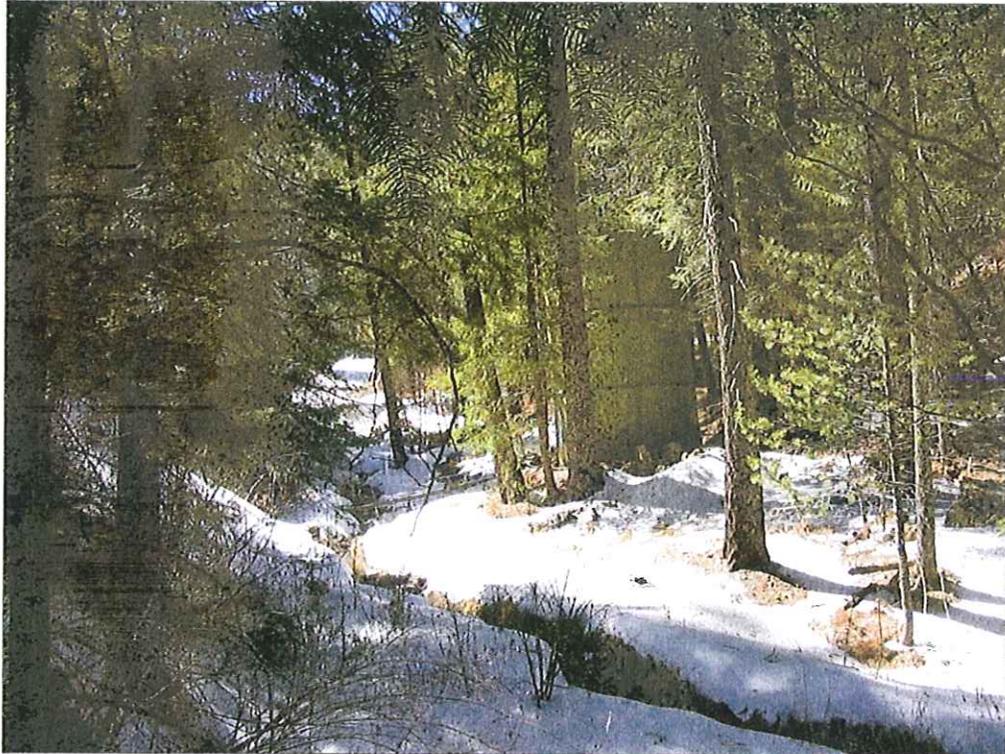


Appendix G

Development of the Upper Santa Catalina Mountains Water Resource Management Plan



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June 17, 2007

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Preface

This report is part of a series of publications issued by the University of Arizona, Department of Hydrology and Water Resources. The purpose of this series is to disseminate research findings about natural resource systems to a broad audience of persons conducting research in natural resources. Any opinions, findings, and recommendations or conclusions in this report are those of the author and do not necessarily reflect the views of the agencies, organizations, or individuals whose support is acknowledged.

Acknowledgements

This study would not have been possible without the assistance of several people. I would like to thank the following current and former Forest Service employees: Steve Hensel for sharing his knowledge, data, and history about water resources on the Santa Catalina Mountains; Robert Lefevre for the records about water rights and conflicts on the Santa Catalina Mountains; Terry Austin and Carson Coates for making maps, and Jennifer Ruyle for a flexible work schedule to work on this report. Thanks to Michael Stanley of the Mt. Lemmon Domestic Water Improvement District for sharing information about the water delivery system, history of conflicts and water use. Thanks to the Santa Catalina Mountain Partnership for making water resources an issue that needs improved management. Thanks to my family, especially my husband Ian, for all their support and encouragement.

Author's Contributions

I am an employee of the USDA Forest Service and currently working for the Coronado National Forest as the Assistant Forest Planner. I have been involved in discussions and activities affecting the Santa Catalina Mountains. I have been one of the Forest Service representatives for the Santa Catalina Mountain Partnership, since the formation of the steering committee. I have worked with fellow Forest Service employees, Michael Stanley of the Mt. Lemmon Domestic Water Improvement District, and the Santa Catalina Mountain Partnership in developing this report. My contribution to this report included; helping to develop possible solutions to the conflicts between the two water providers, evaluating possible water resource management improvements, calculating median streamflow for Sabino Creek, and estimating supply and demand. After completion of my degree I will continue to work for the Forest Service, which will include participating in Santa Catalina Mountain Partnership and assisting in the implementation of a water resource management plan.

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ABSTRACT

An assessment was performed and a proposed water resource management plan for the Upper Santa Catalina Mountains was developed focusing on the Sabino Creek Watershed. Existing data, knowledge, and input from the USDA Forest Service, the Mt. Lemmon Domestic Water Improvement District, Pima County, Summerhaven property owners, and other interested stakeholders was incorporated. Water is a limited and extremely important resource on the Santa Catalina Mountains. Demand is likely to increase in the near future, due to redevelopment. Cooperative management of water resources and implementation of conservation measures could mitigate demand and resulting impacts. Implementation of a water resource management plan would require the cooperation of the Forest Service and Mt. Lemmon Domestic Water Improvement District, as well as other stakeholders including Summerhaven property owners and Pima County. The cooperative management of water resources has the potential to improve management and sustainability of resources on the Santa Catalina Mountains.

CHAPTER 1 INTRODUCTION

Problem Statement

Water resources on the Santa Catalina Mountains are limited and dependent on annual precipitation. Currently there are two separate water distribution systems on the Catalinas. The USDA Forest Service has a system that provides water to Forest Service recreational and administrative sites. The Mt. Lemmon Domestic Water Improvement District (MLDWID) is the other system, providing water to cabin owners and businesses in the Summerhaven area. Since 1944 these two systems have been operating independently. However, most of the water used by the two systems comes from the same source, the Upper Sabino Creek Watershed. Competition for the same water source has led to shortages and conflicts between the two water providers. In 2003, the Aspen Fire significantly impacted the Catalinas and Summerhaven. The demand for water has been greatly reduced, but the potential for demand to exceed pre-Aspen Fire amounts could occur in the future. Collaborative water resource management on the Catalinas could address the need to find a balance between providing water for human use and sustaining the Sabino Creek Watershed.

The objective of this research is to develop the basis of a water resource management plan for the Upper Santa Catalina Mountains. The water resource management plan would serve as an agreement between the Forest Service and the MLDWID, and possibly other stakeholders to cooperatively manage water resources on

the Catalinas. The plan will also emphasize conservation to reduce demand and to work towards a balance to maintain the natural environment.

Watershed Planning

The focus of planning at a watershed scale expanded and became more common practice in the late 1980's (Sabatier et. al., 2005). Prior to this approach, watersheds were usually managed by a government agency with the goals being to maintain reliable water sources for communities and flood protection. Such agencies dealt with a single focus within the watershed, without taking into account the effects on other aspects of the watershed. In the late 20th Century the new approach began to look at the entire watershed, recognizing how an individual activity can affect the whole watershed. There was also an increasing awareness and desire to protect the natural environment.

The best watershed planning is a holistic process that is geographically defined, integrated with other planning efforts, and done collaboratively with many partners (EPA, 2005). Developing a water resource management plan that is based on a watershed allows for all activities and uses that could affect the water resources to be incorporated into the planning efforts. Such planning avoids the conflicts and shortcomings of a more traditional approach to water resource planning which addresses only the uses of water resources for a given area, usually based on political boundaries, and sometimes only looking at either surface water or groundwater used for meeting the demand of one water provider. In contrast, planning around a watershed takes into account the entire system with the potential for consideration of a wider range of issues and entities.

A watershed planning approach can be initiated by various organizations for many reasons. This approach to planning can be driven by a government agency at various levels, a local community, or individuals with a particular interest from within a community such as a group of local farmers. The reason this type of planning is initiated can be due to a single issue facing the watershed such as the building of a reservoir. Or broader focus planning may come about because of an accumulation of issues due to numerous activities occurring at once. This might be because of the different land ownership within a watershed where there has been no coordination to address the cumulative effects of the disparate activities such as two adjacent parcels of land with one experiencing logging and the other being a recreational area.

Collaborative watershed planning requires engagement from many stakeholders and commitment to finding solutions to the problems within a given watershed. Sabatier et. al. explain that successful watershed planning requires key factors that include representations by a diverse group of stakeholders, trust among participants, accomplishment of goals, and survival of the group. Success of watershed planning effort can be measured by the consensus of the group on the issues that need to be resolved, implementation of projects to resolve the issues, and the degree to which the watershed was improved (Sabatier et. al., 2005).

An example of a watershed planning effort that has been successful is the American River Watershed Group (ARWG) in California that was initiated by government agencies to address the issue of fire danger (Timmer, 1999). However, since ARWG's creation in 1996, the group has broadened its scope to address other issues

including water quality monitoring and reestablishing wet meadows. The ARWG meets once a month and has received funding for watershed restoration projects. Although the ARWG has been successful in attaining watershed improvements, the group acknowledges it could achieve even greater success with a broader membership (Timmer, 1999).

Engaging a diverse group of organizations and individuals to come to a consensus on multiple issues over many years is not an easy task. It takes foresight and commitment by the participants and a willingness to work cooperatively, but watershed planning has the potential to lead to trust among a diverse group of stakeholders and improved management of resources for current and future uses.

The Santa Catalina Mountains

The Santa Catalina Mountain Range is located in Southeastern Arizona just north of the City of Tucson. The Catalinas are one of twelve mountain ranges that make up the Coronado National Forest, which is part of the National Forest System lands. The Catalinas were first designated as the Santa Catalina Forest Reserve in 1902 (Hensel, 2003). Then, in 1908, three forest reserves, the Santa Rita, the Santa Catalina, and the Dragoon Mountain in Southeastern Arizona were consolidated to create the Coronado National Forest (Hensel, 2003). One of the most popular locations in the Catalinas is Sabino Canyon Recreation Area, which is visited by millions of visitors each year.

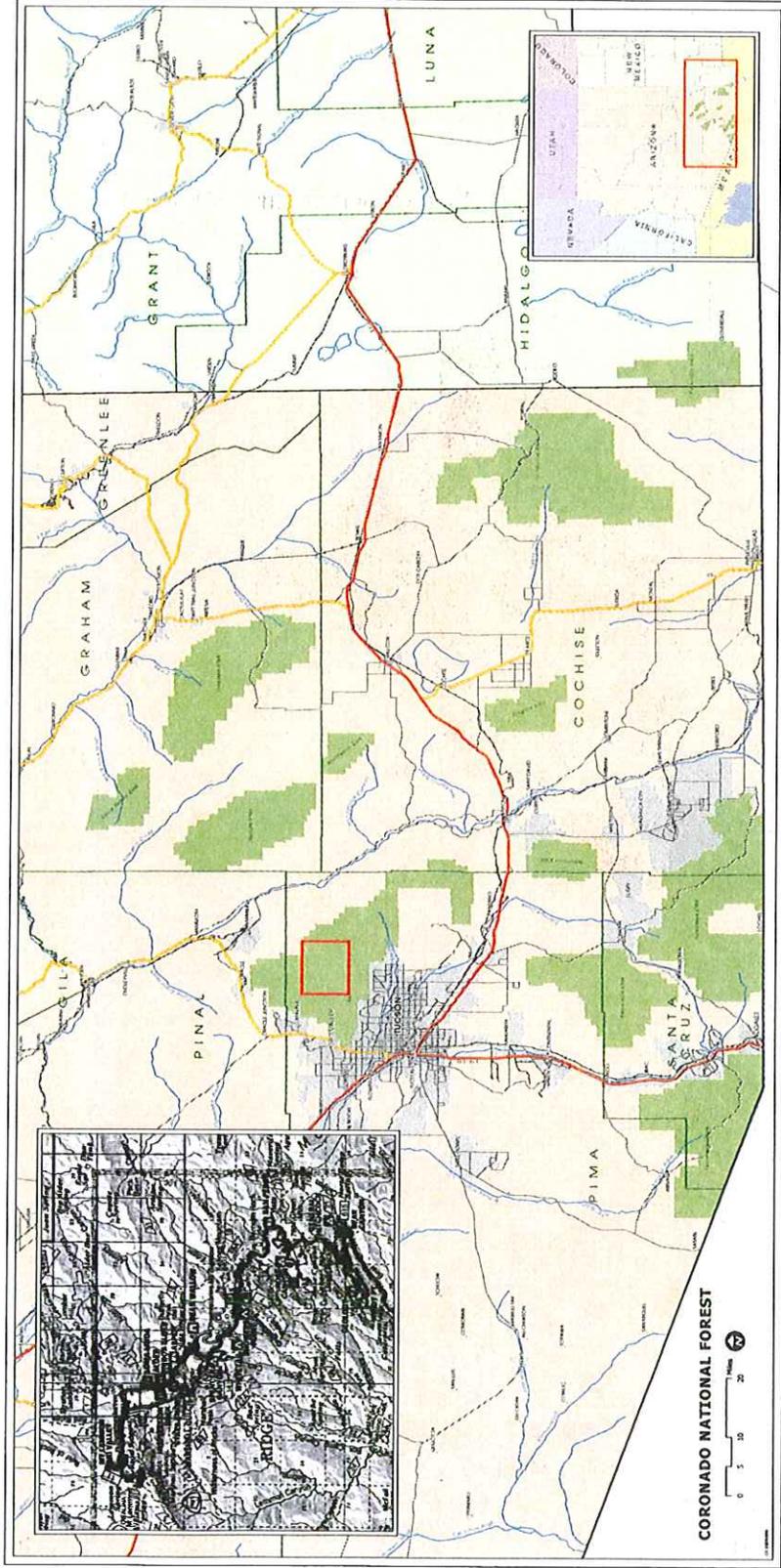


Figure 1.1 Location of the Santa Catalina Mountains

The Santa Catalina Mountains are in the Basin and Range Province in the southwestern United States and surrounded by the Sonoran Desert. The Catalinas are composed of metamorphic granite that is weathered and formed into strange pillars called hoodoos in several locations (Chronic, 1998). The highest peak in the Catalinas is Mount Lemmon, which rises to 9,157 feet above sea level. The Catalinas are part of a series of distinct mountain ranges called sky islands. The term sky island comes from the geography of isolated mountain ranges surrounded by a desert floor. The sky islands are biologically important due to the fact that these mountain ranges are isolated ecosystems where unique species of plants and animals have evolved. For example, on the Catalinas is a unique subspecies of Ponderosa Pine (*Pinus ponderosa* var. *arizonica*) that has five needles per bundle, whereas the more common Ponderosa Pine (*Pinus ponderosa*) has two to three needles per bundle (Little, 1996). There are five main vegetation communities in the Catalinas that change with elevation. Starting on the desert floor at 2,400 feet to 4,200 feet is the Southwest Desertscrub community. From 4,200 feet to 7,200 feet is the Woodland community, which includes both broadleaf and coniferous trees. Above 6,200 feet the Transition Coniferous Forest begins. At the highest elevations, starting at 7,200 feet, is the Mixed-conifer Forest. Sabino Creek Canyon, classified as a Deciduous Riparian Community, is the fifth main community found in the Catalinas.

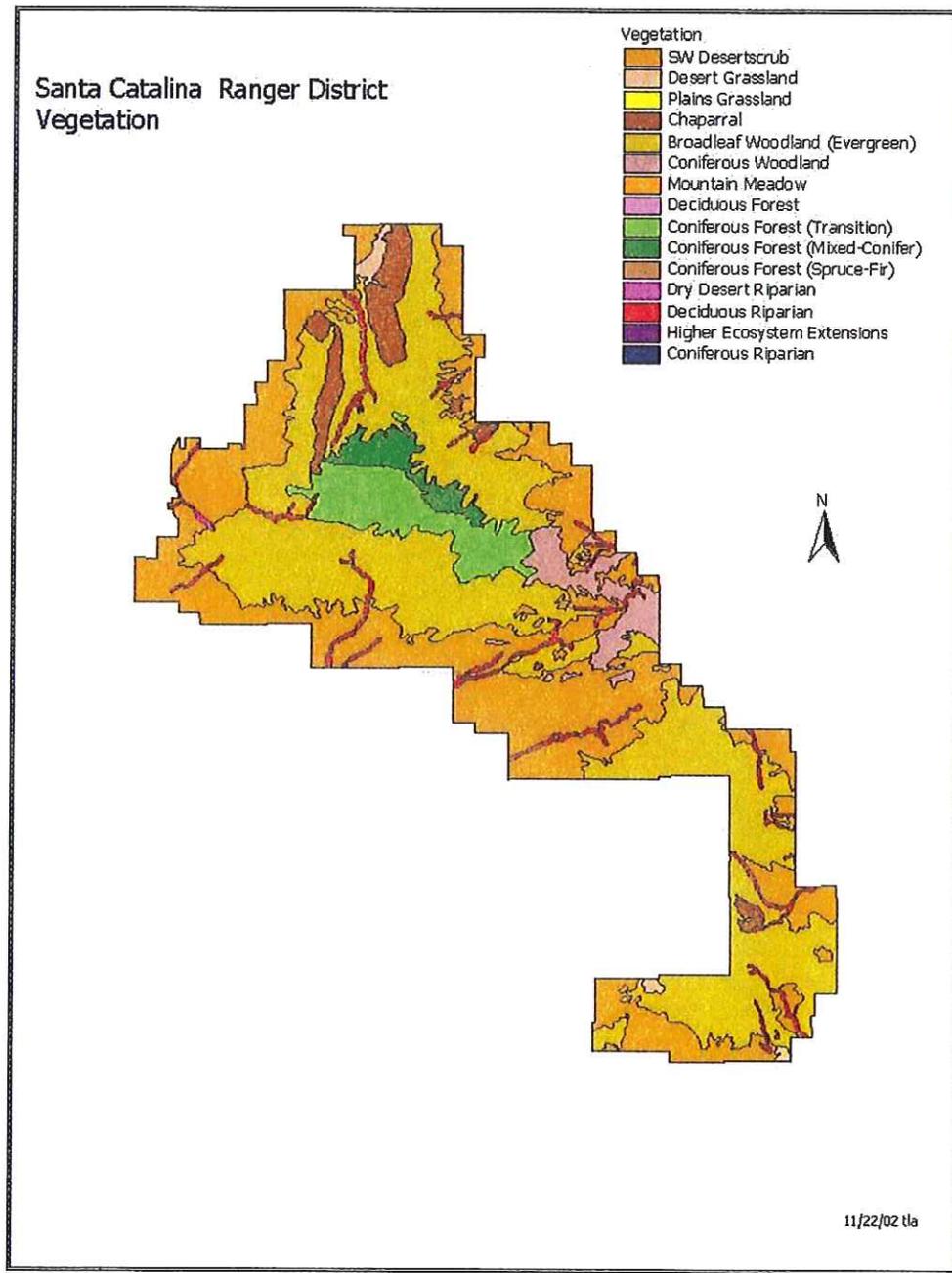


Figure 1.2 Vegetation Communities of the Santa Catalina Mountains

The average temperatures in the upper Santa Catalina Mountains range from the mid-80°F in the summer to lows in the 30°F during the winter months. Precipitation

varies with elevation and ranges from 12 inches below 4,200 feet to 30 inches a year above 7,200 feet. There are two seasons when precipitation occurs, the summer during the monsoons and the winter as either rain or snow. Several creeks originate in the upper Catalinas and flow to the desert floor. Most are dry washes throughout the year, except Sabino Creek. Sabino Creek begins at 8,600 feet and flows down to 2,600 feet where it enters the confluence of Tanque Verde Creek. Since surface water is so scarce in this desert climate Sabino Creek is an important water source for plants, animals, and humans. The State of Arizona has designated upper Sabino Creek for the following uses: full-body contact, domestic water source, fish consumption, and agricultural irrigation (State of Arizona, 2003). Within the Sabino Creek Watershed are four federally listed endangered species; the Mexican Spotted Owl, Gila Chub, Lesser Long-nosed Bat Cactus and Gila Topminnow (US Code of Federal Regulations, 2006 and USDA Forest Service, 1999). The Gila Chub and Gila Topminnow are aquatic species relying upon on the limited surface water found on the Santa Catalina Mountains.

Located at approximately 8,000 feet elevation in the Catalina Mountains is a private inholding of 445 acres, which includes the small community of Summerhaven. The community is surrounded by the Coronado National Forest. Summerhaven became private land in 1910 with a patent through the Homestead Act (Hensel, 2003). Initially the residents in Summerhaven obtained water from nearby springs. With the increasing number of cabin owners over the years came a need to establish a small water utility. The Mt. Lemmon Cooperative Water Company was established in 1944 to serve 100 customers in the Summerhaven area (Barnes, 2005).

Overview of the Two Water Delivery Systems

The Forest Service and the Mt. Lemmon Domestic Water Improvement District (MLDWID) each operate a water delivery system on the Santa Catalina Mountains. The two water delivery systems operate independently, but most of the water used by the two systems comes from the Upper Sabino Creek Watershed.

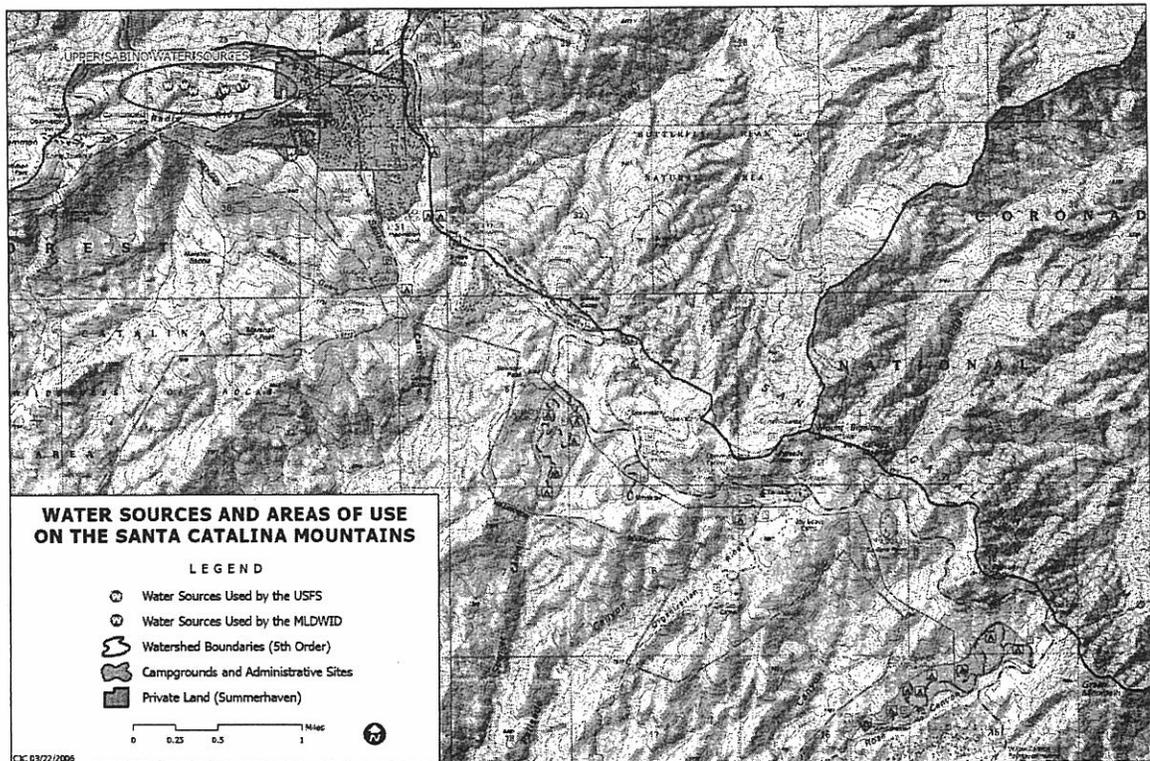


Figure 1.3 Water Sources and Areas of Use on the Santa Catalina Mountains

The Forest Service

The Forest Service owns and operates a complex water delivery system that provides water to four recreational sites (Rose Canyon, Spenser Canyon, Showers Point, and Whitetail), which are all campgrounds, and two administrative sites (Sollers Point and Palisades Work Center) within the Upper Sabino Creek Watershed (Hensel, 2004). Steve Hensel, an employee of the Coronado National Forest, has managed the Forest Service's water delivery system since 1994. When he began managing the system, the Forest Service was using 9 to 12 acre-feet (AF) of water per year. Now the average yearly use ranges from 2.75 to 9 AF per year (Hensel, 2004). The large variance in yearly water use is attributable to wildland fires, closures of Forest Service sites during extreme fire danger, and losses in the system.

In the upper Sabino Creek Watershed, the Forest Service has sixteen certificates of water rights to surface water sources and one groundwater well (Hensel, 2004). Of the sixteen surface water rights, six are not used, one is used by the MLDWID, two are used by organizational camps, and one is used by cabins on National Forest System Land. The six remaining surface water rights and groundwater well are diverted into storage tanks to provide water to four recreational areas from April to October and two administrative sites year round.

Mt. Lemmon Domestic Water Improvement District

The Mt. Lemmon Domestic Water Improvement District (MLDWID) provides water to the private residents and businesses in the community of Summerhaven. Prior to

September 2003 the MLDWID was the Mt. Lemmon Cooperative Water Company. The current operator/manager of the MLDWID is Michael Stanley and he has been working for the MLDWID since 1981. The average annual use by the MLDWID is 18 acre-feet. The MLDWID has seven certificates of water rights to surface water sources and three wells in the Upper Sabino Creek Watershed (Stanley, 2005). Four of its water sources are on private land and seven of the water sources are on Forest Service land. The MLDWID also uses one Forest Service surface water right through an agreement and maintains three water tanks owned by the Forest Service (Hensel, 2004). Starting in 1985 the MLDWID took over operating of the Forest Services' water delivery system and did this for nine years (Stanley, 2005). Citing increasing cost and concern that the Forest Service was transferring water from its designated place of use, the MLDWID stopped operating the system in 1994.

CHAPTER 2 REASONS FOR A WATER RESOURCE MANAGEMENT PLAN

The location of the community of Summerhaven being surrounded by National Forest Systems Lands creates a unique situation when it comes to managing the natural resources of the Santa Catalina Mountains. The fact that there have been two water delivery systems operating independently on the Santa Catalina Mountains for decades has created conflict in managing water resources as described below. A water resource management plan that is at least agreed upon by the two water providers has the potential to reduce or eliminate the conflicts and improve management.

Conflicts Between Water Providers

Conflicts between the Forest Service and the Mt. Lemmon Domestic Water Improvement District (MLDWID) have hindered the development of a water resource management plan that encompasses the whole watershed. Sources of conflict include a pending application for an instream flow right for Sabino Creek, pending water rights applications for consumptive uses, and the inconsistent availability of water on the Santa Catalina Mountains. The resolution of these longstanding conflicts will advance the development of a water resource management plan.

The conflict over an instream flow right for Sabino Creek began in 1987. On 27 July 1987, the Sierra Club filled an application with the Arizona Department of Water Resources (ADWR) for an instream flow right for the portion of Sabino Creek between the upper and lower gauging stations on the creek (Sierra Club, 1987). ADWR's

response to the Sierra Club stated that they did not have legal standing to apply for a water right in the Catalinas because they were not a landowner. Four days later, on 31 July 1987, the Forest Service, without knowledge of the Sierra Club application, also applied for an instream flow right for Sabino Creek (Lefevre, 2004). Once the Forest Service became aware of the Sierra Club's application and ADWR's response to it, the Forest Service decided to join with the Sierra Club on their application because it had a four day earlier priority date (Lefevre, 2004). The Forest Service/Sierra Club co-application brought protest from the MLDWID, fearing an instream flow right downstream from its water sources would impact the ability to take water from the watershed for human consumption. In 1994, a letter from ADWR requested the Forest Service to do several things before the instream flow application could be approved. The requirements included better estimates of the monthly flows on the instream flow application, removal of the Sierra Club from the application, and resolution of the protests to the application (Bushner, 1994). The Forest Service determined better flow measurements, modified the application, and sent the changes to the Sierra Club for their approval (Lefevre, 2004). However, the Forest Service has never received a response from the Sierra Club to submit the changes to ADWR. Thus the instream flow application has yet to be approved or denied. The Forest Service and MLDWID are currently discussing how to resolve this conflict and have an instream flow right for Sabino Creek.

Currently the Forest Service, MLDWID and individual Summerhaven residents have surface water right applications pending for the Sabino Creek Watershed (Lefevre,

2004 and Stanley, 2005). The instream flow application, which has an earlier priority date than these applications, has blocked ADWR from deciding whether to approve these pending surface water applications. The approval of the pending water rights applications for consumptive purposes would resolve the protest and allow the two water providers to move forward with the development of a water resource management plan.

The availability of water has always been an issue on the Catalinas. During the peak demand of the summer months, water shortages are not unusual in the Summerhaven community and at Forest Service sites. Current storage capacities are not sufficient, which leads to the Forest Service and MLDWID competing for water. Possible resolutions to alleviate the problem of water availability are: increase the storage capabilities, allowing for increased capture of water during the low demand winter months; implementation of conservation measures; and, combination of the Forest Service and MLDWID water delivery systems.

The Aspen Fire

The Aspen Fire, which began on June 17, 2003, brought significant changes to the Santa Catalina Mountains. The Aspen Fire was a human caused fire that started in the Marshall Gulch area approximately a half mile south of Summerhaven and burned for nearly a month. By the time this conflagration was contained it had burned 84,750 acres (Barnes, 2005). Of the 600 structures that existed prior to the Aspen Fire 322 residences, 7 businesses, and 4 barns and garages burned, many of which many were in the community of Summerhaven (Pima County Public Works, 2004). The Aspen Fire

brought significant changes to the natural landscape of the Santa Catalina Mountain's and the community of Summerhaven.

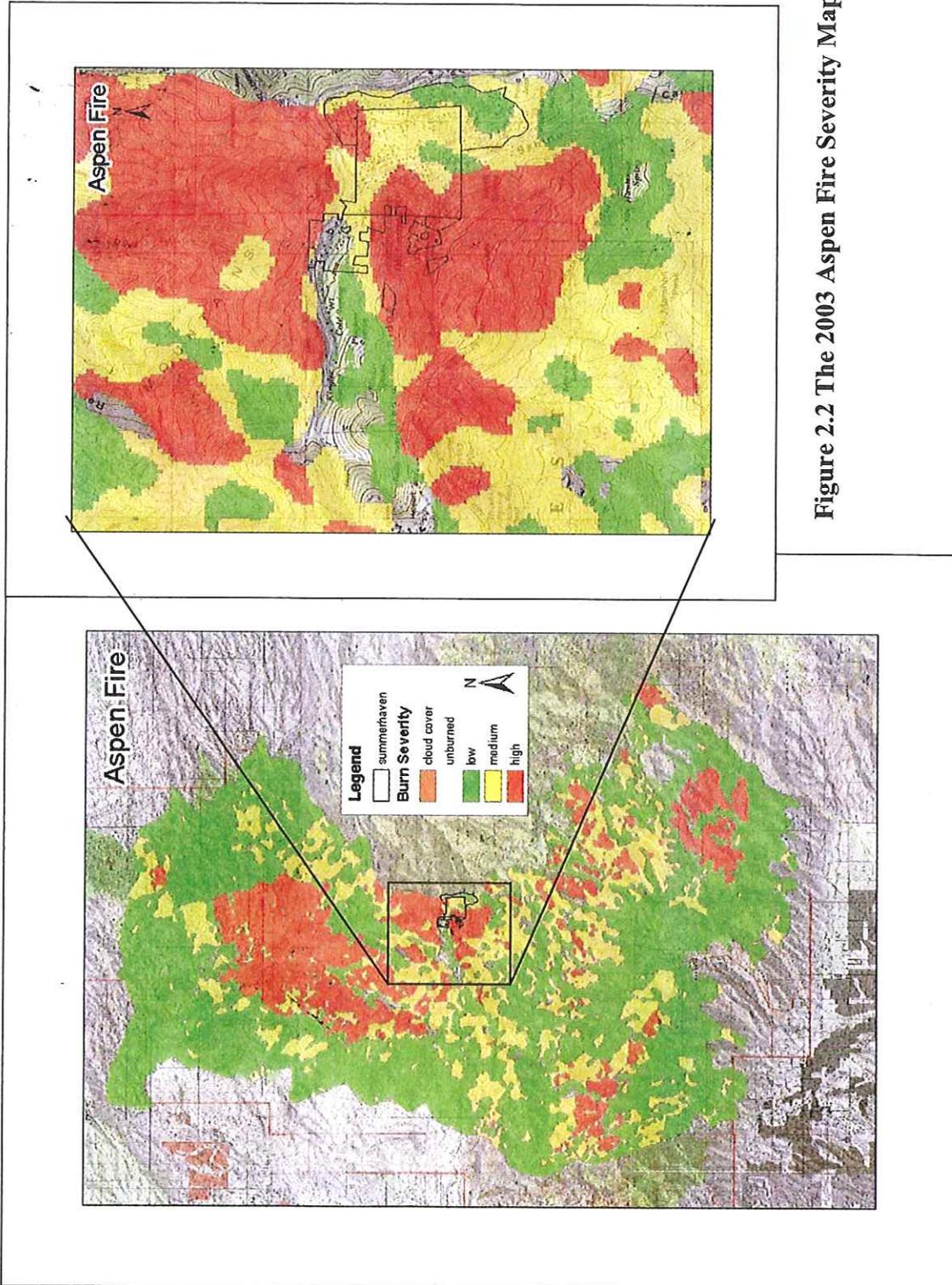


Figure 2.2 The 2003 Aspen Fire Severity Map

The two water delivery systems on the Catalinas also suffered damage from the fire. The Forest Service had to replace hundreds of feet of burned pipe at a cost of approximately \$20,000 (Hensel, 2004). This was the amount of initial rehabilitation funds the Forest Service received following the Aspen fire. Work continued for months following the initial rehabilitation. Several springs used as sources were damaged and are still not used several years after the fire. Two recreational sites were damaged and closed for a season to allow for repairs.

The Mt. Lemmon Domestic Water Improvement District (MLDWID) had damages exceeding \$727,000, including the loss of water tanks, a pump house, waterlines, meters, and valves. Further, the water District's office burned; it lost all its records and documentation (Barnes, 2005). Not only was the infrastructure of MLDWID greatly impacted, but also its water supply. Of the 300 users, over 200 were lost (Stanley, 2005). As cabins burned, the meters were left on and water discharged at a rate of five to seven gallons per minute (Barnes, 2005). Following the fire, the cabin owners elected to change the water cooperative to a domestic water improvement district to allow MLDWID to apply for government assistance to rebuild its infrastructure and lower operating costs (Barnes, 2005). Although MLDWID had lost 200 customers, many of them agreed to continue to pay their monthly connection fee of \$45 to assist in the rebuilding of the water delivery system (Stanley, 2005).

One area that did not burn was the very upper portion of Sabino Creek Watershed. The majority of water sources and several storage tanks are located in this small area. The potential for this area to burn persists should there be another conflagration. This

would undoubtedly do significant damage to the watershed, water sources, and infrastructure.

In March 2007 an assessment of the upper Sabino Creek Watershed from Marshall Gulch Peak to Ski Valley, which included Summerhaven, showed it in a fire regime condition class 3 (Tune, 2007). The fire regime condition class (FRCC) is a measure of how far an ecosystem has departed from its natural occurrence of wildland fire. There are three condition classes based on the dominant vegetation composition (Hann and Bunnell, 2001). If an ecosystem is in a FRCC 1 then it is within the natural range of fire occurrence, an ecosystem in a FRCC 2 has been moderately altered and has the potential for more stand replacement of key species than that of the natural range, and an ecosystem in FRCC 3 has been greatly altered from its natural range of fires and is at a high potential for losing key species well beyond the natural range (Hann and Bunnell, 2001). The upper Sabino Creek Watershed is a mixed conifer vegetation type that naturally has fires occurring every ten years with a probability of only 5% leading to stand replacement conditions. The upper watershed has not had a fire in at least 107 years and the current conditions make it susceptible to a wildfire. Although a large portion of both water providers infrastructure is located in a cool, wet part of the Upper Sabino Creek Watershed there is the potential of significant damage to the infrastructure if a wildfire occurred in this area.

The Santa Catalina Mountain Partnership

Following the Aspen Fire residents of the Summerhaven formed the nonprofit organization Trees for Mt. Lemmon. This group was created to assist the Summerhaven residents with reforestation of the public and private lands with native vegetation and to promote healthy forest policies (Trees for Mt. Lemmon, 2005). Trees for Mt. Lemmon received a grant from the National Forest Foundation. With this money the group decided to organize a meeting of Mt. Lemmon stakeholders “to convene a continuing dialogue between the various private and public entities affecting the watersheds of Mt. Lemmon.” The steering committee that organized the stakeholders meeting was composed of Trees for Mt. Lemmon members, Forest Service employees, and University of Arizona faculty. The steering committee selected and invited 75 individuals from various county, state and federal agencies, academics, and Summerhaven community members to the two-day stakeholders meeting. Two consultants, Ed Merano and Tahnee Robertson, were selected by the steering committee to help develop the framework of the meeting, facilitate the meeting, and write a report of the results of the stakeholders meeting. The steering committee developed a list of outcomes for the stakeholder meeting: to collaboratively identify issues; determine the most important issues; identify the connections between the issues; start a dialog to lead to continued collaboration; determine a mechanism to continue the collaboration. These outcomes were used in developing the framework for the stakeholders meeting.

The first meeting of Mt. Lemmon stakeholders was held on the first and second of April 2005. On April 1st, the general public was invited and there were approximately 65

attendees, mostly from the Summerhaven community (Moreno & Robertson, 2005). The intent of this portion of the stakeholders meeting was to get input from residents on what issues they felt were most pressing regarding the management of Mt. Lemmon. The Summerhaven residents brought up preventing another conflagration and safety as key concerns. Surprisingly, there was no mention of the availability or management of water resources on the mountain.

The stakeholders meeting on April 2nd was by invitation only. Of the 75 stakeholders identified and invited by the steering committee, 32 attended and participated the all day meeting. The purpose of this meeting was to identify the most important issues to be addressed in the management of natural resources on the Santa Catalina Mountains. The input from the stakeholders led to agreement on the following four themes (Moreno & Robertson, 2005):

- Healthy forests and watersheds through sustainable and balanced forest management, planning, collaboration and stewardship.
- A balance between natural systems and community needs through a process of collaborative and integrated management of the whole landscape.
- A sustainable community and healthy economy that provides for residential, commercial and recreational uses, including the commercial use of forest products.
- A spirited sense of collaboration, partnership, cohesion and volunteerism.

Unlike the concerns expressed by the residents, the stakeholders felt that addressing water supply and demand issues was important. The stakeholders developed a list of actions needed in order to achieve healthy watersheds. Following is the list of actions (Moreno & Robertson, 2005):

- Maintain the quantity and quality of the water
- Develop water conservation techniques
- Keep water in the Sabino Watershed, including returning treated wastewater that is currently discharged into the San Pedro watershed
- Reevaluate treated wastewater policy
- Protect all watersheds, including Bear Wallow, Sabino Creek, Rose Canyon, Willow Canyon
- Develop a mountain-wide water management plan; coordinate with Forest Service goals and plans for water
- Evaluate sources of conflict related to water rights and instream flow
- Evaluate techniques of increasing water yield while protecting ecosystems, including promoting water harvesting, watershed management, enhanced storage, etc
- Evaluate water resource availability and demand for natural and human needs over time, including during times of drought and surplus

At the end of the April 2, 2005 meeting, it was determined that the stakeholders would continue to meet and work towards accomplishing the four general themes. This commitment to development of a water management plan was evident from the second Mt. Lemmon Stakeholders meeting held on April 27, 2005. This was an organizational meeting to determine an official name for the group, a mission statement, and assign individuals to the next steps. The group became the Santa Catalina Mountains Partnership with the mission to restore healthy forests and sustainable communities through collaborative management.

The Santa Catalina Mountain Partnership (SCMP) began meeting once a month and committees were formed to focus on four themes; community fire plan, forest products, public education and outreach, and water resource plan. Initially the committees met to work on their issue and would report back to the entire SCMP at its monthly meetings. However, this enthusiasm did not last and the four committees are no longer active. The SCMP now meets on a less formal basis, usually when one stakeholder has something to share with the entire group. There has also been a change in the stakeholders attending the meetings. Initially there was a broad representation with approximately 40 participants. That number has since dropped and the usual participants are from the Summerhaven community, Forest Service, and Pima County.

Resolution of Conflicts

The Santa Catalina Mountain Partnership helped bring the issues relating to the management of water resources to the forefront, with stakeholders discussing possible resolutions. Since 1994 the Forest Service and the Mt. Lemmon Domestic Water

Improvement District (MLDWID) have been operating separate water delivery systems with little interaction as long as each system had the water they needed. After the Aspen Fire, there was limited water and infrastructure to serve the remaining water users. The time had come to look at the water resources differently. Both water providers agreed that the fire had provided an opportunity to approach water management more holistically and with a mutual benefit for the water users and the natural environment.

As stated above, the dispute over water rights stems from the joint Forest Service and Sierra Club application for an instream flow right for Sabino Creek. All parties agree an instream flow water right would be a good environmental move; there is, however, disagreement over who should hold that water right. An instream flow water right that is held jointly by the Forest Service and the MLWDWID would legally hold both water providers accountable for the maintenance of a healthy watershed that supports the natural environment. Removing the Sierra Club, which the Arizona Department of Water Resources (ADWR) has already rejected, would help to resolve the protests that MLWDWID and individuals from Summerhaven have about pending water rights applications. Although the ADWR said the Sierra Club did not have individual standing for a water right on Mt. Lemmon, they were allowed to protest other water rights applications, including the instream flow right for Sabino Creek, creating something of a policy standstill. If the Sierra Club main objective was protection of the Sabino Creek Watershed one would think they would not impede the approval of an instream flow water right. The Arizona Department of Water Resources grants a water right if the

proposed right does not impair other rights, is not a threat to public safety, and is not contrary to the interests and welfare of the public (Arizona Revised Statute 45-153).

Physical water availability has been the other conflict that has plagued the water providers. Since water resources are highly dependent on precipitation, drought years can severely affect availability. Prior to the Aspen Fire MLDWID did not have enough storage to make it through the high demand summer months. Since the fire, the demand in Summerhaven has greatly reduced, but it will increase as redevelopment occurs. Demand could possibly exceed pre-Aspen Fire amounts if there are more homes and businesses built and greater use of residences year round. The Forest Service has not had a significant change in demand between pre and post Aspen Fire amounts.

CHAPTER 3 SUPPLY AND DEMAND

In order to implement a water resource management plan the amount of water available for consumption and the level of demand need to be determined. The amount of water available can be highly variable because it is so closely tied to precipitation. The demand for water is also variable given the seasonality of use. The assessment of the supply and demand that was done for the Upper Santa Catalina Mountains is presented in this chapter.

Supply Assessment

Water Rights

In the State of Arizona water is allocated based on the prior appropriations doctrine. The Department of Water Resources (ADWR) is the state agency responsible for the allocation of water. Surface water is allocated based on the first person to use the water has the highest priority, called a senior water right, and everyone who comes after has a junior priority. During times when there is less surface water than what has been allocated, such as in times of drought, the senior water right holder gets priority over the junior water rights holder. To obtain a water right one must submit an application to ADWR and if approved a certificate of water right is granted (State of Arizona, 2007, ARS 45-162). Even if a certificate of water right is issued it is not until the watershed, in which the right is located, goes through the adjudication process. The adjudication process is where the amount and priority of all surface water rights are determined by the

State Superior Court (State of Arizona, 2007, ARS 45-252). The majority of surface water rights in Arizona, including the Sabino Creek Watershed, have not gone through the adjudication process.

Groundwater has the same application process as surface water, but management of groundwater varies depending on where the withdrawal occurs in the state. There are three levels of management with the lowest level applying statewide, the second level applying in Irrigation Non-Expansion Areas, and the highest level applying to the Active Management Areas (AMA) within the state. The five AMAs are areas where there was severe overdraft of groundwater occurring and are located in the areas surrounding Phoenix, Tucson, Pinal, Santa Cruz, and Prescott (State of Arizona, 2007, ARS 45-411). The Sabino Creek Watershed is located within the Tucson AMA. In an AMA there are designated water providers and individuals are not allowed to drill wells, including exempt well that can not pump more than 35 gallons per minute, if they are within 100 feet of a water provider's operating distribution system in an AMA (State of Arizona, 2007, ARS 45-454). A notice of intent to drill a well is provided to ADWR and ADWR determines if the proposed well will impact the surrounding land and other water users (State of Arizona, 2007, ARS 45-599). Once the well is constructed and approved a registration number beginning with 55 is assigned to the well.

The Mt. Lemmon Domestic Water Improvement District (MLDWID) has certificates of water rights for 27.07 acre-feet (AF) per year of surface water and three groundwater wells with an additional 8.01 AF per year (MT. Lemmon Domestic Water Improvement District, 1996). The Forest Service has certificates of water rights for

33.92 AF per year and one groundwater well with an additional 1.57 AF per year (Lefevre, 2004). All the wells are except and are capable of producing an amount much lower than the allowed maximum amount of 35 gallons per minute, approximately 56 AF pre year. Since the Sabino Creek Watershed has not gone through the adjudication process the actual amount of water rights held by either water provider has the potential to change. At this time there is no enforcement to ensure that either water provider does not take more than what is stated on the certificates of water rights from ADWR. See Appendix 1 for a list of the water rights that includes the names, priority dates, certificate number, and which rights are currently used.

Water Available for Withdrawal

A hydrologic assessment of Upper Sabino Creek Watershed was done in 2001 using the hydrologic data that was available from 1951 to 1999 (Peters and Bales, 2001). The assessment calculated a monthly water budget and a yearly water balance. The Peters and Bales assessment was based on average amounts of precipitation, snowmelt, runoff, human use, evapotranspiration, and groundwater. The average streamflow for Upper Sabino Creek had to be reconstructed using data from the lower gauge nine miles downstream because there was only 15 years of data available from 1951 to 1999 for the upper stream gauge. This assessment used the mean values, which can be skewed by extreme values, as opposed to using median values, which can be a better representative of the typical value and less likely to be influenced by extreme values. Climate variability as it effects precipitation and streamflow was discussed in the assessment, specifically the changes due to the El Nino Southern Oscillation that causes an increase in precipitation

during the winter months. The effects of multiyear climatic variability, such as long term drought, were not discussed in the Peters and Bales assessment. As is discussed in the assessment, there is very little hydrologic data available for the Upper Sabino Creek Watershed, which makes calculating an accurate water budget difficult. Until there is a more realistic water budget calculated, which includes the use of median values and possible effects due to multiyear climatic changes, the results of this assessment will be used for determining supply. However, one must realize there are likely inaccuracies in the data and improvements to be made by conducting a more accurate data study.

An estimate of the available water to be pumped was done by taking the inflow (precipitation and septic return) into the watershed minus the outflows (evapotranspiration, underflow and the median creek flow) for Sabino Creek. Inflow, evapotranspiration, and underflow monthly values were taken from the hydrologic assessment discussed above. The median streamflow for Upper Sabino Creek was determined for this report using all available data from 1951 to 2005, approximately 29 years of data. Table 3.1 shows the average amount of water available by month.

Month	Inflow (Acre-feet)*	Underflow (Acre-feet)*	Evapotranspiration (Acre-feet)*	Median Sabino Flow (Acre-feet)	Outflow (Acre-feet)	Water Available to Pump (Acre-feet)
January	512.3	1.2	130.3	36.9	168.4	+343.9
February	511.5	1.2	161.4	55.5	218.1	+293.4
March	384.5	1.2	258.6	141.4	401.2	-16.7
April	142.2	1.2	370.1	89.3	460.6	-318.4
May	123.8	1.2	500.1	18.4	519.7	-395.9
June	117.9	1.2	561.1	2.9	565.2	-447.3
July	722.8	1.2	523	3.6	527.8	+195.0
August	866.6	1.2	436.1	63.3	500.6	+366.0
September	418.4	1.2	352.2	11.9	365.3	+53.1
October	373.8	1.2	257.5	6.1	264.8	+109.0
November	346	1.2	162.9	11.9	176.0	+170.0
December	539.3	1.2	120.2	18.7	140.1	+399.2
Total	5059.1	14.4	3833.5	460.0	4307.9	+751.2

* Source Peters and Bales, 2001

Table 3.1 Average Monthly Water Available in the Upper Sabino Creek Watershed

The monthly water budget showed a loss in storage during the months of March, April, May, and June. May and June are two of the three months that are the peak demand months for water use. Table 3.2 shows the pre-Aspen Fire pumping quantities per month for both systems. The streamflow of Sabino Creek could be impacted by pumping in the four months that the hydrologic assessment showed a loss in storage.

Month	Water Available to Pump (Acre-Feet)	Average Amount Pumped by MLDWID (Acre-Feet)*	Average Amount Pumped by FS (Acre-Feet)*
January	+343.9	1.5	0.2
February	+293.4	1.0	0.2
March	-16.7	2.5	0.2
April	-318.4	2.7	0.6
May	-395.9	0.8	0.6
June	-447.3	3.5	0.6
July	+195.0	1.6	0.6
August	+366.0	1.5	0.6
September	+53.1	1.5	0.5
October	+109.0	2.6	0.5
November	+170.0	0.7	0.3
December	+399.2	1.7	0.3
Total	+751.2	21.6	5.2

* Source Peters and Bales, 2001

Table 3.2 Water Pumped Prior to Aspen Fire

The annual total pumpage is significantly less than the available quantity according to the hydrologic assessment (Peters and Bales, 2001). However, during the months of March, April, May, and June when precipitation is minimal the pumping impacts the water balance of the watershed. Water should be pumped and stored during the three winter months that have the greatest amount available, December, January, and

February. Water could also be pumped during the summer months of July and August when the summer rains, called the monsoons, cause an increase in supply.

Table 3.3 shows the current amount of water pumped by both systems. The MLDWID rates were determined by the percent decrease in the number of connections from pre-Aspen fire to post Aspen Fire, which was determined to be a 65% decrease (Stanley, 2005). The change in demand for the Forest Service has increased slightly due to a new recreational site, Whitetail Group Campground, which opened in 2005.

Month	Water Available to Pump (Acre-Feet)*	Average Amount Pumped by MLDWID (Acre-Feet)	Average Amount Pumped by FS (Acre-Feet)
January	+343.9	0.5	0.2
February	+293.4	0.4	0.2
March	-16.7	0.9	0.2
April	-318.4	0.9	0.7
May	-395.9	0.3	0.7
June	-447.3	1.2	0.7
July	+195.0	0.6	0.7
August	+366.0	0.5	0.7
September	+53.1	0.5	0.6
October	+109.0	0.9	0.6
November	+170.0	0.2	0.3
December	+399.2	0.6	0.3
Total	+751.2	7.6	5.9
Change from Pre-Aspen Fire Amount		- 14.0	+ 0.7

* Source Peters and Bales, 2001

Table 3.3 Current Amount of Water Pumped

Comparing the total water pumped by the MLDWID before and after the Aspen Fire, as shown in Tables 3.2 and 3.3, the current amount of water they are pumping is about 35% of what was being pumped before the fire while the FS amount actually increased by 12%.

Table 3.4 shows the projected amount of water to be pumped by MLDWID if Summerhaven was rebuilt to capacity, which would include an assumption of the same pre-Aspen Fire percentage of year round residents to cabin owners and all 30 business properties developed, including the lodge with condos and a total of four restaurants. This projected amount is a 192% increase from pre-Aspen Fire demand. Projected demand for MLDWID is 5.45 acre-feet per year above what the MLDWID currently has certificates of water rights to. There is no anticipated increase in the amount of water pumped by the Forest Service and there is no realistic way to estimate this, as compared with Summerhaven, which has zoned lots that could be built upon.

Month	Water Available to Pump (Acre-Feet)*	Projected Average Amount Pumped by MLDWID (Acre-Feet)	Average Amount Pumped by FS (Acre-Feet)
January	+343.9	2.8	0.2
February	+293.4	2.0	0.2
March	-16.7	4.8	0.2
April	-318.4	5.1	0.7
May	-395.9	1.5	0.7
June	-447.3	6.6	0.7
July	+195.0	3.1	0.7
August	+366.0	3.0	0.7
September	+53.1	2.9	0.6
October	+109.0	5.0	0.6
November	+170.0	1.4	0.3
December	+399.2	3.3	0.3
Total	+751.2	41.53	5.9
Change from Pre-Aspen Fire Amount		+ 19.9	+ 0.7

* Source Peters and Bales, 2001

Table 3.4 Projected Amount of Water to be Pumped

The projected increase in water that could be pumped by the two systems will not exceed the available amount based on the water balance. However, if a more accurate water budget is done for Upper Sabino Creek, the projected demand should be compared with the water available. To avoid harm to the natural environment and impacts to the natural flow of Sabino Creek water should not be pumped during the months when the inflow is less than the natural outflow. To balance and accommodate the projected needs of the rebuilt Summerhaven storage capacities should be increased so that no pumping occurs during the months of March, April, May and June.

Storage Capacities

The two water providers both have storage tanks on the Santa Catalina Mountains. However, the current storage capacity is insufficient to offset the demand during the months when supply is less than the demand. The Forest Service has a storage capacity of 2.15 AF in the summer and 1.92 AF in the winter (Hensel, 2004). The change in storage is due to the closure of tanks in recreational sites during the winter months. The tanks are drained to prevent damage from freezing. The MLDWID has a year round storage capacity of 3.68 AF (Stanley, 2005). This amount will increase in the near future, because the MLDWID was recently given approval to construct a 2.46 AF tank on Forest Service land in the Upper Sabino Creek watershed. The MLDWID would like to further increase their storage capacities to 9.2 AF (Stanley, 2005). This amount would allow for enough storage to prevent shortages during the peak demand of the summer months prior to the summer rains. If both water providers had enough storage capacity to capture water during peak supply this would eliminate the need to capture water during the months of March through June when supply is limited and likely impacting the flow in Sabino Creek.

Demand – Historic, Current, and Projected

The demand for water in the upper Santa Catalina Mountains varies throughout the year with the greatest demand during the summer months. Since the Aspen Fire in 2003 the demand has been greatly reduced. However, as the community of Summerhaven rebuilds and the Forest Service opens a new group campground, the

demand will likely increase to above the pre-fire levels. The number of people recreating in the Santa Catalina's will increase as the surrounding desert communities continue to grow with projections doubling the population by 2050 (City of Tucson, 2004). This projected population increase will likely lead to greater demand for water at Forest Service recreational sites.

The following demand calculations and projections are for metered uses. The MLDWID has meters on all of its connections which are used to determine monthly water bills. The Forest Service has meters on its water tanks that serve the recreational and administrative sites to track use, but the tracking of use is not consistently done. Since the Forest Service does not have to track water use for accounting purposes, but only ensure water is delivered to its points of use.

Pre-Aspen Fire Water Use

Prior to the summer of 2003, the Mt. Lemmon Domestic Water Improvement District (MLDWID) had 425 connections, which included master meter connections (Stanley, 2005). Of these connections 36 were year round residents, 354 were cabin owners who mainly used their residents on the weekends, and there were ten connections to businesses. Four of the businesses were restaurants that used a greater amount of water. The MLDWID used an average of 18 acre-feet of water a year from 2000 to 2003 (Stanley, 2005). Table 3.5 shows the pre-Aspen Fire water use that was provided by the MLDWID to metered connections (see Appendix 2 for MLDWID demand calculations).

Demand	Acre-Feet Annual
Year-round Residents	4.0
Cabin Owners	11.3
Businesses	0.3
Restaurants	2.6
Annual Total	18.3

Table 3.5 MLDWID Pre-Aspen Fire Demand

The Forest Service was providing water to three recreational and two administrative sites in the Upper Santa Catalina Mountains prior to the Aspen Fire. The Forest Service uses an average of six acre-feet a year, including unmetered uses for fire fighting (Hensel, 2004). The recreational sites, which are all campgrounds, are open seasonally from April to October; the two administrative sites are open year round. The administrative sites have an increased demand from May to October when seasonal fire fighters are housed at these sites. The recreational sites have potable drinking water for campers and pit toilets. Water used at the Forest Service sites is not metered at the place of use, such as a home, but is metered at the water tanks that serve the sites. The determination of water use at the Forest Service sites was based on data gathered by the Forest Service from 1993 to 1999. During this time period records were kept on how much water was supplied to the recreational sites (Spenser, Rose Canyon, and Showers Point) and Palisades Administrative Site. From these data the amount for the Sollers Point administrative site was assumed to be the same as Palisades. The recreational sites are only open from April to October, with peak demand from June to August. The two administrative sites house Forest Service employees year round with an increase in

demand from May to October. Sollers Point is a four bedroom house and Palisades Work Center has several two-person living quarters and a house. On average there are 20 employees housed year round with a maximum of 60 employees housed during the fire season from May to October. Table 3.6 shows the pre-Aspen Fire demand at the recreational and administrative sites (see Appendix 3 for Forest Service demand calculations).

Demand	Acre-Feet/Year
Recreation Sites	0.7
Administrative Sites	3.1
Total Annual Demand	3.8

Table 3.6 Forest Service Pre-Aspen Fire Demand

Current Water Use

Since the Aspen Fire the number of MLDWID service connections has greatly reduced. According to Michael Stanley as of May 2007 MLDWID has 317 connections. Of those connections 30 are for year round residences, 121 are for cabin owners, five are businesses, and 161 are non-active meters. After the fire many people elected to continue paying their monthly water bill even though they did not have a structure. It can be assumed that these structures will be rebuilt in the near future. The MLDWID has been able to continue operating with such a large loss of connections because of the people who continue to pay their monthly minimum base rate even though they are not using any water. The businesses in Summerhaven were reduced from ten to five. Of the five businesses, there is one restaurant which uses a greater average amount of water than the

other service connections. Table 3.7 shows the current amount of water used by MLDWID metered connections; it is less than half the demand prior to the Aspen Fire.

Demand	Acre-Feet/Year
Year-round Residences	3.36
Cabins	3.86
Businesses	0.22
Restaurants	0.65
Total Annual Demand	8.10
Change from Pre-Aspen Fire Amount	-10.2

Table 3.7 MLDWID Current Demand

The Forest Service is currently providing water to all the sites it had been prior to the Aspen Fire and one new group campground. The new campground, Whitetail, consists of five group sites with a maximum of 20 people per site. Whitetail opened in 2005 and will be a seasonal site open from April to October. The demand for Whitetail was determined from the data taken for Showers Point during the 1990's. Showers Point is also a group campground with three 20 person sites. The amount of water used per site per day was determined for Showers Point and that amount was used to calculate demand at Whitetail for five sites for seven months. Water use has increased slightly due to the new Whitetail campground, but the administrative site use remains the same. Table 3.8 shows the current demand at Forest Service sites.

Demand	Acre-Feet/Year
Recreation Sites	0.8
Administrative Sites	3.1
Total Annual Demand	3.9
Change from Pre-Aspen Fire Amount	0.1

Table 3.8 Forest Service Current Demand

Projected Water Use

Within the private land on the Santa Catalina Mountains there are 716 buildable lots, which means there is the potential for a significant increase in demand by Summerhaven in the future. A lodge has been proposed to be built and will include 26 condo units with eighteen 2-bedroom, five 1-bedroom, and three 3-bedroom units (Swaim, 2005). Service connections will be established for each condo unit. Most private residences will continue to be weekend cabins. The number of year round residents will increase from current levels, but likely remain at the pre-Aspen Fire number of ten percent of total residents. However, this assumption could change if more rental properties are built and used year round. There are 40 commercial lots in Summerhaven that could be developed and two of the lots will be used for the lodge. Restaurants are the largest commercial users of water in Summerhaven. Prior to the fire, Summerhaven had four restaurants. At this time the plan is to rebuild the three that were lost and remodel the Mt. Lemmon Café that did not burn. Table 3.9 shows the projected water use to be approximately 33.8 acre-feet if all 719 lots were developed. This projected water demand for Summerhaven assumes ten percent of the residents are year-round and the 26 condo units in the lodge are also used year-round. Table 3.9 shows the

projected demand for Summerhaven to be nearly double the demand prior to the Aspen Fire.

Demand	Acre-Feet/Year
Year-round Residences	10.6
Cabin	18.6
Businesses	1.9
Restaurants	2.6
Total Annual Demand	33.8
Change from Pre-Aspen Fire Amount	+15.5

Table 3.9 MLDWID Projected Demand

Projected demand increases for the Forest Service are significantly lower than projected increases for Summerhaven. At this time there are no plans for construction of additional new recreational or administrative sites. The communities that surround the Santa Catalinas are continuing to grow, which will increase the number of people recreating in the surrounding mountains. Many of those moving to the area are retirees, free to recreate midweek. Campgrounds that historically have been used mainly on the weekends could see an increase in use on the weekdays with a resulting increase in the demand for water.

Additionally, the Forest Service has been discussing with Pima County the use of a portion of the Forest Service office space at Palisades Work Center for year round use by the Pima County Transportation Department and Sheriff's Department. Currently Palisades serves as residential housing for Forest Service personnel. This change in occupancy at Palisades would convert part of the usage to office space used only during the day, with a resulting decrease in water demand at Palisades. In the immediate future

Palisades will still be used to house fire fighters. The projected demand by the Forest Service does not change from current demand of 3.9 acre-feet per year.

Unmetered Water Use

Unmetered water use can be estimated from the difference between the amount of water pumped by the water providers and the amount of water metered at the points of delivery. Although some of this difference is due to loss in the systems, wildfires are one major use of water that is not metered. During the response to large fires, the water being used is not metered, leaving the Forest Service and MLDWID to estimate this amount. Estimates from the Forest Service show the average yearly water use for fire fighting to be approximately 71,000 gallons, but the amount is highly variable from year to year. If the drought conditions that have been present in the Southwest for the last several years persist, the demand for water to fight wildland fires will continue to be high. Potentially offsetting this increase, however, would be the effects of reduced use of the Forest Service recreational sites. An extreme fire danger can lead to closures on the Coronado National Forest during the summer months and there would not be a demand for water at the campgrounds.

Wildfires can be one of the largest demands for water in a given year. Water used for fire fighting could be metered in two ways, either at the tanks where water is being taken from, or by tracking the number of water trucks and helicopter buckets filled. However, during emergency responses where life and property are at risk, all available water will be used to protect these resources. Given the uncertainty of demand, it seems

impractical for either provider to expend much effort in developing a system specifically for metering use during wildfires. Each provider should track use during each incident in the most efficient way they can manage, as they see fit given their water delivery systems.

The months with greatest supply do not coincide with the peak demand season on the Santa Catalinas Mountains and the natural environment is impacted due to this disparity. Restrictions are enforced by the MLDWID in Summerhaven when supply is not available and if not followed individual connections will be disconnected (Stanley, 2005). If conditions are severe enough the Forest Service can close areas, including campgrounds, which greatly reduces demand. But it is not until extreme conditions occur that restrictions are put in place. Long term management of water resources needs to address water use by both humans and the environment during extreme events. Such as when there is no precipitation during either the summer or winter or both.

Alternative Use/Treatment of Wastewater to Enhance Supply

Pima County and the Forest Service met in February 2006 to discuss the County's plans for a basin study on wastewater in the Upper Sabino Creek Watershed. All parties agree that the current disposal method for treated wastewater should be assessed, with the desire to keep the water within the Sabino Creek Watershed and look at options for reuse.

Pima County constructed a wastewater treatment facility in Summerhaven in 1958 (Adams and Geiser, 1970). The wastewater treatment facility was a large septic tank with a chlorinator and drain field located adjacent to Sabino Creek (Adams and Geiser, 1970). Problems with the facility were noted in 1969 with raw sewage flowing into

Sabino Creek. The combination of the problems with the treatment facility and with aging individual septic systems that pre-date current regulatory requirements caused the water quality of Sabino Creek to decline. In 1975, the Marshall Gulch Picnic Area, located just downstream from Summerhaven, was closed because of public health concerns (Finical and Dombrowski, 1977).

The Forest Service had concerns about the environmental impact of the declining water quality and requested the State of Arizona to increase protection of Sabino Creek. In 1980 the State of Arizona prohibited the discharge of treated wastewater into Sabino Creek. Pima County did not change the operation of the wastewater facility until 1982 after a consent decree was established by the Arizona District Court. The consent decree required that Pima County cease direct discharge of treated wastewater into Sabino Creek. Pima County changed the wastewater treatment facility so the treated wastewater was pumped out of the Sabino Creek Watershed and discharged into the San Pedro Watershed by aerial spraying. The Forest Service allowed 47 connections to the facility and set the maximum daily discharge to the spray field at 17,000 gallons in Pima County's Special Use Permit (USDA Forest Service, 2003).

The Mt. Lemmon Wastewater Treatment Facility has been operating in this capacity since 1982. In 2004 the Forest Service authorized Pima County to modify its Special Use Permit to allow 30 more connections to the facility, but without increasing the daily discharge amount (USDA Forest Service, 2003).

The Arizona Administrative Code for surface water quality standards restricts the direct discharge of treated wastewater into Sabino Creek. To change the State's water

quality standard, a request must be submitted to Arizona Department of Environmental Quality which reviews the Standards every three years (Palawski, 2005). In 2006, Pima County Wastewater agreed to fund a basin study on wastewater in upper Sabino Creek Watershed. This study looked at all aspects of the watershed including the hydrologic system, environmental issues, social issues, and legal constraints. The study was done to assess the best use of the \$7.2 million in bond funds for improvements to the Mt. Lemmon Wastewater Treatment Facility in Summerhaven (Pima County Board of Supervisors, 2004). Changes to the existing system will require Pima County to work with the Forest Service and Summerhaven property owners. Possible uses of the treated wastewater include making snow for Ski Valley, public toilets in Summerhaven, recharge basins, fire fighting, and discharge into Sabino Creek. All of these possible uses would require changes to the existing treatment facility and potentially the Arizona Administrative Code.

To make snow at Ski Valley would require investment from both Pima County and the owners of the skiing facility. The current treatment of wastewater is secondary quality, which is a class B+ quality and not meant for human contact (State of Arizona, 2003). Pima County would have to upgrade the treatment facility so the wastewater is treated to a class A+ quality, which is ADEQ's requirement for treated wastewater that is used for making snow. Once the wastewater was treated, the infrastructure to transport the water to Ski Valley would have to be put in place. This would require investment by both Pima County and the owners of Ski Valley. Additionally, the owners of Ski Valley would have to purchase snow making equipment. Both actions of transporting the water

to the ski hill and making snow would require approval from the Forest Service. The proposal would have to go through an environmental analysis following the National Environmental Policy Act (NEPA) with input from the public. A similar proposal approved by the Coconino National Forest (NF) in February 2005 for a ski area on the San Francisco Peaks required an Environmental Impact Statement, which involves a lengthy, in depth NEPA analysis (USDA Forest Service, 2005). This decision was blocked by the Federal Court of Appeals citing that the use of treated wastewater to make snow infringed upon the Native American Tribes, who consider the San Francisco Peaks sacred and such use would impact their ability to practice their religion (Fletcher, 2007). The Santa Catalina Mountains are not considered as significant as the San Francisco Peaks by the Native American Tribes, but since this court decision the Coronado NF was contacted by the Tribes concerned that the same idea was being considered for Ski Valley. There would likely be opposition by both the Native American Tribes and environmental organizations if analysis of this use for the treated wastewater occurred.

The infrastructure costs to upgrade the treatment facility could lead to higher rates for the Summerhaven residents connected to the system. The investment by the owners of Ski Valley could lead to increases in lift ticket prices for skiers. Although making snow would increase the quality of the treated wastewater and keep the water within the Sabino Creek Watershed, the cost may be deemed prohibitive.

Recharge basins would also allow for wastewater to stay within the Sabino Creek watershed. However, in the area, there is limited soil cover, with only 8 – 18 inches to bedrock (Hennington, 1981). This may be insufficient soil to allow for enough filtration

before the water reappears as surface water. Recharge basins would require approval from the State with the issuance of an aquifer protection permit. This would be a unique situation since most recharge basins are placed in areas to recharge an aquifer and create storage credits to be pumped at a later time. Whereas, basins in the upper Catalinas would be for the purpose of keeping the water within the watershed for the natural environment and not to be retrieved. The basins would allow the water to stay in the watershed without direct discharge into Sabino Creek. As part of obtaining a permit, there would be required water quality testing to ensure the recharged water was not negatively impacting the water quality of Sabino Creek. This option depends also on locating a suitable soil site for the basins. If the best location was found to be on Forest Service land, Pima County would submit a proposal to the Forest Service. If accepted, then environmental analysis of the proposal would have to occur.

The use of treated wastewater for fire fighting would reduce the amount of fresh water currently pumped and stored for use on fires. Wildfires are highly variable from year to year and are not a guaranteed use for treated wastewater. However, when a fire does occur, this would be a good use of the treated wastewater. This would require construction of new storage tanks. Since there is already not enough storage available for potable water, construction of new tanks for the treated wastewater would occur unless Pima County Wastewater invested in this reuse option. The wastewater would need to be treated to a level that would allow for body contact, since fire fighters would likely come in contact with the water.

Discharge of the treated wastewater into Sabino Creek is the most direct way to keep the water in the watershed. However, many actions would have to take place before this could occur. First the Arizona Administrative Code that currently restricts such activity would need to be changed. Since the Forest Service was involved with establishing this restriction, the State may require that all affected parties be in agreement before changes are made. If there is an agreement and the State removes the restriction, then the process for actual discharge could begin. However, this would be a lengthy process. Just a few of the required steps to return wastewater to Sabino Creek would include, at a minimum: Pima County obtaining a pollution discharge system permit from the State of Arizona; environmental assessment of the potential effects of discharge of the treated wastewater; changes to the existing treatment plant; and establishing processes for water quality monitoring of Sabino Creek.

CHAPTER 4 WATER RESOURCE MANAGEMENT IMPROVEMENTS

The implementation of a water resource management plan for Upper Santa Catalina Mountains should include improvements to the management of the water resources and water conservation. These improvements could be implemented by the Forest Service, Mt. Lemmon Domestic Water Improvement District (MLDWID), Summerhaven Property Owners, and Pima County. Some improvements are easy to implement, but may not be very effective. Others require more effort, money, and coordination among the stakeholders, but will yield greater results. The following is an analysis of water resource management improvements that could be incorporated into a water resource management plan. These possible improvements have been discussed by the Santa Catalina Mountain Partnership and are explained in this chapter in order of priority, with the first options being top priority.

Evaluation of Water Resource Management Improvements

Instream Flow Water Right for Sabino Creek

An instream flow water right for Sabino Creek that is granted to at least the Forest Service and Mt. Lemmon Domestic Water Improvement District (MLDWID) and possibly other stakeholders could increase the protection of the watershed by requiring a natural flow to be maintained. If an application was accepted by the Arizona Department of Water Resources (ADWR), then monthly measurements would be required to demonstrate minimum flow amounts are being maintained. Once ADWR preliminarily

accepts the instream flow application the parties requesting the water right have to document that flow amounts are being maintained five years prior to approval of the instream flow water right (State of Arizona, 2000). The Forest Service and MLDWID would have to invest in gathering the stream gauge data and maintaining the minimum flows. The current stream gauge in Upper Sabino Creek is operated by Pima County Flood Control. This gauge does not take readings in small enough increments to show the minimum flows for June and July are being maintained and that there is surface flow occurring.

If an instream flow water right was approved, any future surface water rights in Upper Sabino Creek Watershed could not impact the streamflow, since a new water right approved after the instream flow water right would be junior in status. Prior to the approval of any new water right in the Sabino Creek Watershed, ADWR would need to verify that it would not impact the instream flow right. Long term enforcement of maintaining the instream flow water right would require agreement and coordination by the water providers and the communities of Summerhaven after the five years of records have been provided to ADWR. This commitment could be incorporated into the water resource management plan. An instream flow water right would help secure long term watershed protection while enhancing the natural environment that draws many visitors to the Catalinas. Without an instream flow water right, there is nothing in place to ensure there is and will be water available for the natural environment.

The stakeholders, including the two water providers, could obtain an instream flow water right. By having a water right the two water providers would have to work

together to maintain a natural flow in Sabino Creek and protect the watershed. With both parties in agreement and bound by a water right, the providers would be required to work cooperatively on future water issues on the Catalinas, including having to deal with shortages caused by drought. An instream flow water right would also help with the recovery of the two endangered fish found in Sabino Creek.

Increase Storage Capacities

It has been shown that there is enough water in the Sabino Creek Watershed to supply the needs of the Forest Service and MLDWID for the foreseeable future. However, the best time of year the water is obtained needs to occur outside of the peak demand months. Enough storage should be created to ensure impacts to the natural flow of Sabino Creek are minimal during the peak demand season. Taking any water from the Sabino Creek for consumptive use will impact the natural system, but the impacts can be minimized by increasing storage so pumping occurs when the available supply is increased during periods of high precipitation.

Thinning of Vegetation in the Headwaters of Upper Sabino Watershed

The departure of the upper portion of the watershed from its natural fire regime leaves this area highly susceptible to being damaged if another wildfire occurs. If a wildfire did pass through the upper watershed there could be significant damage to the two water delivery systems. Thinning work would not only reduce the potential damage from a wildfire, but it would also restore the area to a more natural vegetation structure and composition. Opening up the densely vegetated areas would reduce the amount of water taken up by the vegetation, enhance the creek flow, and make more water available

for use. There has been discussion at the Santa Catalina Mountain Partnership meetings about this problem but at this time no projects have been proposed. If any thinning work was to take place in Upper Sabino on Forest Service System Land, an environmental assessment would be required and approval from the US Fish and Wildlife Service would be needed, because this area is habitat for the endangered Mexican Spotted Owl. Funding would need to be obtained for the environmental assessment, implementation of the thinning project and monitoring. If thinning did occur there would also need to be continued maintenance to prevent the area from becoming overgrown again.

Water Conservation Techniques and Devices

There are water conservation techniques and devices that could be implemented by the water providers and users in the upper Santa Catalina Mountains. The following is a list of the possible techniques and devices in three categories; education, plumbing, and outdoor use (see Appendix 4 for detailed explanations of these conservation techniques and devices). The techniques and devices have been discussed with the Santa Catalina Mountain Partnership and are arranged in order of priority within each category, with the first technique or device being the highest priority for implementation.

Plumbing

1. Low consumption toilets in Summerhaven properties and Forest Service administrative sites
2. Low flow showerheads in Summerhaven properties and Forest Service administrative sites

3. Low flow faucets in Summerhaven properties and Forest Service administrative sites
4. Self-closing water spigots at Forest Service Recreational Sites
5. Auto stop faucets in Summerhaven public restrooms
6. Waterless urinals in Summerhaven public restrooms
7. Winterization of outdoor pipes and spigots on Summerhaven properties and Forest Service administrative sites
8. Insulation of hot water pipes at Summerhaven properties and Forest Service administrative sites
9. Point of use water heater in Summerhaven properties and Forest Service administrative sites
10. Low flow urinals in Summerhaven public restrooms
11. Composting Toilets in Summerhaven properties and Forest Service administrative sites
12. Front loading washing machines in Summerhaven properties

Outdoor Use

1. Greywater systems at properties that have non-potable outdoor water use
2. Restrict outdoor planting to vegetation native to upper Santa Catalina Mountains
3. Rainwater catchments at properties that have non-potable outdoor water use
4. Water-efficient drip irrigation system at properties with irrigation

5. Mulch Layer around plants to reduce evaporation
6. Rooftop water catchments at properties that have non-potable outdoor water use
7. Contouring of land around structures to direct water towards landscaping
8. Porous materials for walkways and patios to decrease runoff
9. Automatic sprinklers rain shut-off at properties that have irrigation
10. Rain gauge to track when outdoor plants need watering

Education

1. Water conservation pamphlet for new Summerhaven property owners
2. Water conservation signs at Forest Service administrative sites to educate employees
3. Water Conservation sign in English and Spanish at Summerhaven Community Center to educate visitors
4. Water conservation signs in English and Spanish at Forest Service recreational sites to educate visitors
5. Interpretive sign in English and Spanish along Summerhaven Riverwalk about the hydrologic cycle and importance of water resources
6. Monthly water updates from MLDWID in the Summerhaven newsletter *the Mt Lemmon Echoes*
7. Pamphlet in monthly MLDWID water bills providing updates to customers about past months demand, projected demand, and any restrictions

The implementation of conservation techniques and devices that reduce indoor consumption would yield greater water savings than outdoor uses. This is because the Forest Service and Summerhaven community do not have significant outdoor water use, as compared with other communities in the Southwest that have homes with swimming pools and large-scale irrigation systems for golf courses and parks. So reducing indoor water use on the Upper Catalinas would have a greater effect in reducing demand. The majority of residential water is for typical indoor use. In the case of the Forest Service recreational sites water is used for drinking and cooking.

Efficient and low flow plumbing devices would be most effective in reducing demand on the Catalinas. Plumbing fixtures require financial investment and in some cases the low flow or waterless devices cost more than conventional ones, such as front loading washing machine or self closing water spigots. Or a device could require remodeling of a structure, such as a composting toilet. Over time the extra cost could potentially be recouped with lower water bills for MLDWID customers and the Forest Service may reduce the amount of time employees spend operating the water delivery system.

Although, outdoor water use on the Catalinas is minimal, there is some use. Further, since the Aspen Fire, there has been an increase in outdoor use to reestablish vegetation in the areas where all the trees were burned. Summerhaven property owners who choose to have outdoor water use should use devices and techniques to reduce their demand. If someone is willing to invest an in irrigation system, they should be encouraged to see that the extra cost for more efficient options is minimal and ultimately

a money saver. While the overall reduction in demand from implementations of these outdoor devices and techniques would likely be small when compared with reducing indoor use, the public education to encourage them costs little..

Educational techniques for reducing demand are easy to implement and relatively inexpensive when compared with other conservation options. All of these techniques would require some financial investment by the Forest Service, MLDWID, and Summerhaven community. Relatively inexpensive education techniques include signs with a one time cost, pamphlets costing a few cents each, and updates for the *Mt. Lemmon Echo* requiring a few minutes by a MLDWID employee once a month. The actual amount of water saved through these efforts could be hard to quantify, and there is no guarantee someone would read the information and follow the advice. Overtime, however, the repeat exposure might influence greater awareness.

The Forest Service, MLDWID, and water users should consider the implementation of water conservation techniques and devices. There is a large potential to reduce demand through the use of these techniques and devices, which could minimize the impact to users during times of shortages.

Reuse of the treated wastewater within the Sabino Creek Watershed

Since water is such an important resource on the Catalinas the current method of disposing of wastewater in another watershed needs to be changed. There should either be reuse of the treated wastewater or disposal of it within the Sabino Watershed. Currently, Pima County is looking at all possibilities for the future of wastewater treatment and disposal. Once the wastewater study is complete, Pima County will make a

decision on what to do with the current system by considering the input from the community received during two public meetings, the legal constraints and the likelihood of changes in those constraints, and what can be accomplished with the amount of money allocated to the wastewater treatment plant. Hopefully, this consideration will include keeping the water within the watershed, or at least building infrastructure with that eventual goal in mind.

Use the existing water rights located outside of Upper Sabino Creek

Currently both providers obtain the majority of their water from sources within or just adjacent to the headwaters of Sabino Creek, but both providers hold water rights for other locations in the upper Santa Catalina Mountains. Some of these other rights were damaged in the Aspen Fire, while other rights have gone unused for other reasons including quality. Some are closer to the place of use. Currently the Forest Service has water rights in the areas of Rose Canyon and Palisades that are not used due to problems with quality in the past. Both these locations are connected to the Forest Service's potable water delivery system and receive water from Upper Sabino Creek. There are Summerhaven property owners who receive their water from MLDWID who have certificates of water rights in other locations than upper Sabino Creek (Stanley, 2005). A possibility could be for these property owners to lease their water right to MLDWID. The feasibility of using the water rights located closer to the point of use should be assessed, instead of pumping water from Sabino's headwaters and transporting it a greater distance. There would need to be some investment by the water providers to add a new water source or rehabilitate an old source to their delivery system. This investment

would reduce the cost of transporting water longer distances and impacts to upper Sabino Creek. Spreading out the location of water sources reduces the chance of either or both water providers having significant impacts to their water delivery systems should a wildfire occur in upper Sabino Creek. Water would still be withdrawn from the Sabino Creek Watershed, but the direct impact to streamflow in the headwaters is reduced.

Electronically Map the Water Delivery Systems

The two water delivery systems have been operated for decades with both having had several system operators. Much of the current information about the two systems is institutional knowledge held by the present operators. A significant portion of the MLDWID documentation and data was lost in the Aspen Fire. Mapping of the systems would give both water providers an accurate picture of what currently exists and where there is redundancy in the systems. Mapping of the water delivery systems would entail surveying the infrastructure locating water sources, pumps, storage tanks, pipelines, and meters using existing maps as a starting point. Then the location data is downloaded to create an electronic map in geographic imaging system. There is the potential to improve how efficient the water delivery systems operate with a better understanding of the infrastructure. Also when the current operators retire information about either system could be easily passed on to the next operator. This should be a joint investment by the Forest Service and MLDWID. However, given the potential cost for this activity without other assistance, it will likely not occur.

New Stream Gauge in Upper Sabino Creek

The current stream gauge located in Marshall Gulch is operated by Pima County Flood Control and the gauge takes measurements to a tenth of a cubic foot per second. If an instream flow water right was granted for Sabino Creek a more accurate stream gauge should be installed. Due to the naturally low flow in Sabino Creek during the months of June and July, which are in the hundredths of a cubic foot per second, the existing gauge would be reporting zero flow. However, there is actually flow that should be maintained and monitored during those two months. So, a more sophisticated gauge would be required to be installed. To install a new stream gauge on Forest Service lands the National Environmental Policy Act would have to be followed and some level of environmental analysis would be required.

Assess Operation of One Water Delivery System

The possibility of merging the two water delivery systems into one and having one water provider should be examined, since both water delivery systems begin at the same location and there is likely overlap in the systems. MLDWID has previously operated the Forest Service system, but it was done independently from the MLDWID system. The Forest Service operates many water delivery systems, but this is only one of its many functions and only one of the duties of the current operator. The Forest Service water delivery system may be better served if operated through a contract with an outside entity. If there were a designated entity that specializes in water delivery systems, operating one combined system, the reliability and management of water resources could improve. The cost of contracting out this work would be constrained by the available budget. If the Forest Service had the MLDWID operate its system there would have to

be an agreement on who is served water and what amounts during times of reduced supply.

Tracking of Forest Service Water Use

Currently the Forest Service only tracks water use at some of its storage tanks and there are no meters tracking the amount of water pumped at the sources. Since the Aspen Fire, the Forest Service has not tracked the amount of water pumped or used, and only estimates are made regarding the amounts pumped, used, and lost. Metering the Forest Service water delivery system would more accurately determine how much water is currently used. Metering at the initial locations where the water enters the system would allow for tracking loss and help in pinpointing the location where the loss is occurring.

Relationship to Santa Catalina Mountain Partnership Goals

When the stakeholders first met in April 2005 goals were established for achieving a healthy watershed. Table 4.1 shows the relationship between the water resource management improvements and the Partnership's goals.

Santa Catalina Mountain Partnership Goals							
	Maintain the quality and quantity of water	Develop water conservation techniques	Keep water in Sabino Creek Watershed	Reevaluate treated wastewater system	Protect all watersheds	Increase water yield while protecting ecosystems	Evaluate supply and demand for human and natural needs
Water Resource Management Improvements	Instream Flow Water Right for Sabino Creek		X		X		X
	Increase Storage Capacities	X			X		
	Thinning in the Headwaters of Upper Sabino Watershed	X			X	X	
	Water Conservation Techniques and Devices	X	X				
	Reuse of the treated wastewater within the Sabino Creek Watershed			X	X		
	Use the existing water rights located outside of Upper Sabino Creek					X	X
	Electronically Map the Water Delivery Systems	X					
	New Stream Gauge in Upper Sabino Creek.			X		X	X
	Assess Operation of One Water Delivery System	X					
	Tracking of Forest Service Water Use						X

Table 4.1: Relationship of Water Resource Management Improvements to Santa Catalina Partnership Goals

Some of the improvements tie directly to meeting a goal, such as the implementation of water conservation techniques and devices. Other improvements will assist in reaching goals, such as tracking the Forest Service water use which is needed to better evaluate demand. These recommended management improvements can serve as a starting point for the two water providers and give other stakeholders to achieve healthy watersheds.

Options for Implementing Water Resource Management Improvements

There is work that both water providers would like to be doing. However, the Forest Service has been experiencing a declining budget and work force, with less money being distributed at the district level to do work on the ground. The Mt. Lemmon Domestic Water Improvement District (MLDWID) has had a significant loss in its number of customers and is still trying to recover from the Aspen Fire.

One of the answers to this chronic funding problem could be a joint management agreement. A water resource management plan signed and implemented by the Forest Service and MLDWID would increase available funding opportunities because there are many grants available for partnerships and collaborative efforts. The Forest Service maintains a partnership website that links to numerous databases to search for funding opportunities. There are numerous grants available for partnerships and also matching funds assistance. Working together the two water providers could expand their available resources beyond what is available to them individually in order to implement the needed watershed management improvements.

There are also opportunities to work with the University of Arizona to provide funding for the information needs. Many departments within the university are involved in research relating to water resources. There are opportunities for professors and students to develop research projects to meet the watershed information management needs. Working with the state universities also allows for the potential of funding from the State of Arizona.

CHAPTER 5 RECOMMENDATIONS AND CONCLUSION

Recommendations

The Forest Service and Mt. Lemmon Domestic Water Improvement District (MLDWID) have the potential to improve management of water resources on the Upper Santa Catalina Mountains if done in a timely, cooperative manner. There is an opportunity to take advantage of the redevelopment that is currently occurring in Summerhaven, and a potential to mitigate projected increases in demand. The number of laws and regulations the Forest Service is required to follow will impact how quickly a plan could be approved. The two water providers should determine what type of agreement would best suit both parties, and will not take years to be approved, such as a memorandum of understanding.

A memorandum of understanding (MOU) is used by the Forest Service when the agency wants to document a framework for coordinating activities that it will carry out in cooperation with other agencies or organizations (USDA Forest Service, 2002). Complete implementation of some cooperative management options and regulations involving both water providers and possibly other stakeholders may require another type of agreement that is not covered in an MOU. However, an MOU is an agreement that the agencies could enter into to and begin implementing in a timely manner with the understanding that it is a starting point for cooperative water resource management.

A timeline should be developed with commitments and processes for resolving conflicts, implementation of watershed management policies, and improvements to

infrastructure. This timeline should be part of the MOU and will help ensure both providers will commit the necessary resources to the effort. The dates set need to take into account the realities of budgets and staffing, but also need to ensure the tasks are accomplished before demand is greatly increased, and the current system operators retire.

Once the two providers have a draft plan and/or agreement to cooperatively manage water resources there should be a chance for the public to participate, and provide input. The Santa Catalina Mountain Partnership is a good forum for the presentation of the draft plan and obtaining input from stakeholders. The Partnership can assist in outreach to other individuals and organizations that could be interested in water resource management on the Catalina's.

Conclusion

The implementation of a water resource management plan for the Upper Santa Catalina Mountains would benefit both the humans that enjoy living and recreating on the Catalinas and the natural environment by balancing withdrawals with supply, reducing consumption, and ensuring water is available for years to come. Now is a prime opportunity for the Forest Service and Mt. Lemmon Domestic Water Improvement District (MLDWID) to agree upon management of the water resources in the Catalinas. Because Summerhaven will likely experience a significant increase in demand in the coming years as it rebuilds, as could the Forest Service with increases in recreators visiting the Santa Catalina Mountains, adopting mandatory conservation requirements now is necessary to reduced increases in projected demand. Expanded commercial development including condos, and larger private cabins has been approved for

Summerhaven. If mandatory conservation measures to mitigate demand are not adopted now, the sustainability of water resources and the health of Sabino Creek Watershed in the future is questionable.

Cooperative management of water resources will set the stage for improved management of all resources on the Santa Catalina Mountains. The Aspen Fire made everyone aware of how easily the natural and built environments could be impacted, and that cooperative efforts are a more effective means of planning and management. Water is an important resource closely tied to the health of other natural resources, including vegetation and wildlife. However, until a more accurate assessment of supply and demand is done, this relationship will not truly be known. Improved water resource management will likely enhance the entire Sabino Creek Watershed and sustain the natural beauty that attracts so many visitors.

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Appendix 1 Forest Service and Mt. Lemmon Domestic Water Improvement District Water Rights

Certificate of Water Right Number	Priority Date	Water Source	Right Holder*	User	Type**	Acre-Feet/Year	Active (Yes/No)
94854	10/4/1989	Baptist Camp Diversion	FS	Baptist Camp	SW	2.04	Yes
981	12/10/1938	Bear Wallow Spring	FS	Special Use Permittees	SW	4.48	Yes
838	1/19/1939	Bush Fork	FS	FS	SW	0.22	No
85887	10/1/1980	Caseco Spring	FS	FS	SW	7.00	Yes
840	1/19/1939	Cold Spring	FS	MLDWID	SW	0.56	Yes
Reserved	7/2/1902	Dead Fir Spring	FS	FS	SW	0.88	Yes
1443	2/23/1939	East Fork Kellogg Creek	FS	FS	SW	1.34	Yes
1917	6/18/1938	Kinglet Spring	FS	FS	SW	1.12	No
93105	6/22/1987	Knagge Spring	FS	FS	SW	1.00	No
55-506387	11/23/1983	Loma Linda Well	FS	FS	GW	1.57	Yes
839	1/19/1939	Marshall Gulch	FS	FS	SW	1.61	No
1180	12/10/1938	O'Dowd Canyon	FS	FS	SW	0.22	Yes
701	6/13/1935	Palisades Spring	FS	FS	SW	3.58	No
3121	7/7/1961	Rose Canyon Spring	FS	FS	SW	7.67	No
3107	1/4/1957	Trailside Spring	FS	Girl Scout Camp	SW	1.12	Yes

* FS = Forest Service and MLWDWID = Mt. Lemmon Domestic Water Improvement District

** SW = Surface water and GW = Groundwater

Appendix 1 Forest Service and Mt. Lemmon Domestic Water Improvement District Water Rights

Certificate of Water Right Number	Priority Date	Water Source	Right Holder*	User	Type**	Acre-Feet/Year	Active (Yes/No)
92356	4/13/1987	Tunnel Spring	FS	FS	SW	0.22	Yes
2002	10/8/1938	Pigeon Spring/ Flicker Spring	FS	FS	SW	0.84	Pigeon Yes Flicker No
33-38333	6/3/1976	Sabino Creek	MLDWID	MLDWID	SW	10.00	Yes
33-38334	6/3/1976	Upper Sabino Spring	MLDWID	MLDWID	SW	8.00	Yes
4164	5/13/1938	Carter Canyon Spring	MLDWID	MLDWID	SW	4.09	Yes
4156	5/28/1938	Wren	MLDWID	MLDWID	SW	2.24	No
4157	6/10/1938	Junco Spring	MLDWID	MLDWID	SW	1.12	No
4158	7/7/1938	Pigeon Spring	MLDWID	MLDWID	SW	0.45	
4159	12/13/1938	Conlon Spring	MLDWID	MLDWID	SW	1.17	No
55-805248-L	6/30/1974	Pigeon Well 200'	MLDWID	MLDWID	GW	4.00	Yes
55-805250-L	6/30/1974	Pigeon Well 45'	MLDWID	MLDWID	GW	2.40	Yes
55-805251-L	6/30/1974	Pigeon Well 19'	MLDWID	MLDWID	GW	1.61	Yes

* FS = Forest Service and MLDWID = Mt. Lemmon Domestic Water Improvement District

** SW = Surface water and GW = Groundwater

Appendix 2 Mt. Lemmon Domestic Water Improvement District Demand Calculations

Pre-Aspen Fire*

User	Gallons per Unit per Day	Units	Days of use	Gallons/Year	Acre-Feet/Year
Year-round Residents	100	36	365	1314000	4.03
Cabin Owners	100	354	104	3681600	11.30
Businesses	50	6	365	109500	0.34
Restaurants	580	4	365	846800	2.60
Total Annual Use				5951900	18.27

Current (May 2007)*

User	Gallons per Unit per Day	Units	Days of use	Gallons/Year	Acre-Feet/Year
Year-round Residents	100	30	365	1095000	3.36
Cabin Owners	100	121	104	1258400	3.86
Businesses	50	4	365	73000	0.22
Restaurants	580	1	365	211700	0.65
Total Annual Use				2638100	8.10

Projected*

User	Gallons per Unit per Day	Units	Days of use	Gallons/Year	Acre-Feet/Year
Year-round Residents	100	95	365	3467500	10.64
Cabin Owners	100	583	104	6063200	18.61
Businesses	50	34	365	620500	1.90
Restaurants	580	4	365	846800	2.60
Total Annual Use				10998000	33.75

* Source for number of units and gallons used per unit Stanley, 2005 and 2007

Appendix 3 Forest Service Demand Calculations

Pre-Aspen Fire

Site	Average Annual Use (Gallons)*	Average Annual Use (Acre-feet)	Number of Sites	Gallons/Site	Gallons/Site/Day	Gallons/Person/Day
Rose Canyon Campground	151,091	0.46	76	1,988	9.3	3.1
Spencer Point Campground	87,312	0.27	60	1,455	6.8	2.3
Showers Point Group Campground	13,884	0.04	3	4,628	21.6	1.1
Palisades Administrative Site	498,333	1.53			1365.3	22.8
Sollers Point Administrative Site	498,333	1.53			1365.3	22.8
Totals	1,248,953	3.84				

* Source Hensel, 2004

Appendix 3 Forest Service Demand Calculations

Current (2006) and Projected

Site	Average Annual Use (Gallons)*	Average Annual Use (Acre-feet)	Number of Sites	Gallons/Site	Gallons/Site/Day	Gallons/Person/Day
Rose Canyon Campground	151,091	0.46	76	1,988	9.3	3.1
Spencer Point Campground	87,312	0.27	60	1,455	6.8	2.3
Showers Point Group Campground	13,884	0.04	3	4,628	21.6	1.1
Whitetail Group Campground	13,884	0.04	5	2776.8	21.6	1.1
Palisades Administrative Site	498,333	1.53			1365.3	22.8
Sollers Point Administrative Site	498,333	1.53			1365.3	22.8
Totals	1,262,837	3.88				

* Source Hensel, 2004

Appendix 4 Water Conservation Techniques and Devices

Plumbing

Low Consumption Toilets in Summerhaven properties and Forest Service administrative sites (City of Tucson, 1999)

- Require toilets that use 1.6 gallon per flush or less versus traditional toilets that use up to 5 gallons per flush. Currently, all toilets sold in the U.S. use 1.6 gallons per flush or less. So any new properties built in Summerhaven will have low consumptive toilets. Higher use toilets in any existing properties, either in Summerhaven or at the Forest Service Administrative Sites, could be replaced. This would require property owners and the Forest Service to purchase new toilets, but the cost would be recovered in reduced water bills for property owners and the time and energy the Forest Service would expend to pump more water.

Low flow showerheads in Summerhaven properties and Forest Service administrative sites (City of Tucson, 1999)

- Require showerheads that discharge water at a rate of 2.5 gallons-per-minute or less, as opposed to older showerheads which discharge 5-gallons-per-minute. The State of Arizona requires a rate no higher than 3 gallons per minute, so any new construction will have more efficient faucets, but there are aerators that can be added to showerheads that can further reduce the amount of water discharged per minute. In any existing properties, either in Summerhaven or the Forest Service Administrative Sites, there could be higher use showerheads that should be replaced. This would require both property owners and the Forest Service to

purchase new showerheads, but the cost would be recovered in reduced water bills and time and energy to pump more water. In some case an aerator can be purchased that will fit on existing showerheads and the cost would be even less than replacing the entire showerhead.

Low flow showerheads in Summerhaven properties and Forest Service administrative sites (City of Tucson, 1999)

- Require more efficient faucets, a 1.5 gallons-per-minute for bathroom faucets and a 2.5 gallons-per-minute for kitchen faucets. Conventional faucets flow up to 3.5 gallons or more per minute. The State of Arizona requires a rate no higher than 3 gallons per minute, so any new construction will have more efficient faucets, but not as low as what is available with the addition of an aerator. Existing faucets do not have to be replaced; purchase of a simple aerator that fits the current faucets in the property will reduce water flows to an improved level. The aerators cost as little as a few dollars and should be added to existing properties that have higher use faucets.

Self-closing water spigots at Recreational Sites

- Replace existing manual spigots with ones that close automatically at the Forest Service recreational sites. Self-closing spigots cost more than manual ones, but will save the Forest Service gallons of water that is lost when a spigot is left on. This option reduces the likelihood that recreators could leave the water running and waste it.

Auto stop faucets in Summerhaven public restrooms (Piper, 2003)

- Install auto stop faucets with an electric eye that senses when to turn on and off in the public restrooms at the community center and businesses in Summerhaven. These faucets may cost more than conventional faucets, but the cost would be recouped by the water savings. Pima County is constructing the community center and would be the entity to make this decision. This could be a requirement from any new businesses and establishment of a deadline for current businesses with public restrooms to make the change.

Waterless urinals in Summerhaven public restrooms (Piper, 2003)

- Install waterless urinals in the public restrooms at the community center and public restrooms at businesses in Summerhaven. The Santa Catalina Mountains have millions of visitors a year, many of whom visit Summerhaven. Having waterless urinals in public restrooms would save a large amount of water. Pima County is constructing the community center and would be the entity to make this decision. The initial cost of the urinals may be more than conventional urinals that use water, but the low water bills would recover the cost. Waterless urinals would also reduce the amount of waste entering the wastewater system and the public restrooms are a large contributor to that system.

Winterize outdoor pipes and spigots at Summerhaven properties and Forest Service administrative sites (Water Use It Wisely, 2006)

- Winterize outdoor pipes and spigots to prevent pipes from bursting or freezing. During the winter months there are many days and even more nights when temperatures are at or below 20°F on the Catalinas. At residences in

Summerhaven and Forest Service Administrative sites outdoor pipes and spigots should be winterized. Properties served by MLDWID could be inspected that outdoor spigots and pipes are winterized in the Fall during the monthly meter reading prior to freezing temperatures. The Forest Service administrative sites could be winterized by the seasonal employees housed at these locations prior to leaving in the fall.

Insulate hot water pipes in Summerhaven properties and Forest Service administrative sites (Water Use It Wisely, 2006)

- Insulate hot water pipes to reduce the amount of water it takes to get hot water to the faucet. This can be done at properties in Summerhaven and Forest Service administrative sites. This could be required for any new properties and existing properties could be given a date to have the insulation installed. During the winter months, temperatures in the Upper Santa Catalinas can be at or below freezing, and for properties not used on a daily basis it can take longer to get hot water. By insulating the hot water pipes, the time it takes to get hot water is reduced. This option also helps reduce the chance of pipes freezing and bursting.

Point of Use Water Heater (Piper, 2003)

- Install a point of use water heater on faucets, so the water does not have to run while getting warm. This is option could be implemented by both property owners in Summerhaven and by the Forest Service at its administrative sites.

Low flow urinals in Summerhaven public restrooms (State of Arizona, 1994)

- Install low flow urinals in the public restroom at the community center and public restrooms at businesses in Summerhaven. The State of Arizona requires urinals

that use no more than 1 gallon per flush. So any new public restrooms will have low flow urinals. However, any existing restroom that has the higher use urinals should be upgraded. This would require property owners to purchase new urinals, but the cost would be recovered in reduced water bills and time and energy to pump more water.

Composting Toilets in Summerhaven properties, public restrooms, and Forest Service administrative sites (Steinfeld and Anderson, 2002)

- Composting toilets do not require water and can save a lot of water when compared with traditional toilets using at least 1.6 gallons of water per flush. This would also reduce the amount of wastewater entering the treatment plant if property is connected to the system. This option could be implemented by both Summerhaven property owners and the Forest Service at its administrative sites. Composting toilets do cost more than flush toilets, but the cost would be recovered in reduced water bills for property owners and the time and energy the Forest Service would expend to pump more water. Property owners rebuilding a cabin that are having difficulty qualifying for a septic tank should consider this option.

Front Loading Washing Machines in Summerhaven properties (City of Tucson, 1999)

- Require residences that have washing machines to be front loading models which use almost half the water of conventional top loading models. Prior to the Aspen Fire, washing machines were rare, but as property owners rebuild there is the potential for more residences to have washing machines. Front loading washers do cost more, but will save water and money in the long run. MLDWID could require any new property with a washer hookup to have a front loading washer

installed. A restriction such as this one could help discourage property owners, especially cabin owners who are only there the occasional weekend, from having washing machines.

Landscaping

Greywater systems at properties that have non-potable outdoor water use (City of Tucson, 1999)

- Greywater is wastewater from showers, tubs, sinks, and washing machines. The average person produces 20-40 gallons of greywater per day, or about 10,000 gallons of greywater per year. Although the amount produced per individual may be lower in Summerhaven, especially among property owners who do not have washing machines, greywater systems would be an option for property owners with landscaping. This type of system would cost more than a rainwater catchment system, but would provide a constant supply of irrigation water for weekend visitors. This option would probably be best for businesses and year round residences since these individuals will be using water on a daily basis.

Restrict outdoor planting to vegetation native to the upper Santa Catalina Mountains

- Require that all homes and businesses in Summerhaven plant only native vegetation. Trees for Mt. Lemmon, a special project of the Coronado Resource Conservation and Development Area established to assist the Mt. Lemmon community recover from the Aspen Fire through renewed appropriate vegetation, will help property owners to select native plants and acquire the unique species of Ponderosa Pine that grows in the Santa Catalina Mountains. Native plants have adapted to live in the climate found in the upper Catalina's and although these

plants may need irrigation initially for establishment, in the long-term irrigation would not be necessary. Non-native plants could require irrigation for the life of the plant and further the spread of invasive species on the Santa Catalina's.

Rainwater catchments at properties that have non-potable outdoor water use (City of Tucson, 1999)

- Require all properties in Summerhaven that have outdoor landscaping to have a cistern to collect rainwater for outdoor watering. Plants do not need potable water and a catchment system for rainwater would reduce the amount of water MLDWID would need to pump into its system. An initial investment would have to be made by the property owner, but over the long term the saving would occur in reduced water bills.

Water-efficient drip irrigation system at properties with irrigation (City of Tucson, 1999)

- Choose a water-efficient drip irrigation system for landscaping to eliminate excessive use of water. Watering just the plants that need the irrigation instead of using aerial sprayers will reduce the amount of water that is needed. Property owners installing irrigation systems consider using the most efficient systems available.

Mulch layer around plants to reduce evaporation (Water Use It Wisely, 2006)

- Use a layer of organic mulch around plants to reduce evaporation and save water. This option could be implemented by property owners and would not be a significant expense. Trees for Mt. Lemmon could assist property owners in implementing this option and make it a requirement when receiving new plants from the organization.

Rooftop water catchments at properties that have non-potable outdoor water use (City of Tucson, 1999)

- Use roofs to capture water and channel it directly to plants, or to a storage container for future use. As property owners rebuild and plant new vegetation that needs watering during establishment, rainwater should be used instead of water from MLDWID.

Contouring of land around structures to direct water towards landscaping (City of Tucson, 1999)

- Contour or slope property to direct water to landscaped areas. Many of the lots in Summerhaven have significant gradients which would allow for using this technique without a lot of earth moving. Since much of the established vegetation was lost during the Aspen Fire many property owners are planting trees as they rebuild. As they design their home, cabin, or business they can ensure it is done to take advantage of landscape contouring to help in establishing new vegetation while minimizing the use of irrigation.

Porous materials for walkways and patios to decrease runoff (Water Use It Wisely, 2006)

- Use porous materials for walkways and patios to keep water in yards and prevent wasteful runoff. Although few properties in Summerhaven have walkways and/or patios this would be an option to consider as owners rebuild. When designing the new property, this option could be considered with little extra cost if a walkway or patio is going to be included. The landscape could be designed around the walkway and/or patio so as to capture much of the precipitation that falls on the

porous material. This option could accelerate the establishment of adjacent new vegetation while reducing water bill costs.

Automatic sprinklers rain shut-off at properties that have irrigation (Water Use It Wisely, 2006)

- Install a rain shut-off device on automatic sprinklers to eliminate unnecessary watering. Property owners who install irrigation could be required to have a rain shut-off device. This option would be a very efficient way for property owners who are not in residence on a daily basis to monitor their landscape watering needs. This would reduce the need for water from MLDWID and reduce the cabin owners' water bills.

Rain gauge to track when outdoor plants need watering (Water Use It Wisely, 2006)

- Install a rain gauge to track how much rain landscaping receives to determine if an irrigation cycle can be skipped. MLDWID and property owners could use rain gauges to measure how much precipitation is received, and, when rainfall is sufficient, skip an irrigation cycle, thus reducing over watering. MLDWID could provide the community with estimates of how much precipitation is needed to skip an irrigation cycle.

Education

Water conservation pamphlet for new Summerhaven property owners

- The property owners in Summerhaven are changing since the Aspen Fire as some former residents decide to sell their lot(s) instead of rebuilding. These new residents may be new to the Southwest and unfamiliar with the limited water

resources. When a new property owner contacts MLDWID for service, the new owner could be provided educational materials about the limited water resources available on the Catalina's, options for limiting water use, and an explanation of the curtailment plan.

Water conservation signs at Forest Service administrative sites educating employees.

- Signs are an inexpensive tool the Forest Service could use to educate employees housed at the administrative sites to conserve water use. Most employees housed at the administrative sites are fire fighters who can be from all over the country and who may not be aware of the limited water on the Catalinas. Again, however, posting a sign does not mean people will read or follow what is posted.

Water Conservation sign in English and Spanish at Summerhaven Community Center

- Signs placed at points of use, restrooms and drinking fountains, reminding visitors to limit water use. Visitors to Summerhaven come from all over and may not be familiar with the availability of water resources. Signs are an inexpensive tool the Community could use to educate visitors on the need to conserve water use. However, posting a sign does not mean people will read or follow what is posted.

Water conservation signs in English and Spanish at Forest Service recreational sites

- Signs are an inexpensive tool the Forest Service could use to educate recreators on the need to conserve water use. However, posting a sign does not mean people will read or follow what is posted.

Interpretive sign in English and Spanish along Summerhaven Riverwalk

- The Summerhaven Riverwalk through the community will include interpretive signs about the Santa Catalinas and Sabino Watershed. One sign should explain the hydrologic cycle, how water resources are tied to precipitation, and how both the human and natural environments depend on the limited resource. Visitors to Summerhaven come from all over and may not be familiar with the availability of water resources. Signs are an inexpensive tool the Community could use to educate visitors about water resources.

Monthly Water Updates in the *Mt Lemmon Echoes*

- The Mt Lemmon Echoes is a monthly newsletter for the residences of Summerhaven and is one of the main ways information is distributed to the community. MLDWID could provide the publishers with a monthly update on the current supply and demand for Summerhaven and what is anticipated for the next month. The update could also include what stage of the contingency plan the MLDWID is currently in and if any restrictions will need to be implemented. It would cost MLDWID very little to prepare an article each month for the newsletter and this option would reach a large sector of the Summerhaven residents and cabin owners.

Pamphlet in monthly MLDWID water bills

- A monthly reminder in water bills that gives the month's water use for Summerhaven, a comparison of water use for the same month the previous year, projected water availability for the coming month, and any restrictions due to availability. This option would require MLDWID to produce the pamphlet on a

monthly basis, including someone to gather the information and have it made either internally or printed by someone else. Currently, water bills are sent in a postcard form, so the inclusion of a pamphlet would require MLDWID to change to an enveloped bill which would increase the monthly administrative costs.