth of healthy forests and timber for the forest industry.
4) Recreation. As stated above, improving forest watershed health through forest thinning should result in forest and river landscapes that are attractive to outdoor recreation. Open stand ponderosa pine forest with well-developed understory vegetation will enhance landscapes for hiking, horseback riding, wildlife observation, and hunting. Increased watershed yield and improved water quality will enhance streams and rivers for fishing and boating.

5) Timber Industry. Overgrown ponderosa pine forests are not only susceptible to catastrophic wildfire, but also tree size and timber values are reduced from competition among densely packed trees competing for limited soil water and nutrient resources. Restoration of the forests should lead to favorable future timber resources for the timber industry in the region, providing economic benefits for local communities.
FIGURES

Figure 1. The proposed study location is outlined in red and located within the Gila National Forest, Quemado Ranger District.

Figure 2. Relationship between average annual water yield increase at average conditions and extent of clearing ponderosa pine forest overstories (Ffolliott and Thorud 1975).
Figure 3. Current conditions at the Reserve site, overstock forests with little herbaceous understory.

Figure 4. New Mexico State University Climate Center Staff weather station at a site in the Burro Mountains.
Figure 5. A mini-weather station used by SWCA to monitor watershed rainfall inputs in the Manzano Mountains for a forest thinning monitoring project.

Figure 6. A stream piezometer used by SWCA to monitor watershed stream levels in the Manzano Mountains relative to forest thinning.
Figure 7. Soil moisture sensor and stream channel piezometer used to monitor stream groundwater levels relative to forest thinning in the Burro Mountains.
LITERATURE CITED

(To access the literature cited please follow attached instructions)


To access the literature cited please use the site below with the following login:

Username: ABQgeneral
Password: 2010 SWCA

There will be a folder named **AWSA T2 Literature** with all references not available within the public domain.

If there is trouble with access to the client workspace please contact: Cody Stropki, Watershed Scientist, SWCA Environmental Consultants at cstropki@swca.com or 505-254-1115.
LETTERS OF SUPPORT
New Mexico Interstate Stream Commission
Attn: Mr. Craig Roepke
P.O. Box 25012
Santa Fe, NM 87504-5102

Re: New Mexico Forest Industry Association ("NMFIA") Proposed Project near Luna, NM to be Funded under Arizona Water Settlements Act

Dear Mr. Roepke,

The NMFIA has proposed a mechanical thinning project on the north side of the San Francisco Divide, which is on the south side of Luna, New Mexico. The proposed project would occur on the Luna Allotment. The Spur Ranch Cattle Co. LLC is the permittee for the Luna Allotment. I am a member of that LLC.

Subject to consultation on timing, adequate measures to protect fences and Forest Service approval, I support the proposed measure to thin two sections on the north side of the San Francisco Divide near Luna. Much of this country provides marginal grazing for cattle and wildlife because the fuel load is high and growth is thick. The Wallow Fire this summer illustrated the threat from this problem to a number of stakeholders. Although the Wallow Fire did not reach the north side of the San Francisco Divide near Luna, it is not a question of whether a catastrophic fire will occur but only a question of when calamity will strike and it will be engulfed in a fire that burns so hot it sterilizes the soil and eliminates grazing for an extended period of time. Such a fire will threaten our community of Luna, eliminate 1&1 species, and severely impact the San Francisco watershed for years to come. Thinning,stacking and burning the north side of the San Francisco watershed today will avoid the ravages of catastrophic fire. My only criticism of the proposed project is that it is too modest. The size should be increased to cover the entire north face of the San Francisco Divide from the San Francisco Box to the State Line.

Sincerely,

[Signature]

Thomas W. Paterson, Member

---FREE-RANGE, GRASS-FED BEEF CATTLE---
December 8, 2011

New Mexico Interstate Stream Commission
Attn: Craig Roepke
PO Box 25012
Santa Fe, NM 87504

Dear Mr. Roepke,

I am pleased to offer this letter of support for the AWSA Tier 2 proposal submitted by the Grant Soil & Water Conservation District, “Paired Watershed Study to Track Soil Moisture and Alluvial Water Response Before and After Brush Treatments in the Gila Watershed Region.”

The New Mexico Climate Center has been a collaborator with Ellen Soles for several years and the Center staff have worked together to provide meteorological measurements and evapotranspiration estimates at the Burro Mountain study station since 2008. Climate data from the Burro Mountain weather station will remain in the Center’s archive.

We strongly support the continuation of this study to evaluate watershed responses to thinning treatments over decade-plus scales. The New Mexico Climate Center is dedicated in supporting the project through data archiving and providing evapotranspiration estimates. We appreciate the opportunity to participate in a study of such benefit to long-term forest and watershed management efforts.

Sincerely,

David W. DuBois
NM State Climatologist
Mr. Craig Roepke
New Mexico Stream Commission
PO Box 25012
Santa Fe, NM 87504

Dear Mr. Roepke

This letter is in support of the AWSA Tier 2 proposal submitted by the Grant Soil & Water Conservation District, “Paired Watershed Study to Track Soil Moisture and Alluvial Water Response Before and After Brush Treatments in the Gila Watershed Region”.

One of the two study areas occupies a site just west of the Continental Divide in the Black Range, on the Black Range Ranger District of the Gila National Forest. The Black Range District has been a cooperating partner in this long-term project since its inception in 2008, and receives annual reports on the study’s progress in collection of baseline data. The Black Range District has planned a large-scale prescribed burn that includes the study area. Parts of the area have been burned and burning of the study area will occur as funding becomes available, perhaps as early as 2012.

The project continuation will engage an interdisciplinary team assembled by the NM Forest Industry Association that includes the original project researchers. Studies that evaluate watershed responses to restoration treatments over decade plus scales are rare, due to the obvious difficulties posed by such an extended commitment of time. We appreciate the opportunity to participate in a study of such benefit to long-term forest and watershed management efforts.

Sincerely,

Larry D. Cosper
Black Range District Ranger
New Mexico Interstate Stream Commission

Attn: Craig Roepke

PO Box 25012

Santa Fe, NM 87504

This letter is in support of the AWSA Tier 2 proposal submitted by the Grant Soil & Water Conservation District, “Paired Watershed Study to Track Soil Moisture and Alluvial Water Response Before and After Brush Treatments in the Gila Watershed Region.”

One of the two study areas occupies a site in the Burro Mountains, on the Silver City Ranger District of the Gila National Forest. The Silver City District has been a close cooperator on this long-term project since its inception in 2007. Silver City District staff worked with staff from NM State Forestry to design the thinning treatments on the site that occurred in late 2010, following three years of baseline data collection by project researchers. Silver District staff also performed intensive thinning on part of the study area, and provided guidance and oversight, again in collaboration with NM State Forestry, for prescription thinning by a local contractor and crew on the remaining project area. The Silver District has received annual reports on the study’s progress.

The project continuation will engage an interdisciplinary team assembled by the NM Forest Industry Association that includes the original project researchers. Studies that evaluate watershed responses to thinning treatments over decade-plus scales are rare, due to the obvious difficulties posed by such an extended commitment of time. We appreciate the opportunity to participate in a study of such benefit to long-term forest and watershed management efforts.

Sincerely,

/s/RUSSELL D. WARD

District Ranger
December 13, 2011

To whom it may concern;

SUBJECT: Arizona Water Settlement Act Proposal Project Support

The New Mexico Forestry Division, Socorro District has been a partner in the project proposed by Ellen Soles and the Grant SWCD for four years. As a working group, we have successfully received support from the USDA/Natural Resources Conservation Service, Gila National Forest, NM Interstate Stream Commission, Grant County Soil and Water Conservation District, USDA Natural Resource Conservation Service, NM State Forestry and grazing permittees, Jack Diamond, Dusty Hunt, David Ogilvie. The project, known as “Paired Watershed Study to Track Soil Moisture and Alluvial Water Response Before and After Brush Treatments in the Gila Watershed Region”, intends to increase the instrumentation and biomass measurements on both the Burro Mountain and East Fork Gila River (Stiver Canyon) site in an effort to further research for the Arizona Water Settlement Act towards increasing watershed hydrology in the Gila Basin.

We support the effort of this project and believe this study, and the associated Reserve area project submitted by SWCA, are important in understanding the balance between vegetation and watershed hydrology.

Sincerely;

s/Doug Boykin
Socorro District Forester
October 27, 2011

Mr. Craig Roepke
New Mexico Interstate Stream Commission
P.O. Box 25012
Santa Fe, NM 87504-5102

Dear Mr. Roepke:

The Grant Soil & Water Conservation District is in support of the Paired Watershed Study to observe the affects of soil moisture and alluvial water response to thinning Piñon/Juniper and Ponderosa stands in the Mangas Watershed tributary of the Gila River in Grant County and the East Fork Gila River in Sierra County.

Sincerely,

[Signature]

David McCauley, Chairman
Grant Soil & Water Conservation District
Dear Ellen,

Part of your paired watershed project in the Burro Mountains is conducted on my forest allotment. Thank you for your efforts and I am anxious to learn your conclusions.

Over the past ten years, extensive controlled burning has been conducted on my ranch. These burned areas dramatically out perform the unburned areas. Grama grasses and other herbaceous plants now dominate acres that were shaded by pinion and juniper trees a few years ago. We don’t run any more cattle in these areas but we wean heavier calves. Hopefully we will be able to continue burning in the Burro Mountains.

These burns may also enhance the area’s contribution to the water table. The herbaceous plant roots are stabilizing the surface soils, slowing water runoff and providing a pathway for water to enter the soil. Some of that water is bound to reach the water table. However, some resource managers doubt if this contribution is significant.

Your paired watershed study may answer the question “if we reestablish a natural fire pattern in the Burro Mountains, can we expect the water table to rise”? Best of luck in your efforts to continue funding this work and if there is anything I can do to help, just call.

Sincerely,

Dusty Hunt