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**Forest
Service**

Southwestern
Region

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Draft Environmental Impact Statement, Proposed Mt. Graham Astrophysical Area, Pinaleno Mountains, Coronado National Forest

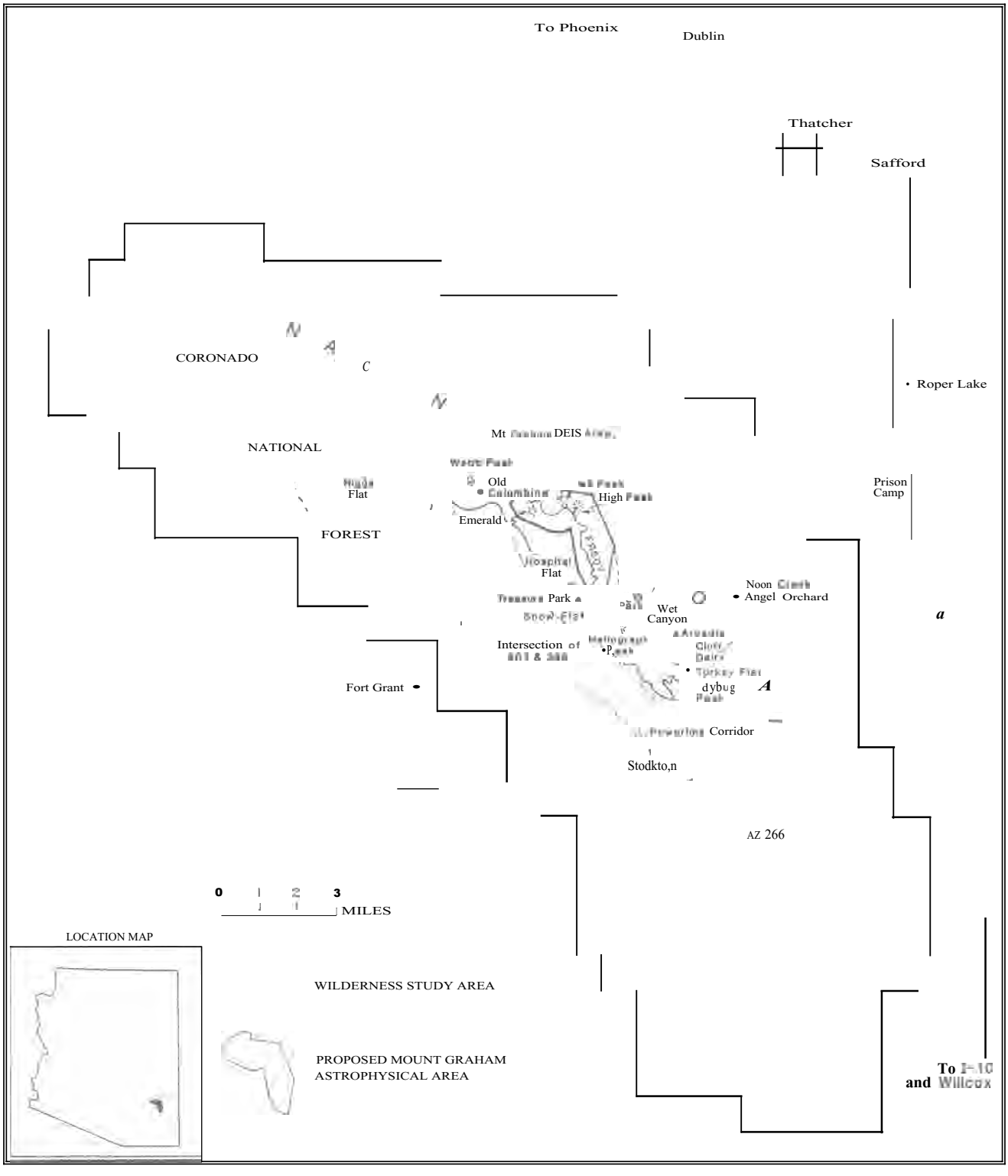

FIGURE 1. VICINITY MAP OF THE CORONADO NATIONAL FOREST PINALENO MOUNTAINS

Draft Environmental Impact Statement. Proposed Mt. Graham Astrophysical Area
Pinaleno Mountains. Graham County. Arizona. Coronado National Forest

DEIS #03-05-86-2

Type of Action Administrative

Lead Agency USDA Forest Service. Coronado National Forest
300 West Congress Street. Tucson, AZ 85701

Responsible Official Sotero Muniz, Regional Forester

For Further Information R. B. Tippeconnic, Forest Supervisor, Coronado National Forest
300 West Congress Street, Tucson, AZ 85701. (602) 629-6483

Abstract A Forest Service Preferred Alternative and 6 alternatives for managing the 3500 acre proposed Mt. Graham Astrophysical Site on the Coronado National Forest are described and compared. The Forest Service Preferred Alternative and other alternatives are:

PA (Forest Service Preferred Alternative): PA places emphasis on simultaneously addressing all issues and concerns, and providing a mix of recreational opportunities including an addition to wilderness and a zoological/botanical area. Astrophysical development is recommended at a level that will provide for this research opportunity while protecting the unique natural environment.

A Alternative A is the continuation of management as described in the Forest Plan. (No Action alternative). It emphasizes motorized and nonmotorized dispersed recreation opportunities and other compatible activities. No astrophysical development occurs.

Alternative B emphasizes motorized and nonmotorized dispersed recreation opportunities related to wildlife values. No astrophysical development occurs.

Alternative C emphasizes a natural environment and more opportunities for nonmotorized recreation. An addition to wilderness and a zoological/botanical area are recommended. No astrophysical development occurs.

Alternative D provides for astrophysical development on up to 15 acres. An addition to wilderness and a zoological/botanical area are recommended. Motorized and nonmotorized dispersed recreation opportunities related to wildlife values are also emphasized.

Alternative E provides for astrophysical development on up to 31 acres. A zoological/ botanical area is recommended. Motorized and nonmotorized dispersed recreation opportunities related to wildlife values are also emphasized.

Alternative F is Steward Observatory's (the proponent) preferred alternative. It provides for astrophysical development on up to 60 acres. Motorized and nonmotorized dispersed recreation opportunities related to wildlife values are also emphasized.

PA constitutes the Forest Service preferred alternative. Upon approval, it will become part of the Coronado National Forest Plan and will guide management of that area for the next 10 to 15 years.

Comments must be received by the Forest Supervisor. Coronado National Forest. 300 W. Congress. Tucson, Arizona 85701 by **JAN 2 0 1987 .**

SUMMARY OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT of the
PROPOSED MT. GRAHAM ASTROPHYSICAL AREA. PINALENO MOUNTAINS. CORONADO NATIONAL FOREST

THE CORONADO NEEDS YOUR OPINION ON A IMPORTANT ALLOCATION OF LAND RESOURCES

Although the broad goals and objectives are set by higher levels of Forest Service management, the Coronado National Forest does have a range of choices in meeting these goals. For example, these choices can emphasize one resource, such as recreation or another such as astrophysical development or both, if that is an important concern of local people. This is why public involvement is so important in this process. Already many individuals and agencies have helped pinpoint issues of special importance **to them. Various interest groups, including Steward Observatory, Earth First!,** Coalition for the Preservation of Mt. Graham, and the Sierra Club have expressed their viewpoints and ideas. These issues have been incorporated into this process and taken into consideration when alternative management choices were developed.

You are asked to remain involved by reviewing this document and by submitting your written comments to the Forest Supervisor, Coronado National Forest, 300 **W. Congress,** Tucson, Arizona 85701. Development of the Final Environmental Impact Statement will be based in part on your comments.

PURPOSE OF THE ENVIRONMENTAL IMPACT STATEMENT

This Environmental Impact Statement (EIS) describes a Forest Service Preferred Alternative and 6 other alternatives for the management of the land and resources of 3500 acres of high elevation country in the Pinaleno Mountains, commonly known as Mt. Graham. Each alternative furnishes a different way of addressing issues; each provides for the use and protection of resources and meets all legislative requirements. Every alternative generates a different mix of goods and services. The EIS also describes the affected environment and discloses environmental consequences of each potential decision. The guidelines set by the National Environmental Policy Act (NEPA) were followed.

Included in the range of alternatives is the astrophysical development proposal made by Steward Observatory. Also included in the range of astrophysical development and nondevelopment alternatives are specific suggestions from the public. Each alternative addresses public issues and management concerns specific to this proposal; responds to identified resource management opportunities; and provides for **use and protection of resources.**

NATURE OF DECISION/RELATIONSHIP TO FOREST PLAN

The decision to be made by the Forest Service is to choose the appropriate allocation (management direction) for the 3500 acre site. While other mountains may be suitable sites for astronomical development, only the suitability of Mt. Graham for astronomical development is being considered. Consequently, consideration of alternative locations is outside the scope of this analysis and decision.

Many thanks are expressed for the comments and information offered by individuals, organizations, and public agencies which have helped Forest managers develop a list of items to be considered in each alternative. These have been organized and are included below under a general heading called ISSUES, CONCERNS, and OPPORTUNITIES (ICOs).

ISSUES, CONCERNS, and OPPORTUNITIES (ICOs)

Management **concerns and issues are termed "issues" and described below. They establish the scope of the EIS (40 CFR 1501.7 and 1508.25). The issues were grouped into nine subject matter areas. Additional detail on scoping, Forest Service policies and goals, and these issues can be found in Chapter 1 under the heading "F. ISSUES". These issues can be tracked through Chapters 2 and 3 under the same headings listed on the following pages.**

Issue Description

1. PLANT AND ANIMAL DIVERSITY

Forest Service policies and goals are to sustain or improve floral and faunal diversity by: 1) providing for the conservation or recovery of all threatened, endangered, and sensitive plant and animal species and their respective habitats; 2) developing and implementing management practices to ensure that species do not elevate to a higher listing status, nor significantly impact the habitat capability of any species, because of Forest Service actions or lack of protection; 3) maintaining viable populations of all native and desired nonnative flora and fauna in habitats distributed throughout their geographic ranges on National Forest System lands; 4) maintaining special or unique habitat features or structures and habitat types to ensure ecological diversity (e.g., old growth, riparian zones, cienegas, etc.).

The Arizona (Apache) trout is a federally listed Threatened Species and the Mt. Graham Red Squirrel is proposed for listing as an Endangered Species. Other wildlife species of particular concern include the black bear and spotted owl.

The Issue Is: How will plant and animal species, communities, and habitat diversity be affected by management alternatives?

2. WATERSHED MANAGEMENT

Water quality in the Pinalenos is high. Testing for fecal coliform bacteria indicates that levels of contamination are well within the standards for all except domestic uses. Simple purification methods would allow achieving those standards. Astrophysical construction and development could increase the potential for water runoff and soil erosion, thus impacting water quality. Impacts to flora and fauna along stream channels could also occur.

Water is limited on Mt. Graham and competition for it may increase. Most of the surface water is appropriated. Questions of water rights must be resolved including the actual transfer of such rights, if necessary. Construction may impact cienegas, springs, and baseflows in creeks. An estimate of changes in water yield and timing of runoff during and following construction is needed.

Frye Canyon Watershed is closed to camping, summer homes, resorts, and commercial recreation uses to protect the municipal watershed of Safford and Thatcher by order of the Secretary of Agriculture dated May 5, 1930. A cooperative agreement dated August 12, 1912 between the Secretary of Agriculture and the Mayor of Safford, also provides for measures to conserve and protect the water supply.

Several cienegas are located near the summit of Mt. Graham. They are small wet areas characterized by high water tables, often with some surface water, numerous water-dependent plants, and some water-dependent animals. Executive Order 11990 defines wetlands management and requirements. The Forest Supervisor has determined that cienegas are wetlands which require certain protective measures. These may include minimizing the destruction, loss, or degradation of wetlands, and their preservation or enhancement.

The Issue Is: How will water quality and quantity in the Pinaleno Mountains, Frye Watershed, and the small cienegas be affected by management alternatives?

3. RECREATION USES AND OPPORTUNITIES

Mt. Graham is one of the most popular outdoor recreation areas in southeastern Arizona. Mt. Graham provides climatic relief to desert dwellers and an opportunity to recreate in the cool conifer forest environment. The Pinalenos are one of only two mountain ranges in southeastern Arizona with paved road

access above 7000' elevation--the other being the very heavily used Mt. Lemmon area. The area proposed for astrophysical use is along an unpaved road with no existing developed recreation sites. The 3500 acre area provides a variety of recreational pursuits including: hiking, camping, driving for pleasure, hunting, nature study, and berry picking. The area has been generally inaccessible during winter months because of deep unplowed snow. Astrophysical development would bring about changes in the variety and timing of recreational use.

There are no developed recreation sites nor are any planned within the 3500 acre area. A major astrophysical site could increase visitor use due to telescope interest and increased accessibility. Increased use could require visitor facilities. Possible developments include: visitor center off the Forest; snowplay (tubing) area; trailhead facilities; and vista sites. The astrophysical development could increase visitor use of existing developed picnic and camp sites along the Swift Trail.

Astrophysical instruments are extremely sensitive and there could be adverse impact to astronomical projects resulting from recreational use of nearby National Forest lands. Unrestricted public access and interference resulting from automobile lights, campfire smoke, and hunters with high-powered rifles could hamper astrophysical projects. Development and operation of observatories may warrant public use restrictions. Necessary restrictions would have to be identified by specific area, and activities.

The Issue Is: What changes in recreation use and opportunities will occur? It is important to consider: changes in seasonal and area use patterns; changes in future use by activity and number of recreationists: potential changes in the quality of recreational experiences; developed recreation sites and visitor needs for services; and opportunities for enhancement of recreation management.

4. WILDERNESS AND SPECIAL AREA DESIGNATIONS

One thousand acres of the 3500 acre area is within the Mt. Graham Roadless Area (RARE II Area #3123) as modified during the roadless area reevaluation, October 1983. None of the 1000 acres is within the Mt. Graham Wilderness Study Area (WSA) designated by the 1984 Arizona Wilderness Act. However, the Coronado National Forest is evaluating that 1000 acre tract for wilderness suitability during this environmental analysis. A 500 foot wide powerline corridor was reserved from the Wilderness Study Area by the 1984 Arizona Wilderness Act. Developments related to astrophysical needs could affect the quality of the wilderness experience for any of the WSA that may be designated wilderness.

It has been suggested by a number of individuals and groups that the Mt. Graham wet meadows and spruce-fir forest are ecosystems that merit designation as either Research Natural Areas (RNAs) or Zoological/Botanical Areas (ZBAs).

The Issue Is: What land, if any, should be allocated to Wilderness, RNAs or ZBAs within the Astrophysical Study Area?

5. VISUAL QUALITY

The 3500 acre area has retained its natural setting and relatively undisturbed state. Primitive roads and evidence of logging activities are the main evidence of human use. The area is managed to maintain a high level of visual quality. The current visual quality objective is retention. Introduction of telescopes and support facilities will change the landscape to include structural features.

The Issue Is: What impacts will occur to visual quality? What changes, if any, should be made in current visual quality objectives?

6. CULTURAL RESOURCES AND NATIVE AMERICAN USE

Archaeological sites are present within the proposed project area. The most appropriate treatment of these sites must be determined in consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. In addition, Native Americans have used the Pinaleno Mountains for hundreds of years.

The Zuni Indian Tribe has expressed concerns about the disposition of potential impacts to religious uses and to existing cultural resources.

The Issue Is: What is the most appropriate treatment of the archaeological sites located within the project area and how will Indian Religious practices be affected?

7. ASTROPHYSICAL VALUES AND BENEFITS

Astronomy is a basic science providing research information that is part of the scientific and cultural knowledge pool. Technological and economic developments, engineering applications, new products, and industrial growth also occur because of astronomy research. In turn, the capability and productivity of astronomy research is increasing due to technological advances of instrumentation. One of the significant limiting factors for astronomers today is available observation time at both traditional and technologically advanced facilities. Site characteristics are critical to the value of these facilities. Since modern astronomy deals with the entire light spectrum (visible and non-visible), sites may have several limiting factors. In many cases existing telescopes cannot be used to their potential because of light pollution from expanding metropolitan areas. New telescopes at these sites would be ineffective not only because of light pollution, but also because of such factors as water vapor, air pollution, or radio wave interference. These factors are especially significant for the NNTT.

Steward Observatory and the University of Arizona are recognized leaders in the field of astronomy. This is paricularly true in the field of infra-red astronomy. Scientists from around the world come to conduct research at the observatories nearby (Kitt Peak, Mt. Hopkins, Mt. Lemmon, and Mt. Bigelow) and consult with scientists in Tucson. Conversely, Steward Observatory scientists are active at telescopes the world over.

Of the telescopes proposed for location on Mt. Graham, one is built and operating -- although at less than capacity -- (Texas 5-meter), one is being built in Germany (10-meter SMT), the primary 1.8 meter mirror on the VATT has been cast, and the remainder are projected but funding has not been secured.

The Issues are:

a. What are the technological and scientific impacts attributable to development of Mt. Graham? What impacts can be expected if development does not occur?

b. What are the impacts to Steward Observatory if Mt. Graham is developed, or if it is not?

8. SOCIO-ECONOMIC IMPACTS

Mt. Graham is located in Graham County, a rural area of southeastern Arizona. Safford, with a population of 7,700, is the largest community in the county and is located at the base of Mt. Graham. Thatcher and Pima are close neighbors to the northwest. Total county population is 23,200. Agriculture, possible because of irrigation water from the Gila River, was the first industry of the county when it was settled in 1880 and remains the primary source of income today. The Phelps-Dodge copper mine in Morenci was an important employer of Graham County residents until the recent decline of the industry. Federal, state, and local governments are also important employers in the Gila Valley,

especially at Eastern Arizona College in Thatcher. Because of hard times in agriculture and copper mining and reduced government spending locally, unemployment in Graham County is 15%.

Willcox, located in northern Cochise County, is also within the socio-economic area influenced by activities on Mt. Graham. Willcox is 81 miles east of Tucson along 1-40 and the last commercial center for Mt. Graham visitors from Tucson before they turn onto Swift Trail from U.S. Highway 666.. Safford, although closer to Mt. Graham, is 9 miles past the Swift Trail junction. Gas stations, restaurants, and motels in Willcox benefit primarily from 1-40 travelers, but also pick up business from those headed for Graham County and Mt. Graham.

Arizona's economy is principally based on four industries: manufacturing, tourism, agriculture, and copper mining. Of these, manufacturing -- and most dominantly high tech manufacturing -- provides the highest employment in the state. Tucson follows a similar pattern with a doubling of manufacturing employment -- mostly in high tech firms -- in the last ten years, and a significant tourism industry. Tucson, however, differs from the state-wide pattern in that government is the largest employer in Pima County. The University of Arizona and Davis-Monthan Air Force Base each employ about 10,000.

Astronomy research and related industries is a unique feature of the Tucson and Arizona economy. In 1982-83 almost $34 million was spent by astronomy research facilities in Arizona, directly employing 860 people. About 90% of the funding for astronomical activities comes from Federal sources.

The Issues Are:

a. How would development of an observatory on Mt. Graham impact the Graham County/Willcox area economically and sociologically? What sort of impacts could be expected during construction; and during operations with an associated increase in tourism?

b. Will development of Mt. Graham have any significant effect on Pima County (Tucson) or the state as a whole?

9. SAFETY/PROTECTION

Occasionally during dry periods, there will be danger of wildfire damage to facilities and equipment as well as possible danger to people in the area. It may be necessary to conduct prescribed fuels reduction for wildlife habitat management and fire hazard reduction. Smoke resulting from prescribed burns or wildfires may adversely affect astrophysical equipment and projects.

Astrophysical development will require winter access. This could lead to a demand for access by the public during the winter months. Astrophysical development on Mt. Graham could endanger visitors at construction sites or by meeting trucks or heavy equipment on narrow mountain roadways.

The Issues Are:

a. How will the Forest fuels treatment program be adjusted to meet the needs of wildlife and to protect the Mt. Graham area?

b. What measures would be employed to manage winter access and public safety?

c. What closures to public use will be necessary to protect both Forest visitors and astrophysical efforts?

OVERVIEW OF ALTERNATIVES

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

The Forest Service Preferred Alternative (PA) provides for minimum astrophysical development on up to 7 acres. A tightly clustered astrophysical site (site 3, High Peak) would be developed. Of the 13 telescopes proposed by Steward Observatory, 5 telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, and one small and one large optical/IR telescope. The National New Technology Telescope (NNTT) and interferometer would not *be* developed. One logistics site would be considered (L-13). There would be no dormitory or visitor center on the Forest. Special public use restrictions would be proposed for 123 acres (area 5 Figure 2-PA Forest Service Preferred Alternative).

The Forest Service Preferred Alternative (PA) would manage 1801 acres as in alternative B, except that commercial sawtimber and fuelwood sales could occur. However, any timber harvest activities including sanitation/salvage would be done only to benefit specific wildlife (Mt. Graham red squirrel) or recreation values after consultation with the appropriate parties, e.g. U.S. Fish and Wildlife Service, Forest Biologist, and Arizona Game and Fish Department. A snow play area, picnic site, restroom facility, scenic view point and an amateur astronomy vista would be developed. Special area designations would be recommended (wilderness 1000 acres and zoological/botanical area 569 acres). All 3500 acres would be recommended for mineral withdrawal, including the 1000 acres that would be recommended for wilderness designation.

Alternative A emphasizes dispersed recreation opportunities while watershed conditions are maintained or improved. Sawtimber and fuelwood harvest are compatible with recreation oriented opportunities. The visual quality objective is retention. Wildfires are aggressively suppressed

Alternative B emphasizes dispersed recreation opportunities and wildlife values. Watershed conditions would be maintained or improved. There would be no commercial sawtimbr or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued. The visual quality objective would be retention. Wildfires would be aggressively suppressed.

Alternative C emphasizes a natural appearing environment. **The** old growth timber habitat would be increased over time. There would be no commercial sawtimber or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued (note no motorized access allowed). Wildlife values and dispersed recreation opportunities are emphasized. Special area designations (wilderness and a zoological/botanical area) are recommended. Opportunities for primitive and semi-primitive experiences increase. The visual quality objectives would be retention and preservation. Wildfires would be aggressively suppressed.

All existing roads in the 3500 acres, including Forest Roads 507 **and 669, would be closed and revegetated. All** trails would be closed to motorized use.

Alternative D provides for the minimum astrophysical development as defined by the proponent, Steward Observatory, on up to 15 acres. Three tightly clustered astrophysical sites (sites 3, 6, and 7) would be developed. Of the 13 telescopes proposed by Steward Observatory, 5 telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, and one small and one large optical/IR telescope. The **National New Technology Telescope (NNTT)** and interferometer would not be developed. Two logistics sites would be considered; only one would be selected. There would be no dormitory or visitor center on the Forest. Special public use restrictions would be proposed for 284 acres (area 5 Figure 2-D).

Alternative D would manage 1801 acres as in alternative B. A snow play area, picnic site, restroom facility, scenic view point, and an amateur astronomy vista would be developed. Special area designations would be recommended (wilderness 1000 acres and zoological/botanical area 400 acres). All 3500 acres would be recommended for mineral withdrawal, including the 1000 acres that would be recommended for wilderness designation.

Alternative E provides for astrophysical development on up to 31 acres. Astrophysical sites 1 and 3 would be developed. Of the 13 telescopes proposed by Steward Observatory, 11 telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, four small and two large optical/IR telescopes. The following two telescopes could be developed: The National New Technology Telescope (NNTT) and/or an interferometer consisting of six separate structures that can be arranged and re-arranged in a "Y" shaped array along Forest Roads 507 and 669. Two logistics sites would be considered: only one would be selected. A visitor center would be off forest, with shuttle service to the exclusive use areas for the public provided by Steward Observatory or private enterprise. A dormitory (on Forest) would be constructed on the logistics site. It would house approximately 25 astrophysical staff/observers. Special public use restrictions would be proposed for 738 acres (area 5 Figure 2-E).

Alternative E would propose to manage 2,502 acres as in alternative B. A snow play area, picnic site, restroom facility, scenic view point and an amateur astronomy vista would be developed. A special area designation would be recommended for a 150 acre zoological/botanical area. All 3500 acres would be recommended for mineral withdrawal, including the 1000 acres that would be recommended for wilderness designation.

Alternative F is Steward Observatory's preferred alternative. Alternative F provides for astrophysical development on up to 60 acres. Astrophysical sites 1 through 11 would be considered and up to 5 sites would be selected for development. All 13 telescopes proposed by Steward Observatory could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, five small and three large optical/IR telescopes. The following two telescopes could be developed: The National New Technology Telescope (NNTT) and/or an interferometer consisting of six separate structures that can be arranged and re-arranged in a "Y" shaped array along Forest Roads 507 and 669. Three logistics sites would be considered: only one would be selected. A visitor center would be off forest, with shuttle service to the exclusive use areas for the public provided by Steward Observatory or private enterprise. A dormitory (on Forest) would be constructed on the logistics site. It would house 40 astrophysical staff/observers. Special public use restrictions would be proposed for 1240 acres (area 5 Figure 2-F).

Alternative F would manage 2,188 acres as in alternative B. A picnic site, restroom facility, scenic view point and an amateur astronomy vista would be developed. All 3500 acres would be recommended for mineral withdrawal, including the 1000 acres that would be recommended for wilderness designation.

SUMMARY OF SIGNIFICANT ENVIRONMENTAL EFFECTS BY ALTERNATIVE

A summary of significant environmental effects identified in Chapter 3 for all alternatives is displayed below.

Chances for survival of the Mt. Graham red squirrel decrease as the level of activity and/or facility development increases due to old growth and potential old growth habitat loss in the long term. The risk increases as the level of man-induced activity increases. Alternatives D, E, and F are more than twice as likely as alternatives A, B, or C to cause extinction of the Mt. Graham red squirrel within 30 years. The Forest Service Preferred Alternative (PA) is less than twice as likely as alternatives A, B, or C to cause extinction of the Mt. Graham red squirrel within 30 years (see Chapter 3. Wildlife Section).

Alternatives D (15 acres), E (31 acres), F (60 acres), and PA (7 acres) would result in a loss in natural character and productivity of the environment over the life of the project and reduce these areas to a single purpose use.

Effects created by long term occupancy of the proposed astrophysical area include human-wildlife conflicts and changes in types and patterns of recreation use. The significance and positive or negative effects of these changes depends on the personal values of the interested and affected publics.

Recreation management in alternative C changes the area to a more natural and primitive environment resulting in an recreation opportunity spectrum (ROS) setting of semi-primitive non-motorized and primitive. Alternatives PA, D, E, and F (in ascending order) all result in increased pockets of urban development and visitation above the current level. The National New Technology Telescope (NNTT) would contribute the greatest share, up to 50,000 visitors per year, in increased visitation to the area. The NNTT is proposed in alternative E and F. Without development of the NNTT, increases in visitation in alternatives E and F would be similar to alternative D and the PA. In the Forest Service Preferred Alternative (PA) and alternative D the carrying capacity is projected to be reached in the Pinaleno Mountains by the year 2019 with 15,000 observatory visitors. In alternatives E and F with the NNTT developed, carrying capacity would be reached in the year 2015 and 2019, respectively. Winter access and snow play opportunities would increase in alternatives D, E, F and the Forest Service Preferred Alternative (PA). With the projected current 2% annual increase in visitation, alternatives A and B would reach capacity of 470,000 RVDs in the Pinaleno Mountains by the year 2022 and alterative C would reach capacity by the year 2023.

Visual quality would be significantly affected in all development alternatives but to a greater magnitude in alternatives E and F with the interferometer and/or NNTT. Even with proper design, siting, and mitigation, natural features would no longer dominate the landscape.

The potential for inadvertent damage to cultural resource sites exists under all alternatives. Alternative C reduces potential cultural resource impacts from that in alternative A because visitation and discovery is less likely to occur. As development and visitation increases from the Forest Service Preferred Alternative (PA) and D to E to F, mitigation measures become increasingly necessary. Development alternatives D, E, F and the Forest Service Preferred Alternative (PA) would adversely impact at least one cultural resource site. Alternatives D, E, F, and PA may not be able to avoid rock cairn site AR-03-05-04-103. In all development alternatives site AR-03-05-04-102 appears to be unavoidable and would be adversely impacted. Both sites occur in the astrophysical exclusive use area for all 4 development alternatives.

Development alternatives D, E, and F and PA could stimulate the growth of the astrophysical community in southern Arizona. The cultural and scientific knowledge pool would increase from the Forest Service Preferred Alternative (PA) and D to E to F. Technological and economic development, engineering applications, new products, and industrial growth would increase in some degree from alternatives PA and D to E to F.

Development alternatives D, E, F and PA increase risk of fire resulting in the hiring of one additional Forest Service fire prevention technician. Increased winter public access increases public risk including: traffic accidents resulting from icy road conditions and inexperienced drivers; delays due to winter storms; hypothermia.

DRAFT ENVIRONMENTAL IMPACT STATEMENT
PROPOSED MT. GRAHAM ASTROPHYSICAL AREA
CORONADO NATIONAL FOREST

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CHAPTER 1 - PURPOSE OF AND NEED FOR ACTION

This Environmental Impact Statement documents the analysis of Issues, Concerns, and Opportunities considered in selecting a management plan for a 3500 acre area on Mt. Graham. Seven management strategies (alternatives) are displayed (Chapter 2). Each way of managing the area results in a different mix of public services and land uses. The allocation of land uses on the 3500 acre area will determine whether astrophysical development is appropriate for the Mt. Graham area.

A. OVERVIEW

Mt. Graham (10,720 feet) is the highest peak in the Pinaleno Mountains which are located in Southeast Arizona near the city of Safford. The Pinaleno Mountains, which are often referred to as Mt. Graham, are part of the Safford Ranger District of the Coronado National Forest. The entire mountain range **includes approximately 198,411 acres that range** from 4,000 to over 10,000 feet in elevation. The mountain is accessible via State Highway 366 (Swift Trail).

Since early 1981, the Smithsonian Institution and the University of Arizona, in cooperation with the National Optical Astronomy Observatories (Kitt Peak), have conducted tests on Mt. Graham, Arizona and Mauna Kea, Hawaii to determine the quality of these sites for modern astronomical observatories.

In June 1982 the Smithsonian Institution requested that the Coronado National Forest consider Mt. Graham as a future astronomical facility of major national significance. No specific proposal was received at that time. The location was generally described as approximately five square miles (3500 acres) above 9,600 feet in elevation. (See Figure 1 inside front cover.)

The Smithsonian Institution was issued a permit in June 1983 to conduct second phase testing using two temporary towers on selected peaks of the Pinaleno Mountains. **(A** revised permit was issued to Steward Observatory, University of Arizona, in early 1986 to continue the testing program.)

In June 1984, the University of Arizona (Steward Observatory) submitted an astrophysical site and facility proposal to the Coronado National **Forest. A** revised Site Development Proposal from Steward Observatory was received in May 1986.

While the testing was being done, the Coronado National Forest was intensively involved in the analysis and development of a Forest Plan. After receiving the proposal (June 1984) for astrophysical development of **Mt.** Graham, the Forest incorporated the analysis of the astrophysical site proposal into the ongoing planning effort. However, as the planning effort progressed, the amount of public interest and the lack of site specific data for the 3500 acre Mt. Graham area caused a change in analysis strategy. In June 1985 a separate environmental analysis process was initiated and analysis of the proposed astrophysical site was dropped from the Forest Plan. This Environmental Impact Statement documents the analysis of management plans for the 3500 acre site on Mt. Graham.

In December 1985, the Office of Arid Land Studies, University of Arizona provided an environmental data report **(Office of Arid Land Studies Environmental Data Report Proposed Mt. Graham Astrophysical Area, Pinaleno Mountains, Graham County, Arizona) for the 3500 acre area. This report is referenced throughout this Environmental Impact Statement as a primary source of information. The report can be viewed at the Coronado National Forest Supervisor's office in Tucson, Arizona or the Safford Ranger District office in Safford, Arizona.**

B. THE NEED FOR THE PROPOSED PROJECT

Astronomy is dynamic and a rapidly developing field of research. This rapid progress is in part due to developments in technology which now permit astronomical research **to** be pursued not only in visible **light, but also in radio, infrared, ultraviolet, x-ray and gamma ray wavelengths. Technology**

developments have also made it possible to build optical, infrared and submillimeter (see Glossary) telescopes of unprecedented size and sensitivity. A new generation of giant instruments is likely to be constructed in the next few decades. The number of astrophysical sites suitable and available for these new telescopes are limited. Steward Observatory expects Mt. Graham to have characteristics that are vital to a high quality astrophysical site. It is understood that other peaks elsewhere in the Southwestern U.S. could also be suitable but are located further away from the University of Arizona in Tucson. Many of these other possible sites have limited or no vehicular access. Light pollution encroachment from population centers limit astrophysical site possibilities at some sites.

The need for the proposed project comes from: 1) the development of new types of telescopes and new instrumentation sensitive to a broader area of the electromagnetic spectrum; 2) the site requirements for these new telescopes that differ from previous dark-sky optical telescopes; 3) the costs and infancy of space-based telescopes; 4) the demand for observation time by competing atronomers exceeds the time available (Additional information in Office of Arid Land Studies Environmental Data Report, section 2.2).

The criteria for selecting an astronomical observatory site for the new telescopes and instruments are: 1) clear skies; 2) minimum water vapor above telescope; 3) dark skies; 4) image sharpness; 5) radio free skies; 6) low wind speed; 7) access; 8) political stability; 9) environmental impacts; and 10) human health, safety, and productivity (Additional information in Office of Arid Land Studies Environmental Data Report, Table 2.4). Steward Observatory believes Mt. Graham fits the above criteria. Steward Observatory believes the proximity of the Pinaleno Mountains to the University of Arizona in Tucson is advantageous for logistics and costs of operation.

C. STEWARD OBSERVATORY PROPOSED PROGRAM OF DEVELOPMENT AND PHASING

The proposed project consists of thirteen telescopes. Twelve of these telescopes could be placed on three to five of eleven identified sites. One of three possible logistic sites will also be chosen (See Appendix 1, Figure 9 for site locations). Seven telescopes are large (greater than 7.5 meters in diameter) and five are small (less than 4.0 meters in diameter). In addition, an interferometer, would use a roadway with nine roadside turnouts. The proposed construction period is thirty years. The life-span of the project is one hundred years. The construction plan is divided into three phases.

Telescope development and support facilities are summarized in Tables 1 thru 4.

A brief narrative of STEWARD OBSERVATORY's three phase proposed project follows. Phase 1 has assured funding but phases 2 and 3 do not. Financial and technological changes in astronomy could alter Phases 2 and 3 significantly.

Phase 1

Proposed:

Three telescopes. Two are well defined (see Table 1) and have assured funding. The third is in planning stages. Operations funds are 75 percent assured. Construction funds are 75 percent assured. Infrastructure includes one septic tank system; hauled water; a water storage tank; a water treatment system; diesel generators; a snowplow garage, and communications building with a meteorological tower. Fifteen staff and observers will be involved in daily operations with a maximum of ten living in the support building. There will be minimal roadwork with the exception of the realignment of the sharp turn and steep grade known as the "wall"and the "Y" between the High Peak spur road and Hawk Peak road. Phase 1 would be completed by 1990.

TABLE 1

Mt. Graham Development Plan: Phase 1 Facilities (Summary)
(1986-1990)

Telescopes

- 2 Meter Class Optical/Infrared Telescope (Vatican Observatory Advanced Technology Telescope--VATT) The 1.8 meter primary mirror has been cast at the University of Arizona. Steward Observatory and the Vatican Observatory would collaborate on the development and construction of this telescope.
- 10 Meter Submillimeter Telescope (SMT) Max Planck Institute for Radio Astronomy in West Germany is providing the telescope. The housing would be built by Steward Observatory.)
- 5 Meter Submillimeter Telescope (Texas 5 Meter is in operation in Texas and would be moved to Mt. Graham.)

Support Facilities

- Support Building
- Equipment Garage: Snow Blower, Loader, Dozer, etc.
- Power House
- Communications Building: Radio, Telephone, Data Link
- Dormitory (Alternatives E and F only.)
- Water System: Water Tank, Treatment System and Distribution Lines. (Water will be hauled to the site from the City of Safford's Deadman Creek Canyon supply and/or other off forest locations).
- Forest Road 507: Parking, sharp steep turn called the Wall" (milepost 3.6) Re-alignment, "Y" Expansion, Grading
- Septic Tank System
- Solid Waste Storage System

Phase 2
Proposed:

Six telescopes (2 large, 4 small). One is well defined and in advanced stages of planning. The possibility of the New National Technology Telescope (NNTT) dominates this phase of development. It would contribute 75 percent of the financing. No funding is assured for Phase 2. Infrastructure would include, at least, one more septic tank system; development of a water source on the peak area; installation of a powerline to the mountain top. During this phase, a dormitory/commons building, mirror coating facility, engineer's residence and shop areas would be added. Approximately 34 staff and observers would work on the mountain with a maximum of 25 living in the newly constructed dormitory/commons building. The proposed construction period is from 1990 to 1996.

TABLE 2

Mt. Graham Development Plan: Phase 2 Facilities (Summary)

(1990-1996)

Telescopes

- One Large (8 Meter Class) Telescope
- Four Small (2 Meter Class) Telescopes
- National New Technology Telescope (NNTT)

Support Facilities

- Site Engineer's Residence
- Dormitory/Commons Area
- Electrical/Mechanical Shop Area
- Visitor Center (off Mountain)
- Helicopter Landing Pad
- Additional Power Generation Equipment
- Commercial Power Line
- Roads: Spur Roads, Erosion/Runoff Control, Possible Widening
- Mirror Coating Facility
- Water Diversion, Supply and Treatment System
- Additional, as Necessary, Water Storage Tanks; Water and Power Distribution Lines and Septic Tank Systems

Phase 3

Proposed:

Three large telescopes are planned. Neither the exact dimensions nor the sponsor for these telescopes is known at this time. No funding is assured. In addition, the Smithsonian Astrophysical Observatory Interferometer is considered a possibility of Phase 3. If Forest Road 507 has not been widened and paved in Phase 2, it will be in this Phase. Proposed infrastructure additions of water, power and sewage would occur as additional site locations are developed. Dormitory expansion would similarly increase. Sleep-in staff and observers would total 40. Another 16 personnel would commute daily. The proposed construction period is from 1996 to 2016.

TABLE 3

Mt. Graham Development Plan: Phase 3 Facilities (Summary)

(1996-2000+)

Telescopes

- Three Large (8 Meter Class) Telescopes
- Smithsonian Interferometer (6 Dishes)

Support Facilities

- Interferometer Control Building
- Road and Pullout Widening for Interferometer
- Emergency Equipment Garage/First Aid Station
- Paving Forest Road 507
- Addition to Dormitory/Commons Area
- Additions as Necessary, to Water Storage, Treatment and Distribution Systems, Septic Tank Systems and Power Distribution Lines

Each Phase would also include temporary facilities (usually trailers) for construction operations. Phase 1 will also include site-testing equipment to determine the best astronomical sites for various telescopes in Phases 2 or 3. This will include a portable telescope.

TABLE 4

Telescope Installation Summary

	Large	Small	Interferometer	Totals
Phase 1	2	1	-	3
Phase 2	2	4	-	6
Phase 3	3	-	1	4
Total	7	5	1	13

Additional detail on the astrophysical proposal can be found in Appendix 1 and through a review of the Office of Arid Land Studies Environmental Data Report.

D. NATURE OF DECISION/RELATIONSHIP TO FOREST PLAN

The decision to be made by the Forest Service is to choose the appropriate allocation (management direction) for the 3500 acre site. While other mountains may be suitable sites for astronomical development, only the suitability of Mt. Graham for astronomical development is being considered. Consequently, consideration of alternative locations is outside the scope of this analysis and decision.

The Record of Decision for the Forest Plan and Environmental Impact Statement (August 4, 1986) defers the land allocation decision on the 3500 acre Mt. Graham area. The information analyzed in this Enviromental Impact Statement will provide the basis to determine:

1) the land allocation and management objectives desired on the 3500 acre Mt. Graham area,
2) the degree of development or nondevelopment of the area, and
3) the types of mitigation that will be required under each alternative management proposal.

Management decisions have been made for all areas of the Forest not directly affected by the proposed Mt. Graham Astrophysical Area in the Forest Plan. The only area directly affected is the 3500 acres originally proposed by Steward Observatory. Management direction for this entire 3500 acre area will be addressed in this EIS and when finalized will be included in Management Area 2A of the current Forest Plan.

E. PURPOSE OF THE ENVIRONMENTAL IMPACT STATEMENT

This Environmental Impact Statement (EIS) describes alternatives for future management of the land and resources of a 3500 acre area at the summit of Mt. Graham within the Coronado National Forest. Included in the range of alternatives is the astrophysical development proposal made by Steward Observatory. Also included in the range of astrophysical development and nondevelopment alternatives are specific suggestions from the public. Each alternative addresses public issues and management concerns specific to this proposal; responds to identified resource management opportunities; and provides for use and protection of resources.

The EIS describes the affected environment, discloses the significant environmental consequences, and responds to issues, concerns, and opportunities (ICOs) identified. An EIS is required by the implementing regulations for the National Forest Management Act of 1976 (NFMA) [36 Code of Federal Regulations (CFR) 219] and the National Environmental Policy Act (NEPA) of 1969 (40 CFR 1500-1508).

A Notice of Intent to prepare an EIS for the proposed Mt. Graham Astrophysical Area was published in the Federal Register on July 16, 1985. A revised Notice of Intent was issued on May 30, 1986 updating the schedule for completion and release of the EIS. The Regional Forester will use this EIS in making a decision under NFMA and NEPA on the land allocation for the 3500 acre area on Mt. Graham. This decision will be documented in a record of decision which will be available to the public.

Management practices and standards and guidelines developed in this EIS will be incorporated into the Forest Plan and guide management of the 3500 acres within the Safford Ranger District of the Coronado National Forest for the next 10 to 15 years.

This EIS will guide any subsequent project implementation. Specific project proposals will be tiered to this EIS (40 CFR 1508.28). Tiering means that, if needed, future environmental documents for projects based on this EIS will summarize or incorporate by *reference* the issues discussed in this EIS. Environmental documents for those projects will focus on site specific issues, concerns, and opportunities unique to the project. Environmental documents may not be prepared for projects that have been found to have limited context and intensity (40 CFR 1508.27(a) and (b)) and produce no significant effects, individually or cumulatively, to either the biological or physical components of the human

environment (40 CFR 1508.14), or to have been adequately addressed in other environmental documents, including this EIS.

F. ISSUES

Summary of Scoping Process

The September 1982 Proposed Coronado National Forest Plan and Draft Environmental Impact Statement mentioned astrophysical development as a possible special use for Mt. Graham. No official proposal had been made by any party for astrophysical development. Testing was taking place to determine astrophysical characteristic quality of this and other U.S. sites.

During 1983, news articles began to appear in area newspapers. The public began to express concerns.

In June 1984, Steward Observatory made an official proposal asking the Forest to consider allowing astrophysical development on Mt. Graham. The Forest began formal scoping which resulted in the initial Issues, Concerns, and Opportunities (ICOs). It was from these ICOs that the Preliminary Analysis Actions document was developed and subsequently made available to the public and special interest groups in February 1985.

In the Fall of 1984, the decision was made to include alternatives that considered astrophysical development on Mt. Graham in the Forest Plan Draft Environmental Impact Statement. In June 1985, a decision was made to prepare a separate Environmental Impact Statement (EIS) to address future management decisions for the area affected by the Mt. Graham astrophysical proposal. A Notice of Intent to prepare an EIS was published in the Federal Register on July 16, 1985. Starting in July 1985, the public was mailed the Land Management Plan documents along with a letter explaining that the astrophysical proposal would be considered in its own separate Environmental Impact Statement. This information went to over 4500 interested agencies, organizations and individuals. News articles were released.

The Forest solicited comments on the astrophysical area proposal as part of its review of the Coronado National Forest Land and Resource Management Plan. In July and August 1985, open house meetings were held in many Southeast Arizona communities.

Comments on the astrophysical proposal were encouraged at these open houses as part of the scoping process. Various interest groups, including Steward Observatory, Earth First!, Coalition for the Preservation of Mt. Graham, and the Sierra Club, disseminated information. Approximately 700 written comments have been received. Ten petitions bearing approximately 1700 signatures have also been received.

Issues, Concerns, and Opportunities (ICOs) identified in the scoping process by the public, special interest groups, U.S. Forest Service, and Arizona Game and Fish Department were reviewed by the Forest Service and the final list approved by the Regional Forester.

Issues and Opportunities Addressed

Management concerns and issues are termed "issues" and described below. They establish the scope of the EIS (40 CFR 1501.7 and 1508.25). The issues were grouped into nine subject matter areas. They can be tracked through Chapters 2 and 3 under the same headings.

Issue Description

1. PLANT AND ANIMAL DIVERSITY

Forest Service policies and goals are to sustain or improve floral and faunal diversity by: 1) providing for the conservation or recovery of all threatened, endangered, and sensitive plant and animal species and their respective habitats; 2) developing and implementing management practices to ensure that species do not elevate to a higher listing status, nor significantly impact the habitat capability of any species, because of Forest Service actions or lack of protection; 3) maintaining viable populations of all native and desired nonnative flora and fauna in habitats distributed throughout their geographic ranges on National Forest System lands; 4) maintaining special or unique habitat features or structures and habitat types to ensure ecological diversity (e.g., old growth, riparian zones, cienegas, etc.).

The Arizona (Apache) trout is a federally listed Threatened Species and the Mt. Graham Red Squirrel is proposed for listing as an Endangered Species. Other wildlife species of particular concern include the black bear and spotted owl.

The Issue Is: How will plant and animal species, communities, and habitat diversity be affected by management alternatives?

2. WATERSHED MANAGEMENT

Water quality in the Pinalenos is high. Testing for fecal coliform bacteria indicates that levels of contamination are well within the standards for all except domestic uses. Simple purification methods would allow achieving those standards. Astrophysical construction and development could increase the potential for water runoff and soil erosion, thus impacting water quality. Impacts to flora and fauna along stream channels could also occur.

Water is limited on Mt. Graham and competition for it may increase. Most of the surface water is appropriated. Questions of water rights must be resolved including the actual transfer of such rights, if necessary. Construction may impact cienegas, springs, and baseflows in creeks. An estimate of changes in water yield and timing of runoff during and following construction is needed.

Frye Canyon Watershed is closed to camping, summer homes, resorts, and commercial recreation uses to protect the municipal watershed of Safford and Thatcher by order of the Secretary of Agriculture dated May 5, 1930. A cooperative agreement dated August 12, 1912 between the Secretary of Agriculture and the Mayor of Safford, also provides for measures to conserve and protect the water supply.

Several cienegas are located near the summit of Mt. Graham. They are small wet areas characterized by high water Tables, often with some surface water, numerous water-dependent plants, and some water-dependent animals. Executive Order 11990 defines wetlands management and requirements. The Forest Supervisor has determined that cienegas are wetlands which require certain protective measures. These may include minimizing the destruction, loss, or degradation of wetlands, and their preservation or enhancement.

The Issue Is: How will water quality and quantity in the Pinaleno Mountains, Frye Watershed, and the small cienegas be affected by management alternatives?

3. RECREATION USES AND OPPORTUNITIES

Mt. Graham is one of the most popular outdoor recreation areas in southeastern Arizona. Mt. Graham provides climatic relief to desert dwellers and an opportunity to recreate in the cool conifer forest environment. The Pinalenos are one of only two mountain ranges in southeastern Arizona with paved road

access above 7000' elevation--the other being the very heavily used Mt. Lemon area. The area proposed for astrophysical use is along an unpaved road with no existing developed recreation sites. The 3500 acre area provides a variety of recreational pursuits including: hiking, camping, driving for pleasure, hunting, nature study, and berry picking. The area has been generally inaccessible during winter months because of deep unplowed snow. Astrophysical development would bring about changes in the variety and timing of recreational use.

There are no developed recreation sites nor are any planned within the 3500 acre area. A major astrophysical site could increase visitor use due to telescope interest and increased accessibility. Increased use could require visitor facilities. Possible developments include: visitor center off the Forest; snowplay (tubing) area; trailhead facilities; and vista sites. The astrophysical development could increase visitor use of existing developed picnic and camp sites along the Swift Trail.

Astrophysical instruments are extremely sensitive and there could be adverse impact to astronomical projects resulting from recreational use of nearby National Forest lands. Unrestricted public access and interference resulting from automobile lights, campfire smoke, and hunters with high-powered rifles could hamper astrophysical projects. Development and operation of observatories may warrant public use restrictions. Necessary restrictions would have to be identified by specific area, and activities.

The Issue Is: What changes in recreation use and opportunities will occur? It is important to consider: changes in seasonal and area use patterns; changes in future use by activity and number of recreationists; potential changes in the quality of recreational experiences; developed recreation sites and visitor needs for services; and opportunities for enhancement of recreation management.

4. WILDERNESS AND SPECIAL AREA DESIGNATIONS

One thousand acres of the 3500 acre area is within the Mt. Graham Roadless Area (RARE II Area #3123) as modified during the roadless area reevaluation, October 1983. None of the 1000 acres is within the Mt. Graham Wilderness Study Area (WSA) designated by the 1984 Arizona Wilderness Act. However, the Coronado National Forest is evaluating that 1000 acre tract for wilderness suitability during this environmental analysis. A 500 foot wide powerline corridor was reserved from the Wilderness Study Area by the 1984 Arizona Wilderness Act. Developments related to astrophysical needs could affect the quality of the wilderness experience for any of the WSA that may be designated wilderness.

It has been suggested by a number of individuals and groups that the Mt. Graham wet meadows and Spruce-Fir forest are ecosystems that merit designation as either Research Natural Areas (RNAs) or Zoological/Botanical Areas (ZBAs).

The Issue Is: What land, if any, should be allocated to Wilderness, RNAs or ZBAs within the Astrophysical Study Area?

5. VISUAL QUALITY

The 3500 acre area has retained its natural setting and relatively undisturbed state. Primitive roads and evidence of logging activities are the main evidence of human use. The area is managed to maintain a high level of visual quality. The current visual quality objective is retention. Introduction of telescopes and support facilities will change the landscape to include structural features.

The Issue Is: What impacts will occur to visual quality? What changes, if any, should be made in current visual quality objectives?

6. CULTURAL RESOURCES AND NATIVE AMERICAN USE

Archaeological sites are present within the proposed project area. The most appropriate treatment of these sites must be determined in consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. In addition, Native Americans have used the Pinaleno Mountains for hundreds of years.

The Zuni Indian Tribe has expressed concerns about the disposition of potential impacts to religious uses and to existing cultural resources.

The Issue Is: What is the most appropriate treatment of the archaeological sites located within the project area and how will Indian Religious practices be affected?

7. ASTROPHYSICAL VALUES AND BENEFITS

Astronomy is a basic science providing research information that is part of the scientific and cultural knowledge pool. Technological and economic developments, engineering applications, new products, and industrial growth also occur because of astronomy research. In turn, the capability and productivity of astronomy research is increasing due to technological advances of instrumentation. One of the significant limiting factors for astronomers today is available observation time at both traditional and technologically advanced facilities. Site characteristics are critical to the value of these facilities. Since modern astronomy deals with the entire light spectrum (visible and non-visible), sites may have several limiting factors. In many cases existing telescopes cannot be used to their potential because of light pollution from expanding metropolitan areas. New telescopes at these sites would be ineffective not only because of light pollution, but also because of such factors as water vapor, air pollution, or radio wave interference. These factors are especially significant for the NNTT.

Steward Observatory and the University of Arizona are recognized leaders in the field of astronomy. This is paricularly true in the field of infra-red astronomy. Scientists from around the world come to conduct research at the observatories nearby (Kitt Peak, Mt. Hopkins, Mt. Lemmon, and Mt. Bigelow) and consult with scientists in Tucson. Conversely, Steward Observatory scientists are active at telescopes the world over.

Of the telescopes proposed for location on Mt. Graham, one is built and operating -- although at less than capacity -- (Texas 5-meter), one is being built in Germany (10-meter SMT), the primary 1.8 meter mirror on the VATT has been cast, and the remainder are projected but funding has not been secured.

The Issues are:

a. What are the technological and scientific impacts attributable to development of Mt. Graham? What impacts can be expected if development does not occur?

b. What are the impacts to Steward Observatory if Mt. Graham is developed, or if it is not?

8. SOCIO-ECONOMIC IMPACTS

Mt. Graham is located in Graham County, a rural area of southeastern Arizona. Safford, with a population of 7,700, is the largest community in the county and is located at the base of Mt. Graham. Thatcher and Pima are close neighbors to the northwest. Total county population is 23,200. Agriculture, possible because of irrigation water from the Gila River, was the first industry of the county when it was settled in 1880 and remains the primary source of income today. The Phelps-Dodge copper mine in Morenci was an important employer of Graham County residents until the recent decline of the industry. Federal, state, and local governments are also important employers in the Gila Valley.

especially at Eastern Arizona College in Thatcher. Because of hard times in agriculture and copper mining and reduced government spending locally, unemployment in Graham County is 15%.

Willcox, located in northern Cochise County, is also within the socio-economic area influenced by activities on Mt. Graham. Willcox is 81 miles east of Tucson along 1-40 and the last commercial center for Mt. Graham visitors from Tucson before they turn onto Swift Trail from U.S. Highway 666.. Safford, although closer to Mt. Graham, is 9 miles past the Swift Trail junction. Gas stations, restaurants, and motels in Willcox benefit primarily from 1-40 travelers, but also pick up business from those headed for Graham County and Mt. Graham.

Arizona's economy is principally based on four industries: manufacturing, tourism, agriculture, and copper mining. Of these, manufacturing -- and most dominantly high tech manufacturing -- provides the highest employment in the state. Tucson follows a similar pattern with a doubling of manufacturing employment -- mostly in high tech firms -- in the last ten years, and a significant tourism industry. Tucson, however, differs from the state-wide pattern in that government is the largest employer in Pima County. The University of Arizona and Davis-Monthan Air Force Base each employ about 10,000.

Astronomy research and related industries is a unique feature of the Tucson and Arizona economy. In 1982-83 almost $34 million was spent by astronomy research facilities in Arizona, directly employing 860 people. About 90% of the funding for astronomical activities comes from Federal sources.

The Issues Are:

a. How would development of an observatory on Mt. Graham impact the Graham County/Willcox area economically and sociologically? What sort of impacts could be expected during construction: and during operations with an associated increase in tourism?

b. Will development of Mt. Graham have any significant effect on Pima County (Tucson) or the state as a whole?

9. SAFETY/PROTECTION

Occasionally during dry periods, there will be danger of wildfire damage to facilities and equipment as well as possible danger to people in the area. It may be necessary to conduct prescribed fuels reduction for wildlife habitat management and fire hazard reduction. Smoke resulting from prescribed burns or wildfires may adversely affect astrophysical equipment and projects.

Astrophysical development will require winter access. This could lead to a demand for access by the public during the winter months. Astrophysical development on Mt. Graham could endanger visitors at construction sites or by meeting trucks or heavy equipment on narrow mountain roadways.

The Issues Are:

a. How will the Forest fuels treatment program be adjusted to meet the needs of wildlife and to protect the Mt. Graham area?

b. What measures would be employed to manage winter access and public safety?

c. What closures to public use will be necessary to protect both Forest visitors and astrophysical efforts?

G. READER'S GUIDE This Reader's Guide is provided to assist the reader's understanding of the subject matter in subsequent chapters.

Chapter 2 Alternatives Including the Proposed Action. This chapter summarizes information and analysis presented in Chapter 3. The environmental impacts of the preferred alternative are compared to other alternatives. This chapter provides the basis for choice among the various options. Issue resolution of each alternative is also compared.

Chapter 3 Affected Environment and Environmental Consequences. This chapter describes the environment of the area affected by the alternatives under consideration including the physical and biological setting, the socioeconomic setting, and current resource situation and management for specific resources. Information is presented that discloses the environmental impacts of all alternatives. any adverse environmental effects which cannot be avoided, and relationship between short-term uses of the environment and maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources.

Chapter 4 List of Preparers. This chapter lists people who were primarily responsible for preparing the EIS. or significant background papers.

Chapter 5 Consultation With Others. This chapter lists the businesses, industries. organizations, federal agencies. Native American. individuals, local governments and/or officials. State agencies and/or officials, and others that received the EIS .

References.

Glossary.

Appendices.

1 - Astrophysical
2 - Wildlife
3 - Recreational Use and Opportunities
4 - Socio-Economic
5 - Water
6 - Standards and Guidelines for the Forest Service Preferred Alternative (PA)

Index.

A. OVERVIEW

This chapter presents the Forest Service Preferred Alternative, alternatives considered in detail, and alternatives considered but eliminated from detailed study. Major environmental impacts associated with the alternatives are presented in comparative form based on information and analysis presented in Chapter 3 and the Appendices. Comparisons displayed were selected because they address the issues, concerns, and opportunities described in Chapter 1, and show major differences between the Forest Service Preferred Alternative (PA) and the other alternatives considered in detail.

Alternatives described and presented in this chapter address the Issues, Concerns, and Opportunities in varying degrees. The alternatives propose different strategies for managing the lands within the 3500 acres. Each alternative is a unique combination of management prescriptions applied to the land. As a result, each would generate a different mix of services for the public, and a different combination of land uses and environmental effects.

B. ALTERNATIVE DEVELOPMENT PROCESS

The process of formulating alternatives responded to a number of regulatory requirements. Regulations (40 CFR 1502.14) for implementing the procedural provisions of the National Environmental Policy Act (NEPA) require that agencies:

Rigorously explore and objectively evaluate all reasonable alternatives. For alternatives that were eliminated from detailed study, briefly discuss the reasons for their elimination.

Devote substantial treatment to each alternative considered in detail including the Preferred Alternative so reviewers may evaluate their comparative merits.

Include reasonable alternatives not within the jurisdiction of the lead agency.

Formulate reasonable alternatives which may require a change in existing law or policy to implement, if necessary, to address a major public issue, management concern, or resource opportunity identified during the planning process.

Include a No Action Alternative.

Identify the agency's preferred alternative.

Include appropriate mitigation measures not already included in the Forest Service Preferred Alternative or other alternatives.

In addition, alternatives shall provide different ways to address and respond to the major public issues, management concerns, and resource opportunties identified during the planning process.

C. ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

This section deals with those alternatives considered and subsequently eliminated from further study. The reasons they were not considered further are presented.

Aerial Transportation Alternatives

a. Helicopter Access

The reasons for elimination of daily helicopter access are: high cost of operation and maintenance; unreliable weather conditions; safety; daily high noise levels; inability to safely transport heavy and/or large pieces of telescopes; limited number of persons per flight; and payload limitations on helicopter use at high elevations.

The usefulness of helicopter access would be limited to emergency health and safety situations.

b. Tramway Access

Although the Forest Service is not proposing to fund or to build a tramway and no one in the public sector has come forth with a tramway proposal and/or funding, two types of tramways have been considered: a reversible tramway and a gondola system. The reversible tramway would require only two towers, the gondola system four to six towers. Neither the tramway nor the gondola system can handle mirrors or telescope parts that can weigh up to 30 tons apiece. The gondola system cannot be adapted to handle this kind of transport at all. The tramway system would require special equipment at additional costs and still could not handle the largest sized payloads and dimensions.[1]

Transport of humans is possible by either method. A gondola system would require at least three or four terminal clearings with passengers changing from one gondola to another. A tramway would need only two towers. The major objection to a tramway or gondola for human transport is the large investment costs.[2] While a tramway could physically accomplish the job of human transport, its cost/benefit ratio, even without considering environmental impacts, is considered poor by experts in the field.[1,2,3]

The environmental impacts of a tramway or gondola cannot be adequately assessed because there is no proposed project and the two possible routes are only vaguely defined (see Section 6.4.6 Office of Arid Land Studies Environmental Data Report). In general, a gondola system would require extensive timber cutting because the longest length of continuous circulation is 7,000 to 10,000 feet. A tramway or gondola would require terminal clearings. A road and a shuttle bus would be necessary to carry visitors from the summit terminal to the telescopes or other destinations. It could also lessen the wilderness quality of surrounding land. Tramway impacts would not eliminate roadway impacts which must be done for materials and telescope transport as well as the interferometer movement.

In summary, the tramway is not useful to transport construction materials and telescope parts. It is not economically feasible with the predicted visitor use patterns over the next 15 years. It would have a significant environmental impact on the mountain and on land allocation policies.

Less Development Alternatives

Astrophysical development with less development than the minimum development alternatives.

Any project smaller than the minimum development alternatives are considered by Steward Observatory to be economically unacceptable. A smaller project would not meet the goals of Steward Observatory:

"(1) To maintain a world-class astronomical research and teaching program at the University of Arizona." "(2) To bring to Arizona first-class national and international astronomy projects and the technological base that attends such activities."[4]

Other Land Based Location Alternatives

The scope of this DEIS deals with the land allocation decision for the defined 3,500 acre Proposed Mt. Graham Astrophysical Area. Evaluation of other locations and considerations are outside the scope of this Environmental Impact Statement.

The reasons for eliminating the following alternatives are summarized below. More detail can be found in this EIS Chapter 1 sections A and B. and the Office of Arid Land Studies Environmental Data Report sections 2.2.2 through 2.2.6.

Space-based Astronomy Alternative

The overriding limitation is development costs. Space-based telescopes may cost 500 times the equivalent (same sized) ground-based telescope. Repair costs are much more expensive than ground-based telescopes. Instrumentation costs are also much higher. The size of launchable telescopes is small to moderate (e.g.. 1.0-2.5 meters). Many of the astronomical problems can, at the moment, only be solved with large light gathering power and hence large telescopes. Space telescopes are over subscribed; thus limiting chances for many astronomers to use them. The technology (designing, building and testing orbital telescopes) is too new to replace ground-based astronomy in the near future.

Use of Steward Observatory's Existing Sites

Alternative - Put more telescopes or replace telescopes on Steward Observatory's already existing sites or other nearby existing sites.

Because of light pollution, large optical/IR telescopes cannot be placed near Tucson. One site near Mt. Lemon is only marginally suitable for submillimeter telescopes due to radio pollution effects. Only a single-purpose IR (infrared) telescope has a variety of sites available (Catalina and Mt. Hopkins). Single-purpose IR telescopes are not considered cost-effective at large size and none are planned.

Observation Time

Alternative - Increase observation time at existing telescopes.

The ratio of total observing time requested to total time available is termed the "oversubscription" rate for telescopes. The oversubscription rates for international, national and Steward Observatory ground-based telescopes generally are by factors of two or more. The oversubscription rate for ground-based telescopes has held constant for over ten years and it does not appear that it would relax in the next ten.

Existing Worldwide Developed Sites

Alternative - Locate Steward Observatory's telescopes on other worldwide sites that are already in use.

Only two developed sites exist worldwide that could fulfill astronomical requirements and have room for new telescopes. These observatories are in Hawaii and Chile. The Science Reserve on Mauna Kea, Hawaii would fulfill all the astrophsycial requirements. However, the current plan for the Science Reserve has only three remaining telescope sites. This would not adequately fulfill Steward Observatory's needs. Existing Chilean sites would fulfill optical and most IR (infrared) requirements but elevation is too

low for submillimeter telescopes. Hawaii and Chile are distant from Steward Observatory and would pose logistic and travel cost limitations.

Research Natural Area Proposals

Several environmental groups proposed that three cienega watersheds be designated as research natural areas (RNA). Areas from 12 to 53 acres in size were considered for RNA designation. RNA designation was not included in the alternatives considered in detail because the proposed areas failed to meet established criteria for RNA's. In the west, 300 acres is generally considered the minimum size for an adequate RNA and the proposed areas are much smaller than the minimum. The cienega areas have not been identified as ecosystems to be represented in the National RNA system from the Southwestern Region. Finally, there is no clearly demonstrated research need that would be met by RNA designation of the cienega areas.

FOOTNOTES

1. Site Development Plan, Ibid, and personal communications with Charles Dwyer, Forest Service Chief Aerial Engineer, Denver, Colorado.
2. Office of Arid Land Studies Environmental Data Report, Appendix 5-I and Section 5.2.15.2 p.302.
3. Site Development Plan for the Mt. Graham International Observatory, 1985.
4. Steward Observatory Program Review, Peter Strittmatter, Director, Steward Observatory, 1984.

D. ALTERNATIVES CONSIDERED IN DETAIL

Nondevelopment Alternatives (A, B, and C do not allow astrophysical development.)

Alternative A

(Figure 2-A)

Response to Issues, Concerns, and Opportunities:

Alternative A is the No Action Alternative required by the NEPA regulations. This provides a base for comparison of other alternatives by projecting existing management into the future.

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activitities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 20% risk that the Mt. Graham red squirrel would become extinct within 30 years.

Plant diversity will shift because old growth acres are declining. Animal diversity is maintained for most species. Old growth species such as the Mt. Graham red squirrel may not be maintained in the long term. The character of the existing cienegas would be maintained. Riparian ecosystems are maintained by natural succession; Apache trout habitat is maintained. Tree resources are managed under uneven-aged management to remove the older age classes (120 years and older). The removal of older age classes decrease the critical habitat acres of the Mt. Graham red squirrel. Prescribed fire would be used to improve wildlife habitat.

Water quality and water quantity would be maintained in the Pinaleno Mountains, Frye Watershed, and the cienegas within the 3500 acre area.

Recreation management on all 3500 acres would emphasize dispersed recreation opportunities in a predominantly natural or natural appearing environment. The recreation opportunity spectrum (ROS) settings are semi-primitive motorized and roaded natural. Both motorized and non-motorized recreation

activities are available. Use of motorized vehicles would *be* restricted to existing trails and roads. Some trails may be closed to motorized vehicles for safety, resource protection, and user conflict reasons. Sawtimber and fuelwood harvest would be compatible with recreation oriented opportunities.

See Table 15, Chapter 2 for recreation use and facility matrix.

There would be no special area designations such as wilderness or zoological/botanical areas.

The existing character of cienega watersheds would be maintained.

The 3 500 acre area would be open to mining and oil and gas leasing. Exploration and development of common variety minerals for use as aggregate material must be based on needs identified in transportation plans.

The visual quality objective is retention (see Glossary, Visual Quality Objective). The landscape on-site and from the distant view points would essentially remain unchanged.

Cultural resource protection is emphasized. Before surface-disturbing activities occur, the specific land area would be inventoried for cultural resources and Native American religious use.

Astrophysical development would not occur in this alternative.

Wildfires of all types would be aggressively suppressed to protect resource values. Fuel treatment may consist of chipping, broadcast burning, piling and burning, or lopping and scattering; or utilization of dead and down material for fuelwood. Public safety and access remains unchanged from current Forest Service policy; Swift Trail and Forest Road 507 access will not be limited or closed to vehicular traffic, except when limited or closed by snow.

Alternative B
(Figure 2-B)

Response to Issues, Concerns, and Opportunities:

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activitities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 20% risk that the Mt. Graham red squirrel would become extinct within 30 years.

Plant and animal diversity would be affected as additional old growth acres increase over time through natural succession. Habitat for old growth species such as the Mt. Graham red squirrel would be maintained in the long term. The character of the existing cienegas would be maintained. Riparian ecosystems would be maintained by natural succession; Apache trout habitat would be maintained. Natural regeneration of trees would be emphasized in the fuelbreak along Forest Road 507.

Water quality and water quantity would be maintained in the Pinaleno Mountains, Frye Watershed, and the cienegas within the 3500 acre area.

Recreation management on all 3500 acres would emphasize dispersed recreation opportunities in a predominantly natural or natural appearing environment. The recreation opportunity spectrum (ROS) settings are semi-primitive motorized and roaded natural. Both motorized and non-motorized recreation activities would be available. Use of motorized vehicles would be restricted to existing roads. All trails would be closed to motorized vehicles. Existing roads determined to be unneeded would be closed

(Forest Roads 507 and 669 would remain open). Opportunities for non-motorized recreation would be increased.

See Table 15, Chapter 2 for recreation use and facility matrix.

There would be no special area designations such as wilderness or zoological/botanical areas.

The existing character of the cienega watersheds would be maintained.

The 3,500 acre area would be open to mining and oil and gas leasing. Exploration and development of common variety minerals for use as aggregate material must be based on needs identified in transportation plans.

The visual quality objective would be retention (see Glossary, Visual Quality Objective). The landscape on-site and from the distant view points would essentially remain unchanged.

Cultural resource protection would be emphasized. Before surface-disturbing activities occur, the specific land area would be inventoried for cultural resources and Native American religious use.

Astrophysical development would not occur in this alternative.

There would be no commercial timber or fuelwood sales. Permits for removal of dead and down fuelwood material may be issued.

Wildfire suppression of all types would be aggressively suppressed to protect resource values. Trails would be closed to motorized vehicle use and unneeded roads closed. Otherwise access would be the same as in alternative A.

Alternative C
(Figure 2-C)

Response to Issues, Concerns, and Opportunities:

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 20% risk that the Mt. Graham red squirrel would become extinct within 30 years.

All existing roads in the 3500 acres, including Forest Roads 507 and 669, would be closed and revegetated. All trails would be closed to motorized use.

Plant diversity would change as old growth acres increase over the long term. Habitat would be improved for old growth species such as the Mt. Graham red squirrel in the long term. The character of the existing cienegas would be maintained. Riparian ecosystems would be maintained by natural succession; Apache trout habitat would be maintained. There would be no commercial sawtimber or fuelwood sales. Natural succession would increase the acres of old growth timber habitat. The habitat acres of the Mt. Graham red squirrel would increase. Natural regeneration of trees would be emphasized in the fuelbreak along Forest Road 507.

Water quality and water quantity would be maintained in the Pinaleno Mountains, Frye Watershed, and the cienegas within the 3500 acre area.

Recreation management on 1,820 acres (area 1 Figure 2-C) would emphasize dispersed recreation opportunities in a predominantly natural or natural appearing environment. The recreation opportunity spectrum (ROS) setting would be semi-primitive non-motorized; there would be no motorized travel activities.

On 1000 acres (area 4 Figure 2-C): Recreation management would emphasize a predominantly natural environment with a recreation opportunity spectrum setting of primitive.

On 680 acres (area 2 Figure 2-C): Recreation management would emphasize a predominantly natural or natural appearing environment with a recreation opportunity spectrum setting of semi-primitive non-motorized.

See Table 15, Chapter 2 for recreation use and facility matrix.

There would be special area designations: 1000 acres (area 4 Figure 2-C) would be managed and recommended for wilderness designation. An area of approximately 680 acres (area 2 Figure 2-C), above 10,000 feet elevation, would be managed as a zoological/botanical area (ZBA) to perpetuate the Mt. Graham red squirrel and Spruce-Fir forest.

Mineral withdrawal would be recommended for all 1,680 acres of special area designations (including the 1000 acres proposed for wilderness).

The existing character of cienega watersheds would be maintained.

Interpretive and educational opportunities exist and would be developed for the special designated areas.

The visual quality objective would be retention for all acres except wilderness which would be preservation (see Glossary, Visual Quality Objectives). The landscape on-site would gradually become more natural appearing, while the appearance from distant viewpoints would essentially remain unchanged.

Cultural resource protection is emphasized. Before surface-disturbing activities occur, the specific land area would be inventoried for cultural resources and Native American religious use.

Astrophysical development would not occur in this alternative.

There would be no commercial sawtimber or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued (note no motorized access allowed).

Wildfire suppression and fuels treatment would be the same as in alternative B. The exception to this is area 4 Figure 2-C (wilderness) where prescribed fire could only be used to reduce risk from wildfire, or allow lightning caused fires to more nearly play their natural ecological role, or to enhance wilderness values. There would be no motorized access into the 3500 acre area. Forest Roads 507 and 669 would be closed, water barred, and revegetated.

Astrophysical Development Alternatives D, E, F and Forest Service Preferred Alternative (PA)

All 3500 acres would be recommended for mineral withdrawal in alternatives D, E, F, and Forest Service Preferred Alternative (PA).

Relationship of Proposed Development Phases to Alternatives:

1. Steward Observatory has divided their astrophysical development proposal into implementation phases based on anticipated financing and technology development (See Chapter 1). These phases of implementation are not alternatives. Any development alternative selected would likely be implemented in phases. There is a relationship to the development alternatives and the three phases of the proponents original proposal. This relationship is shown here for informational purposes.

Note: Alternative D is phase 1, a powerline plus two telescopes from phase 2 (either one large and one small or two small telescopes).

Alternative E is phase 1, phase 2, one telescope from phase 3, and the interferometer.

Alternative F is phase 1, phase 2, and phase 3 complete.

The Forest Service Preferred Alternative (PA) is similar to Alternative D, but telescope siting is more clustered.

2. For purposes of this EIS, the implementation (phasing) of any development alternative is not discussed in further detail except where it has a direct bearing on environmental consequences.

Proposed Logistical Site Locations for Development Alternatives D, E, F and Forest Service Preferred Alternative (PA)

Three logistical sites have been proposed. Only one logistics site would be **developed and would contain the: generator building, Texas support building, equipment garage, meteorological tower/communications building, shop area, site engineer's residence, water storage tanks, and helicopter landing pad (approximately 350 square feet for emergency use only). Any dormitory would be located off Forest in alternative D and Forest Service Preferred Alternative (PA). In alternatives E** and F a dormitory would be located in one of the logistic sites identified.

Conceptual layouts of the proposed sites are shown in Figures 16, 18, and 22 in Appendix 1.

Logistic sites 12 or 13 (L-12 and L-13) are considered for development in **alternatives D and E. Logistic sites 12, 13, or 14 (L-12, L-13, and L-14) are considered for development in alternative F. Only logistics site L-13 is considered for development in the Forest Service Preferred Alternative** (PA). (See Figure 2-F and Appendix 1).

Logistics Site 12: **L-12** is two acres in size at an elevation of **10,470** feet. It is within the **proposed area for telescope construction and restricted use (clustered) in all the development alternatives. Site L-12 is located adjacent to Forest Road 507 below the junction of Forest Roads 507 and 669. L-12 is part of the proposed spur road to sites 6 and 7.**

Logistics Site 13: L-13 is two acres in size at an elevation of 10,600 feet. It is within the proposed area for telescope construction and restricted use (clustered) in all the development alternatives. It is in the Bearwallow watershed and adjacent to the trail to Bearwallow Spring. Site L-13 is located near High Peak, adjacent to Forest Road 507, and above the junction of Forest Roads 507 and 669.

Logistics Site **14: L-14 is two acres in size at an elevation of 9,800 feet. It is not within the proposed area for telescope construction (not clustered) in any of the development alternatives. Site L-14 is located adjacent to Forest Road 507 approximately 0.8 miles below the lowest proposed astrophysical site (site 11). It is located near a trailhead, at the headwaters of an unnamed seep or cienega, and adjacent to a major bear trail.**

Alternative D
(Figure 2-D)

Alternative D provides for minimum astrophysical development on up to 15 acres. Three tightly clustered astrophysical sites (sites 3, 6, and 7) would be developed. Of the 13 telescopes proposed by Steward Observatory, 5 telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, and one smalland one large optical/IR telescope. The National New Technology Telescope (NNTT) and interferometer would not be developed. Two logistics sites would be considered; only one would be selected. There would be no dormitory or visitor center on the Forest. Special restrictions would be proposed for 284 acres (area 5 Figure 2-D). Only one high environmental impact site (site 3, High Peak) is developed.

Response to Issues, Concerns, and Opportunities:

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 45% risk that the Mt. Graham red squirrel would become extinct within 30 years.

Plant and animal diversity on 1801 acres (area 1 Figure 2-D) would be the same as alternative B.

Natural regeneration of trees would be emphasized in the fuelbreak (80 acres) along Forest Road 507.

The existing character of the cienega watersheds would be maintained.

Plant and animal diversity on 1,400 acres (areas 2 and 4 Figure 2-D), would be the same as in alternative C.

On 284 acres (area 5 Figure 2-D); plant and animal diversity would be maintained for most species. Losses would occur due to man's increased activities, noise, lights, and odors. These factors would result in displacement of species and avoidance of habitat in and around the project. Tree resources would be managed to increase the acres of old growth timber habitat. The habitat acres for the Mt. Graham red squirrel would not increase. The population of Mt. Graham red squirrel is more likely to decrease than to increase in the long term. Natural regeneration of trees would be emphasized in the fuelbreak along Forest Road 507. There would be no commercial sawtimber or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued. Prescribed fire would not be used in the 284 acres surrounding the astrophysical development.

Up to 15 acres for exclusive astrophysical use (Figure 2-D) would be cleared of all vegetation and its wildlife habitat.

Water quality and water quantity would be maintained in the Pinaleno Mountains, Frye Watershed, and the cienegas within the 3500 acre area. All toxic waste chemicals would be hauled off the Forest to a suitable treatment facility. Garbage and trash would be hauled off Forest to a suitable disposal site. A septic tank and drainage field combination is preferred for sewage and gray water disposal. Material removed from septic tank(s) would be hauled off Forest to a suitable disposal site. Topsoil would be stockpiled and redistributed to provide a fertile base, and slopes would be revegetated with species of plants currently found on the mountain. Cut material (soil and rock) from construction sites not used as fill or for revegetation would be hauled off the Forest to a suitable disposal site. Construction and operation activities would not be allowed within the cienega watersheds. All domestic and construction water needed on site would be hauled from a location off the Forest. During construction phases, areas would be cleared only for construction planned in that year.

Recreation management on 1801 acres (area 1 Figure 2-D) would be the same as alternative B.

A snow play area would be identified and a snow plowed area would be provided for parking (Figure 5. Chapter 3) by Steward Observatory.

Interpretive and educational opportunities exist for the natural and physical sciences on and/or off Forest. Signs, displays, literature and/or talks relative to the environment on Mt. Graham could be presented.

On 1000 acres (area 4 Figure 2-D): Recreation management would emphasize a predominantly natural environment with a recreation opportunity spectrum setting of primitive.

On 400 acres (area 2 Figure 2-D): Recreation management would emphasize a natural or natural appearing environment with a recreation opportunity spectrum setting of semi-primitive motorized.

On 284 acres (area 5 Figure 2-D): Recreation management would emphasize a predominantly natural appearing environment with a recreation opportunity spectrum setting of roaded natural.

Restricted Use (Buffer Zone) Area 284.0 acres (Surrounding the Exclusive Use acres)
- -No hunting
- -No headlights
- -No campfires (Nighttime)
- -Radio transmissions controlled
- -Hiking allowed
- -Dispersed camping/picnicking
- -Public access; daylight drive-in only, restricted wet weather and night driving (all year).
- -No pets

On 15 acres (exclusive astrophysical use): Recreation management would emphasize a substantially urbanized environment with a recreation opportunity spectrum setting of urban. A public picnic site, restroom facility, scenic viewpoint, and amateur astronomy vista would be developed by Steward Observatory.

Exclusive Use (Astrophysical Use) Area-15.0 acres
- -No camping, hiking or camp fires
- -Fences contain telescope sites/areas
- -Roadways blocked at night; limited daytime public access
- -Radio transmissions controlled
- -No hunting

See Table 15. Chapter 2 for recreation use and facility matrix.

There would be special area designations: 1000 acres (area 4 Figure 2-D) would be managed and recommended for wilderness designation. An area of approximately 400 acres (area 2 Figure 2-D), above 10,200 feet elevation, would be managed as a zoological/botanical area (ZBA) to perpetuate the Mt. Graham red squirrel and Spruce-Fir forest.

All 3,500 acres would be recommended for mineral withdrawal (including the 1000 acres of proposed wilderness).

The visual quality objective would be: Retention on 2201 acres (areas 1 and 2 Figure 2-D). Preservation on 1000 acres (area 4 Figure 2-D). Partial retention on 284 acres (within area 5 Figure 2-D). The visual diversity of the area would increase. Structures would be visible from distant viewpoints. The visual quality objective would be changed to maximum modification on 15 acres of exclusive astrophysical use within area 5 (Figure 2-D). Trees would remain dominant and continuous along skylines. Trees could be used to partially screen structures from public view. In general, for all telescope structures, all but the southerly aspects of the structures would use colors that blend into the landscape. Tree cutting would be minimized; this objective would be included in the structural design. Areas within the astrophysical construction sites could be shaped and revegetated to help screen structures from public view. When possible, astrophysical sites should be higher than Forest Road 507 and designed to fit natural contours.

Cultural resource protection is emphasized. Before surface-disturbing activities occur, the specific land area would be inventoried for cultural resources and Native American religious use. Within area 5 (Figure 2-D) rock cairns site AR03-05-04-103 is located. Avoidance of the site should be possible. If avoidance is not possible, it must be more fully examined; i.e. evaluated formally in terms of the National Register of Historic Places eligibility criteria. A second cultural resource site is located within the exclusive astrophysical use area (Figure 2-0). This site (AR03-05-04-102) would be difficult to avoid and impacts to the site cannot be avoided if development occurs. A specific course of action to mitigate impacts to this significant site would be finalized after Zuni religious leaders provide their recommendations to the Forest. Final clearance would be granted only after consultation with the State Historic Preservation Office, the Advisory Council on Historic Preservation, and the Zuni Tribe.

Astrophysical Values and Benefits: A world-class astronomical research and teaching program at the University of Arizona would be maintained. The State of Arizona would have the opportunity to participate in national and international astronomy projects. Arizona's technological base would continue to grow with these activities. Arizona would also benefit from increased education and research opportunities that funding of these activities would bring. Other benefits would be: Basic knowledge (understanding laws of nature and man's place in the universe); Practical knowledge (understanding the solar system); Technical Developments (optics, computer/image analysis, light sensors/receivers); Commercial benefits (new companies, source of income/employment, cooperation in product development, spin-off high technology companies that market products originally based on astronomical research in Arizona); Education (teaching basic science).

Wildfire suppression and fuels treatment would be the same as in alternative B. An exception to this is area 4 Figure 2-D (wilderness) where prescribed fire could only be used to reduce risk from wildfires. or allow lightning caused fires to more nearly play their natural ecological role, or to enhance wilderness values. Steward Observatory would be notified of schedule, size, and location of all prescribed burns in the Pinaleno Mountains.

Public Safety and Access: Forest Road 507 would remain unpaved, but widened an average of 7 feet (including curves). This widening would take approximately 4 acres of mostly non-cienega meadow type and some mixed conifer. Steward Observatory would provide for snow removal on Swift Trail and Forest Road 507 as needed for astrophysical access. Signs would be posted on Swift Trail warning that roads might not remain passable on a continual basis during periods of snow. Vehicle access would be limited to vehicles with tire chains and/or four-wheel drive above the snowline. If traction aids are necessary, sand or gravel would be used; use of ash, salts, or other chemicals would be prohibited. A 12 foot high snow fence would be installed by Steward Observatory at milepost 1.8 to reduce snow drifting on to FR 507. Steward Observatory would have improvement and maintenance responsibilities on Forest Road 507. The maximum steepness for cuts and fills required for road improvements would be 1 1/4:1. During astrophysical construction. Swift Trail and Forest Road 507 would have periods of restricted public access (traffic control) for safety considerations.

Alternative E
(Figure 2-E)

This alternative places as many telescopes on as few sites as possible. The two sites which can contain the most telescopes (High Peak and Emerald Peak) are developed. The two sites have room for 11 of 13 telescopes. Alternative E provides for astrophysical development on up to 31 acres. Astrophysical sites 1 and 3 would be developed. Of the 13 telescopes proposed by Steward Observatory, 11 telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, four small and two large optical/IR telescopes. The following two telescopes could be developed: The National New Technology Telescope (NNTT) and/or an interferometer consisting of six separate structures that can be arranged and re-arranged in a "Y" shaped array along Forest Roads 507 and 669. Two logistics sites would be considered; only one would be selected. A visitor center would be off forest, with shuttle service to the exclusive use areas for the public provided by Steward Observatory or private enterprise. A dormitory (on Forest) would be constructed on the logistics site. It would house approximately 25 astrophysical staff/observers. Special public use restrictions would be proposed for 738 acres (area 5 Figure 2-E).

Response to Issues, Concerns, and Opportunities:

A visitor center would be off forest, with shuttle service to the exclusive use areas for the public provided by Steward Observatory or private enterprise.

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 50% risk that the Mt. Graham red squirrel would become extinct within 30 years.

Plant and animal diversity on 2,582 acres (area 1 Figure 2-E) would be the same as alternative B.

Natural regeneration of trees would be emphasized in the fuelbreak (80 acres) along Forest Road 507.

The existing character of the cienega watersheds would be maintained.

Plant and animal diversity on 150 acres (area 2 Figure 2-E) would be the same as in alternative C.

On 738 acres (area 5 Figure 2-E): Plant and animal diversity would be maintained for most species. Losses would occur due to man's increased activities, noise, lights, and odors. These factors would result in displacement of species and avoidance of habitat in and around the project. Tree resources would be managed to increase the acres of old growth timber habitat. The habitat acres for the Mt. Graham red squirrel would not increase in the long term. The probability of the population of the Mt. Graham red squirrel decreasing is greater than in alternative D. There would be no commercial sawtimber or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued. Natural regeneration of trees would be emphasized in the fuelbreak along Forest Road 507. Prescribed fire would not be used in the 738 acres surrounding the astrophysical development.

Up to 31 acres for exclusive astrophysical use (Figure 2-E) would be cleared of all vegetation and its wildlife habitat.

Water quality and water quantity would be maintained in the Pinaleno Mountains, Frye Watershed, and the cienegas within the 3500 acre area. All toxic waste chemicals would be hauled off the Forest to a suitable treatment facility. Garbage and trash would be hauled off Forest to a suitable disposal site. A septic tank and drainage field combination is preferred for sewage and gray water disposal. Material

removed from septic tank(s) would be hauled off Forest to a suitable disposal site. Topsoil would be stockpiled and redistributed to provide a fertile base and slopes would be revegetated with species of plants currently found on the mountain. Cut material (soil and rock) from construction sites not used as fill or for revegetation would be hauled off the Forest to a suitable disposal site. Construction and operation activities would not be allowed within the cienega watersheds. All domestic and construction water needed on site in construction phase 1 would be hauled from a location off the Forest. In construction phase 2 water would continue to be hauled; water could be taken from Deadman Creek as long as a sufficient level of water remained available for the maintenance of the existing aquatic/riparian life (flora and fauna) and state water rights obtained. During construction phases, areas would be cleared only for construction planned in that year.

Recreation management on 2,582 acres (area 1 Figure 2-E) would be the same as alternative B.

A snow play area would be identified and a snow plowed area would be provided for parking (Figure 5, Chapter 3) by Steward Observatory.

Interpretive and educational opportunities exist for the natural and physical sciences on and/or off Forest. Signs, displays, literature and/or talks relative to the environment on Mt. Graham could be presented.

On 150 acres (area 2 Figure 2-E): Recreation management would emphasize a natural or natural appearing environment with a recreation opportunity spectrum setting of semi-primitive motorized.

On 738 acres (area 5 Figure 2-E): Recreation management would emphasize a predominantly natural appearing environment with a recreation opportunity spectrum setting of roaded natural.

Restricted Use (Buffer Zone) Area 738 acres (Surrounding the Exclusive Use acres)
- -No hunting
- -No headlights
- -No campfires (Nighttime)
- -Radio transmissions controlled
- -Hiking allowed
- -Designated camping/picnicking areas
- -Public access; daylight drive-in only and restricted night driving (all year).
- -No pets

On 31 acres (exclusive astrophysical use): Recreation management would emphasize a substantially urbanized environment with a recreation opportunity spectrum setting of urban. A public picnic site, restroom facility, scenic viewpoint, and amateur astronomy vista would be developed by Steward Observatory.

Exclusive Use (Astrophysical Use) Area-31 acres:
- -No camping, hiking or camp fires
- -Fences contain telescope sites/areas
- -Roadways blocked at night; limited daytime public access
- -Radio transmissions controlled
- -No hunting

See Table 15, Chapter 2 for recreation use and facility matrix.

There would be a special area designation: An area of approximately 150 acres (area 2 Figure 2-E), above 10,200 feet elevation, would be managed as a zoological/botanical area (ZBA) to perpetuate the Mt. Graham red squirrel and Spruce-Fir forest.

All 3,500 acres would be recommended for mineral withdrawal.

The visual quality objectives would be: Retention on 2,732 acres (areas 1 and 2 Figure 2-E). Partial retention on 738 acres (within area 5 Figure 2-E). Structures would be visible from distant viewpoints and would be more obvious than alternative D. The visual quality objective would be changed to maximum modification on 31 acres of exclusive astrophysical use within area 5 (Figure 2-E). Trees would remain dominant and continuous along skylines where practical. The NNTT would dominate the landscape and the skyline. Trees could be used to partially screen structures from public view. In general, for all telescope structures, all but the southerly aspects of the structures would use colors that blend into the landscape. Tree cutting would be minimized; this objective would be included in the structural design. Areas within the astrophysical construction sites could be shaped and revegetated to help screen structures from public view. When possible astrophysical sites should be higher than Forest Roads 507 and 669 and designed to fit natural contours.

Cultural resource protection is emphasized. Before surface-disturbing activities occur, the specific land area would be inventoried for cultural resources and Native American religious use. Cultural resource site AR03-05-04-101 lies within area 5 (Figure 2-E) and appears to be avoidable. Periodic monitoring would occur to determine if any indirect effects to the site occur. Within area 5 (Figure 2-E) rock cairns site AR03-05-04-103 is located. Avoidance of the site should be possible. If avoidance is not possible, it must be more fully examined, i.e. evaluated formally in terms of the National Register of Historic Places eligibility criteria. A second cultural resource site is located within the exclusive astrophysical use area (Figure 2-E). This site (AR03-05-04-102) would be difficult to avoid and impacts to the site cannot be avoided if development occurs. A specific course of action to mitigate impacts to this significant site would be finalized after Zuni religious leaders provide their recommendations to the Forest. Final clearance would be granted only after consultation with the State Historic Preservation Office, the Advisory Council on Historic Preservation, and the Zuni Tribe.

Astrophysical Values and Benefits: A world-class astronomical research and teaching program at the University of Arizona would be maintained or expanded. The State of Arizona would have the opportunity to participate in national and international astronomy projects. Arizona's technological base would continue to grow with these activities. Arizona would also benefit from increased education and research opportunities that funding of these activities would bring. Other benefits would be: Basic knowledge (understanding laws of nature and man's place in the universe); Practical knowledge (understanding the solar system); Technical Developments (optics, computer/image analysis, light sensors/receivers); Commercial benefits (new companies, source of income/employment, cooperation in product development, spin-off high technology companies that market products originally based on astronomical research in Arizona); Education (teaching basic science).

Wildfire suppression and fuels treatment would be the same as in alternative B. Steward Observatory would be notified of schedule, size, and location of all prescribed burns in the Pinaleno Moutains.

Public Safety and Access: Forest Road 507 would be paved and Forest Road 669 could be paved. Both Forest Roads 507 and 669 would also be widened as in alternative D. With the interferometer Forest Roads 507 and 669 would be widened to approximately 28 feet. Steward Observatory would provide for snow removal on Swift Trail and Forest Roads 507 and 669 as needed for astrophysical access. Signs would be posted on Swift Trail warning that roads might not remain passable on a continual basis during periods of snow. Vehicle access would be limited to vehicles with tire chains and/or four-wheel drive above the snowline. If traction aids are necessary, sand or gravel would be used; use of ash, salts, or other chemicals would be prohibited. A 12 foot high snow fence would be installed by Steward Observatory at milepost 1.8 to reduce snow drifting on to FR 507. Steward Observatory would have improvement and maintenance responsibilities on Forest Roads 507 and 669. The maximum steepness for cuts and fills required for road improvements would be 1 1/4:1. During astrophysical construction, Swift Trail and Forest Roads 507 and 669 would have periods of restricted public access (traffic control) for safety considerations.

Alternative F
(Figure 2-F)

This alternative would give Steward Observatory the maximum flexibility to choose sites with the greatest image sharpness. The results could be scattered or clustered. There could be as few as three sites and as many as five chosen for development.

The National Environmental Policy Act (NEPA) guidelines require "flexible" alternatives, such as alternative F, to have all possibilities analyzed within the proposal. The environmental impacts of implementing alternative F would be less than portrayed in Chapter 3 (Affected Environment and Environmental Consequences) when up to 5 development sites are selected.

This astrophysical development alternative is Steward Observatory's proposal. Alternative F provides for astrophysical development on up to 60 acres. Astrophysical sites 1 through 11 would be considered and up to 5 sites would be selected for development. All 13 telescopes proposed by Steward Observatory could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, five small and three large optical/IR telescopes. The following two telescopes could be developed: The National New Technology Telescope (NNTT) and/or an interferometer consisting of six separate structures that can be arranged and re-arranged in a "Y" shaped array along Forest Roads 507 and 669. Three logistics sites would be considered; only one would be selected. A visitor center would be off forest, with shuttle service to the exclusive use areas for the public provided by Steward Observatory or private enterprise. A dormitory (on Forest) would be constructed on the logistics site. It would house 40 astrophysical staff/observers. Special public use restrictions would be proposed for 1240 acres (area 5 Figure 2-F).

Response to Issues. Concerns, and Opportunities:

A visitor center would be off forest, with shuttle service to the exclusive use areas for the public provided by Steward Observatory or private enterprise.

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 50% risk that the Mt. Graham red squirrel would become extinct within 30 years.

Plant and animal diversity on 2,188 acres (area 1 Figure 2-F) would be the same as alternative B.

Natural regeneration of trees is emphasized in the fuelbreak (80 acres) along Forest Road 507.

On 1,240 acres (area 5 Figure 2-F): Plant and animal diversity would be maintained for most species. Losses would occur due to man's increased activities, noise, lights, and odors. These factors would result in displacement of species and avoidance of habitat in and around the project. Tree resources would be managed to increase the acres of old growth timber habitat. The habitat acres for the Mt. Graham red squirrel would not increase in the long term. The probability of the population of the Mt. Graham red squirrel decreasing is the same as in alternative E, but there is no chance of the population strongly increasing. There would be no commercial sawtimber or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued. Natural regeneration of trees is emphasized in the fuelbreak along Forest Road 507. Prescribed fire would not be used in the 1,240 acres surrounding the astrophysical development.

Up to 60 acres for exclusive astrophysical use (Figure 2-F) would be cleared of all vegetation and its wildlife habitat.

Water quality and water quantity would be the same as in alternative E. During construction phases, areas would be cleared only for construction planned in that year.

Recreation management on 2,200 acres (area 1 Figure 2-F) would be the same as alternative B.

Interpretive and educational opportunities exist for the natural and physical sciences on and/or off Forest. Signs, displays, literature and/or talks relative to the environment on Mt. Graham could be presented.

On 1,240 acres (area 5 Figure 2-F): Recreation management would emphasize a predominantly natural appearing environment with a recreation opportunity spectrum setting of roaded natural.

Restricted Use (Buffer Zone) Area 1,240 acres (Surrounding the Exclusive Use acres)
- -No hunting
- -No headlights
- -No campfires (Nighttime)
- -Radio transmissions controlled
- -Hiking allowed
- -Designated camping/picnicking by permit only
- -Public access; prohibited public driving (day-night, all year). Access by shuttle or walk-in.
- -No pets

On 60 acres (exclusive astrophysical use): Recreation management would emphasize a substantially urbanized environment with a recreation opportunity spectrum setting of urban. A public picnic site, restroom facility, scenic viewpoint, and amateur astronomy vista would be developed by Steward Observatory.

Exclusive Use (Astrophysical Use) Area-60 acres
- -No camping, hiking or camp fires
- -Fences contain telescope sites/areas
- -Roadways blocked at night; limited daytime public access (by shuttle or walk-in)
- -Radio transmissions controlled
- -No hunting

See Table 15. Chapter 2 for recreation use and facility matrix.

There would be no special area designations.

The existing character of cienega watersheds would be maintained.

All 3,500 acres would be recommended for mineral withdrawal.

The visual quality objectives would be: Retention on 2,200 acres (areas 1 and 3 Figure 2-F). Partial retention on 1,240 acres (within area 5 Figure 2-F). Structures would be visible from distant viewpoints and would be most obvious in this alternative. The visual quality objective would be changed to maximum modification on 60 acres of exclusive astrophysical use within area 5 (Figure 2-F). Trees would remain dominant and continuous along skylines where practical. The NNTT would dominate the landscape and the skyline. Trees could be used to partially screen structures from public view. In general, for all telescope structures, all but the southerly aspects of the structures would use colors that blend into the landscape. Tree cutting would be minimized; this objective would be included in the structural design. Areas within the astrophysical construction sites could be shaped and revegetated to

help screen structures from public view. When possible astrophysical sites should be higher than Forest Roads 507 and 669 and designed to fit natural contours.

Cultural resources and native American religious use would be the same as in alternative E (see Figure 2-F instead of Figure 2-E).

Astrophysical values and benefits would be slightly increased above alternative E because of two additional optical/IR telescopes. A world-class astronomical research and teaching program at the University of Arizona would be maintained or expanded. The State of Arizona would have the opportunity to participate in national and international astronomy projects. Arizona's technological base would continue to grow with these activities. Arizona would also benefit from increased education and research opportunities that funding of these activities would bring. Other benefits would be: Basic knowledge (understanding laws of nature and man's place in the universe); Practical knowledge (understanding the solar system); Technical Developments (optics, computer/image analysis, light sensors/receivers); Commercial benefits (new companies, source of income/employment, cooperation in product development, spin-off high technology companies that market products originally based on astronomical research in Arizona); Education (teaching basic science).

Wildfire suppression and fuels treatment would be the same as in alternative B. All mitigation measures would be the same as in alternative E.

Public safety would be improved over alternative E; public access would be by shuttle or walk-in only in the restricted use area (see Figure 2-F area 5).

Forest Service Preferred Alternative (PA)
(Figure 2-PA)

The Forest Service Preferred Alternative (PA) is more clustered than alternative D and eliminates man's development activities from environmentally sensitive sites 6 and 7; reduces exclusive use acres from 15 to 7; increases public access; eliminates possible development impacts on High Peak Cienega watershed; reduces development impacts on Bearwallow Cienega watershed; reduces restricted use acres from 284 to 123; reduces risk of extinction of the Mt. Graham red squirrel from 45% to 35%; increases zoological/botanical area acres from 400 to 569.

The astrophysical site (site 3 and logistics site L-13) are clustered and involve only the High Peak area. Structures and spur roads at these sites would be located and/or adjusted to avoid any Mt. Graham red squirrel middens. L-13 would be moved out of the Bearwallow Cienega but would still be located in the restricted use area. This minimum development alternative reduces disturbed acreage by 53 percent and buffer zone by approximately 169 acres as compared to alternative D. Because of the pattern of clustering, this alternative protects cienegas more than any other development alternative. Only one high impact environmental site (site 3, High Peak) is developed.

The Forest Service Preferred Alternative (PA) provides for minimum astrophysical development on up to 7 acres. A tightly clustered astrophysical site (site 3) would be developed. Of the 13 telescopes proposed by Steward Observatory, 5 telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, and one small and one large optical/IR telescope. The National New Technology Telescope (NNTT) and interferometer would not be developed. One logistics site would be considered (L-13). There would be no dormitory or visitor center on the Forest. Special public use restrictions would be proposed for 123 acres (area 5 Figure 2-PA).

Response to Issues, Concerns, and Opportunities:

The Forest Service Preferred Alternative (PA) would manage 1801 acres (area 1 Figure 2-PA) as in alternative B, except that commercial sawtimber and fuelwood sales could occur. However any timber harvest activities other than sanitation/salvage would be done only to benefit specific wildlife (Mt. Graham red squirrel) or recreation values after consultation with the appropriate parties, e.g. U.S. Fish and Wildlife Service, Forest Biologist, and Arizona Game and Fish Department.

A recovery plan for the Mt. Graham red squirrel would be developed. Any future land management activities within the critical habitat would require consultation on the Mt. Graham red squirrel with the U.S. Fish and Wildlife Service.

In the short term, there is a 35% risk that the Mt. Graham red squirrel would become extinct within 30 years.

Natural regeneration of trees would be emphasized in the fuelbreak (80 acres) along Forest Road 507.

Plant and animal diversity on 1,569 acres (areas 2 and 4 Figure 2-PA), would be the same as in alternative C.

On 123 acres (area 5 Figure 2-PA): plant and animal diversity would be maintained for most species. Losses would occur due to man's increased activities, noise, lights, and odors. These factors would result in displacement of species and avoidance of habitat in and around the project. Tree resources would be managed to increase the acres of old growth timber habitat. The habitat acres for the Mt. Graham red squirrel would not increase in the long term. The probability of the population of Mt. Graham red squirrel is more likely to decrease than to increase in the long term. Natural regeneration of trees would be emphasized in the fuelbreak along Forest Road 507. There would be no commercial sawtimber or fuelwood sales. Permits for removal of dead and down fuelwood material could be issued. Prescribed fire would not be used in the 123 acres surrounding the astrophysical development.

Up to 7 acres for exclusive astrophysical use (Figure 2-PA) would be cleared of all vegetation and its wildlife habitat.

Water quality and water quantity would be maintained in the Pinaleno Mountains, Frye Watershed, and the cienegas within the 3500 acre area. All toxic waste chemicals would be hauled off the Forest to a suitable treatment facility. Garbage and trash would be hauled off Forest to a suitable disposal site. A septic tank and drainage field combination is preferred for sewage and gray water disposal. Material removed from septic tank(s) would be hauled off Forest to a suitable disposal site. Topsoil would be stockpiled and redistributed to provide a fertile base, and slopes would be revegetated with species of plants currently found on the mountain. Cut material (soil and rock) from construction sites not used as fill or for revegetation would be hauled off the Forest to a suitable disposal site. Construction and operation activities would not be allowed within the cienega watersheds. All domestic and construction water needed on site would be hauled from a location off the Forest. During construction phases, areas would be cleared only for construction planned for in that year.

Recreation management on 1801 acres (area 1 Figure 2-PA) would be the same as alternative B.

A snow play area would be identified and a snow plowed area would be provided for parking (Figure 5, Chapter 3) by Steward Observatory.

Interpretive and educational opportunities exist for the natural and physical sciences on and/or off Forest. Signs, displays, literature and/or talks relative to the environment on Mt. Graham could be presented.

On 1000 acres (area 4 Figure 2-PA): Recreation management would emphasize a predominantly natural environment with a recreation opportunity spectrum setting of primitive.

On 569 acres (area 2 Figure 2-PA): Recreation management would emphasize a natural or natural appearing environment with a recreation opportunity spectrum setting of semi-primitive motorized.

On 123 acres (area 5 Figure 2-PA): Recreation management would emphasize a predominantly natural appearing environment with a recreation opportunity spectrum setting of roaded natural.

Restricted Use (Buffer Zone) Area 123 acres (Surrounding the Exclusive Use acres)

- -No hunting
- -No headlights
- -No campfires (Nighttime)
- -Radio transmissions controlled
- -Hiking allowed
- -Dispersed camping/picnicking
- -Public access; daylight drive-in only, restricted wet weather and night driving (all year), Forest Road 507
- -Public access and use of Forest Road 669 remains open
- -No pets

On 7 acres (exclusive astrophysical use): Recreation management would emphasize a substantially urbanized environment with a recreation opportunity spectrum setting of urban. A public picnic site, restroom facility, scenic viewpoint, and amateur astronomy vista would be developed by Steward Observatory.

Exclusive Use (Astrophysical Use) Area - 7 acres

- -No camping, hiking or camp fires
- -Fences contain telescope sites/areas
- -Roadways blocked at night; limited daytime public access
- -Radio transmissions controlled
- -No hunting

See Table 15, Chapter 2 for recreation use and facility matrix.

There would be special area designations: 1000 acres (area 4 Figure 2 -PA) would be managed and recommended for wilderness designation. An area of approximately 569 acres (area 2 Figure 2-PA), above 10,200 feet elevation, would be managed as a zoological/botanical area (ZBA) to perpetuate the Mt. Graham red squirrel and Spruce-Fir forest.

The existing character of the cienega watersheds would be maintained.

All 3,500 acres would be recommended for mineral withdrawal (including the 1000 acres of proposed wilderness).

The visual quality objective would be: Retention on 2370 acres (areas 1 and 2 Figure 2-PA). Preservation on 1000 acres (area 4 Figure 2-PA). Partial retention on 123 acres (within area 5 Figure 2-PA). The visual diversity of the area would increase. Structures would be visible from distant viewpoints. The visual quality objective would be changed to maximum modification on 7 acres of exclusive astrophysical use within area 5 (Figure 2-PA). Trees would remain dominant and continuous along skylines. Trees could be used to partially screen structures from public view. In general, for all telescope structures, all but the southerly aspects of the structures would use colors that blend into the landscape. Tree cutting would be minimized; this objective would be included in the structural design. Areas within the astrophysical construction sites could be shaped and revegetated to help

screen structures from public view. When possible, astrophysical sites should be higher than Forest Road 507 and designed to fit natural contours.

Cultural resource protection is emphasized. Before surface-disturbing activities occur, the specific land area would be inventoried for cultural resources and Native American religious use. Within area 5 (Figure 2-PA) rock cairns site AR03-05-04-103 is located. Avoidance of the site should be possible. If avoidance is not possible, it must be more fully examined; i.e. evaluated formally in terms of the National Register of Historic Places eligibility criteria. A second cultural resource site is located within the exclusive astrophysical use area (Figure 2-PA). This site (AR03-05-04-102) would be difficult to avoid and impacts to the site cannot be avoided if development occurs. A specific course of action to mitigate impacts to this significant site would be finalized after Zuni religious leaders provide their recommendations to the Forest. Final clearance would be granted only after consultation with the State Historic Preservation Office, the Advisory Council on Historic Preservation, and the Zuni Tribe.

Astrophysical Values and Benefits: A world-class astronomical research and teaching program at the University of Arizona would be maintained. The State of Arizona would have the opportunity to participate in national and international astronomy projects. Arizona's technological base would continue to grow with these activities. Arizona would also benefit from increased education and research opportunities that funding of these activities would bring. Other benefits would be: Basic knowledge (understanding laws of nature and man's place in the universe); Practical knowledge (understanding the solar system); Technical Developments (optics, computer/image analysis, light sensors/receivers); Commercial benefits (new companies, source of income/employment, cooperation in product development, spin-off high technology companies that market products originally based on astronomical research in Arizona); Education (teaching basic science).

Wildfire suppression and fuels treatment would be the same as in alternative B. An exception to this is area 4 Figure 2-PA (wilderness) where prescribed fire could only be used to reduce risk from wildfires, or allow lightning caused fires to more nearly play their natural ecological role, or to enhance wilderness values. Steward Observatory would be notified of schedule, size, and location of all prescribed burns in the Pinaleno Mountains.

Public Safety and Access: Forest Road 507 would remain unpaved, but widened an average of 7 feet (including curves). This widening would take approximately 4 acres of mostly non-cienega meadow type and some mixed conifer. Steward Observatory would provide for snow removal on Swift Trail and Forest Road 507 as needed for astrophysical access. Signs would be posted on Swift Trail warning that roads might not remain passable on a continual basis during periods of snow. Vehicle access would be limited to vehicles with tire chains and/or four-wheel drive above the snowline. If traction aids are necessary, sand or gravel would be used; use of ash, salts, or other chemicals would be prohibited. A 12 foot high snow fence would be installed by Steward Observato:y at milepost 1.8 to reduce snow drifting on to FR 507. Steward Observatory would have improvement and maintenance responsibilities on Forest Road 507. The maximum steepness for cuts and fills required for road improvements would be 1 1/4:1. During astrophysical construction, Swift Trail and Forest Road 507 would have periods of restricted public access (traffic control) for safety considerations.

Public access and use of Forest Road 669 would remain open except when closed by weather conditions. Steward Observatory would not snow plow nor maintain Forest Road 669.

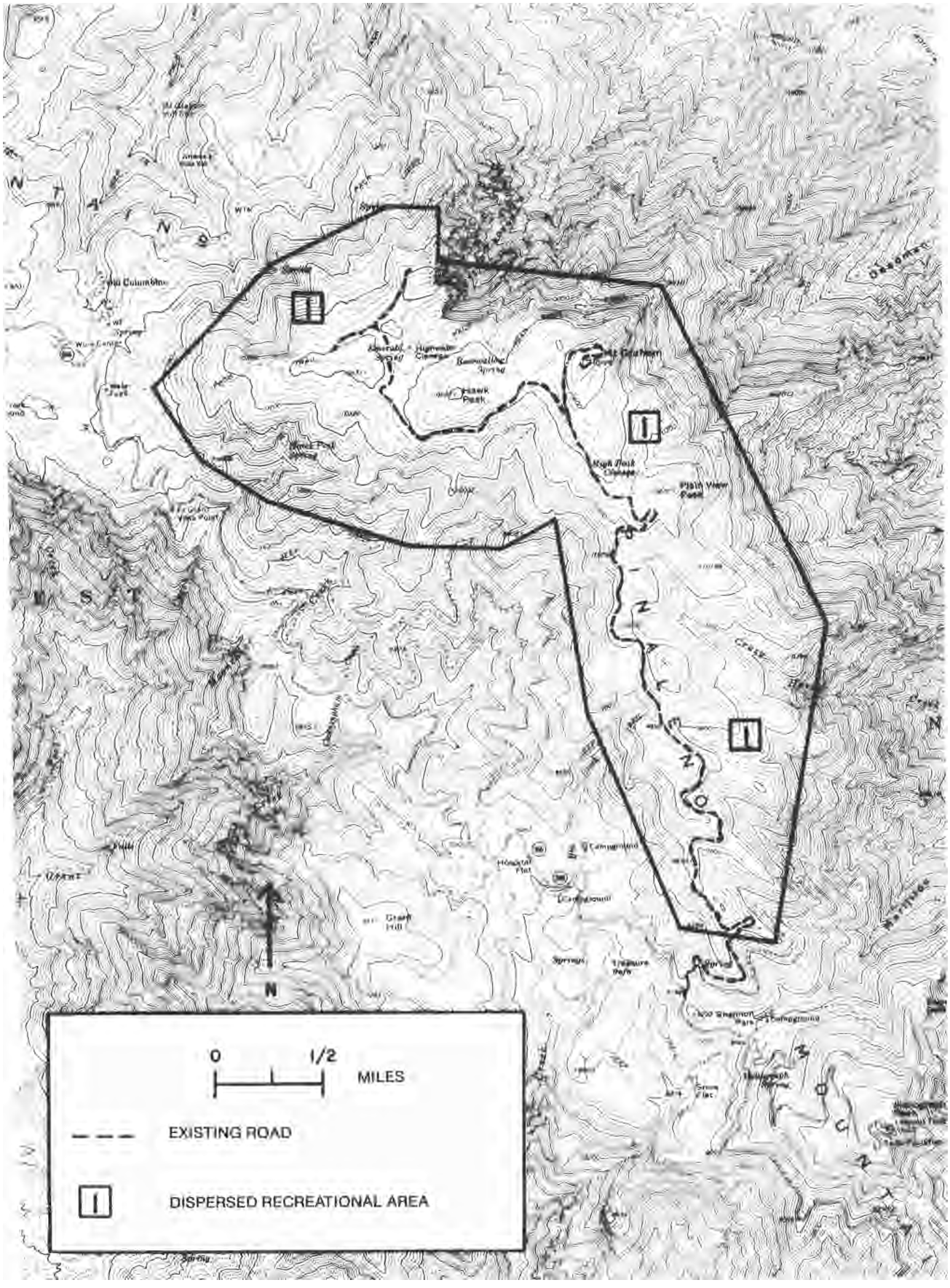

Figure 2-A

ALTERNATIVE A

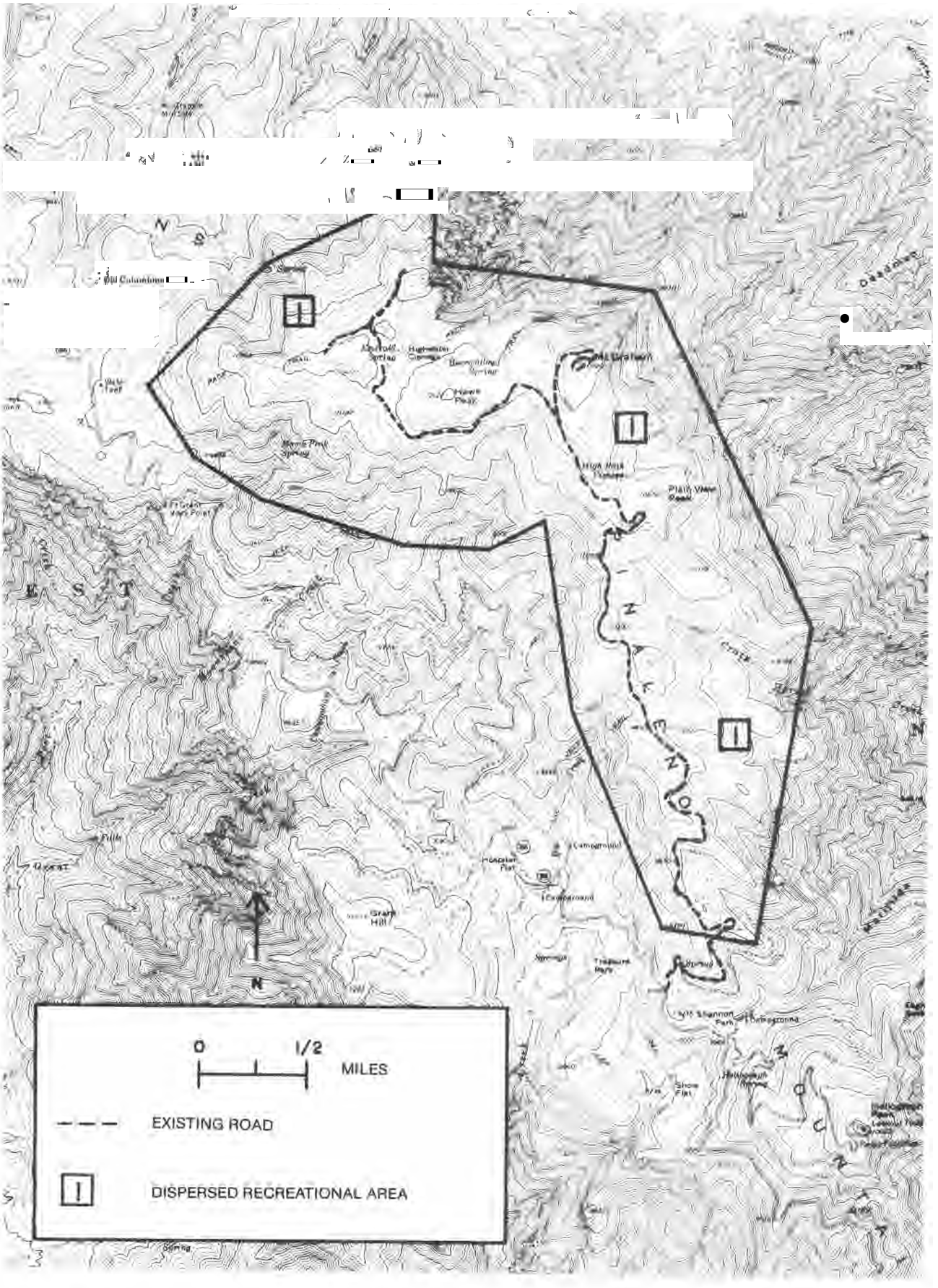

Figure 2-B

ALTERNATIVE B

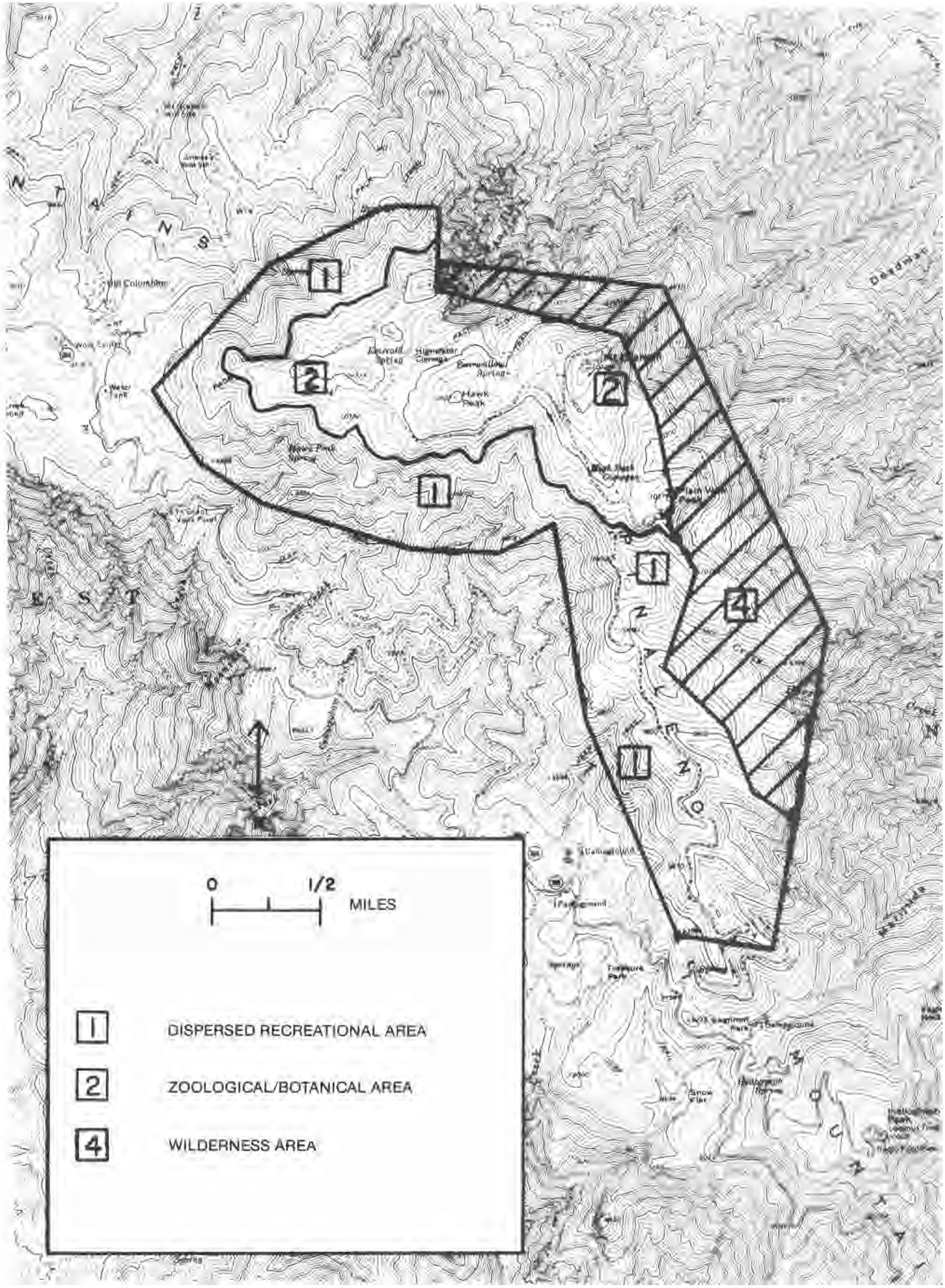

Figure 2-C **ALTERNATIVE C**

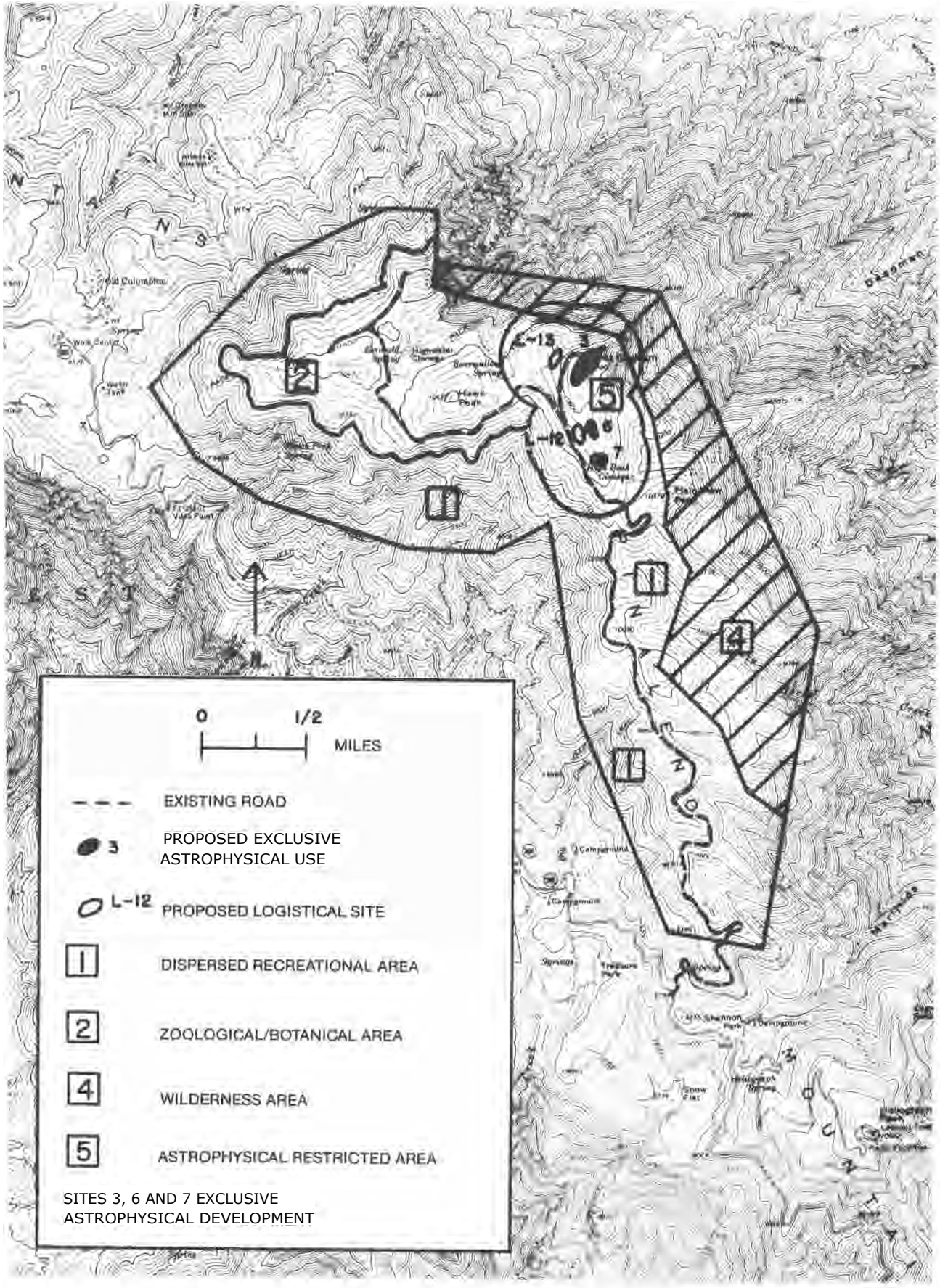

Figure 2-D

ALTERNATIVE D

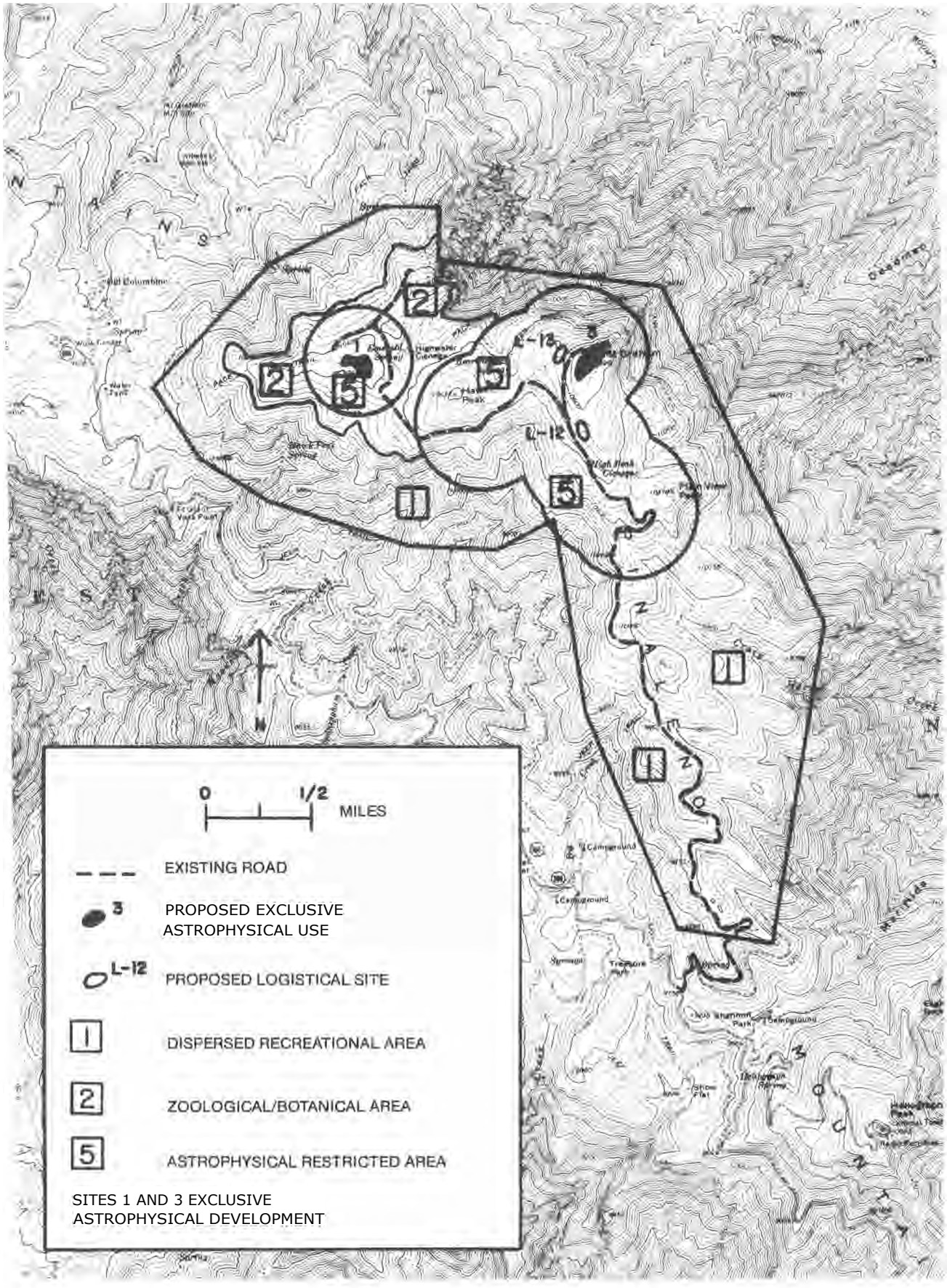

Figure 2-E **ALTERNATIVE E**

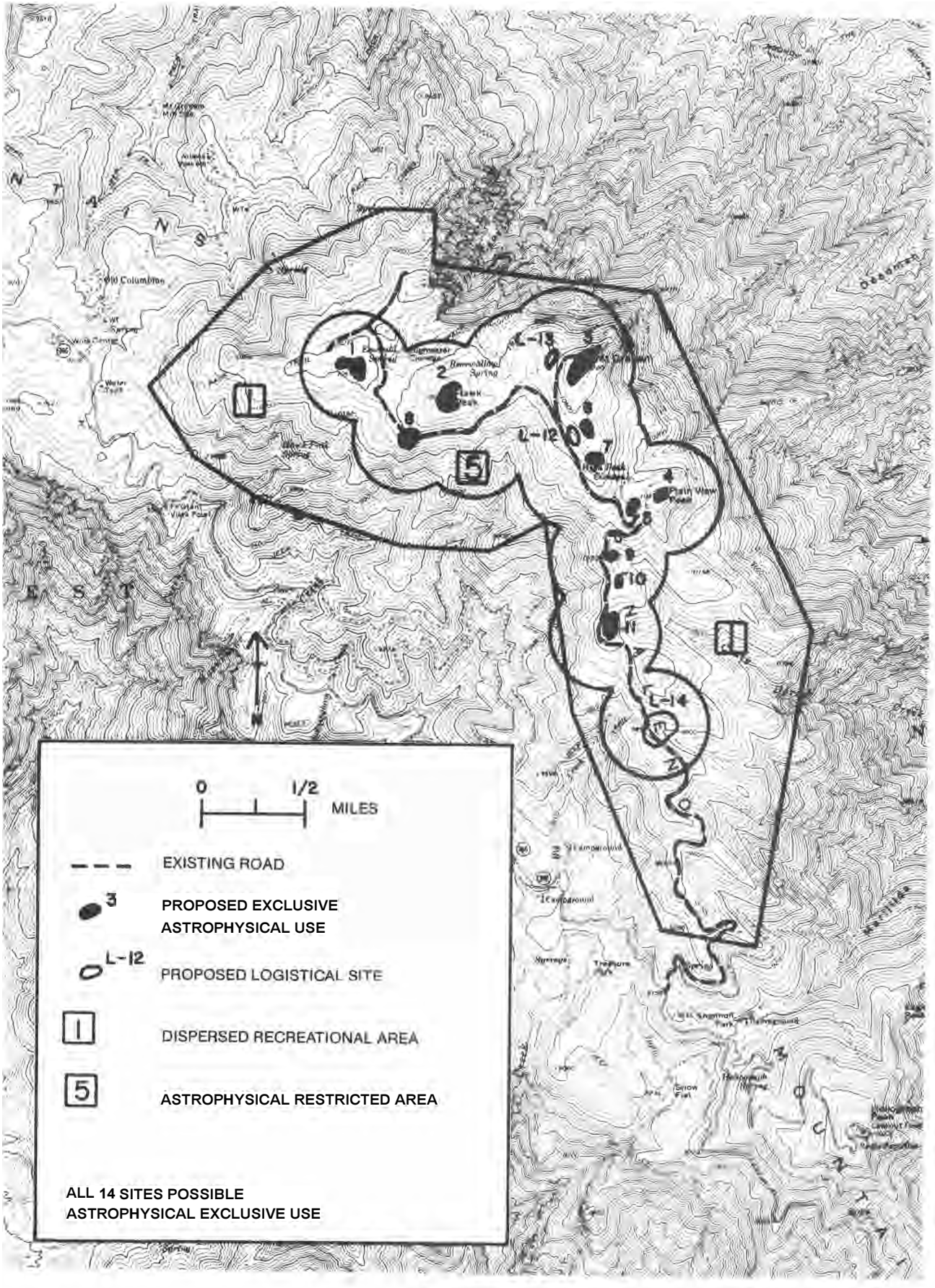

Figure 2-F

ALTERNATIVE F

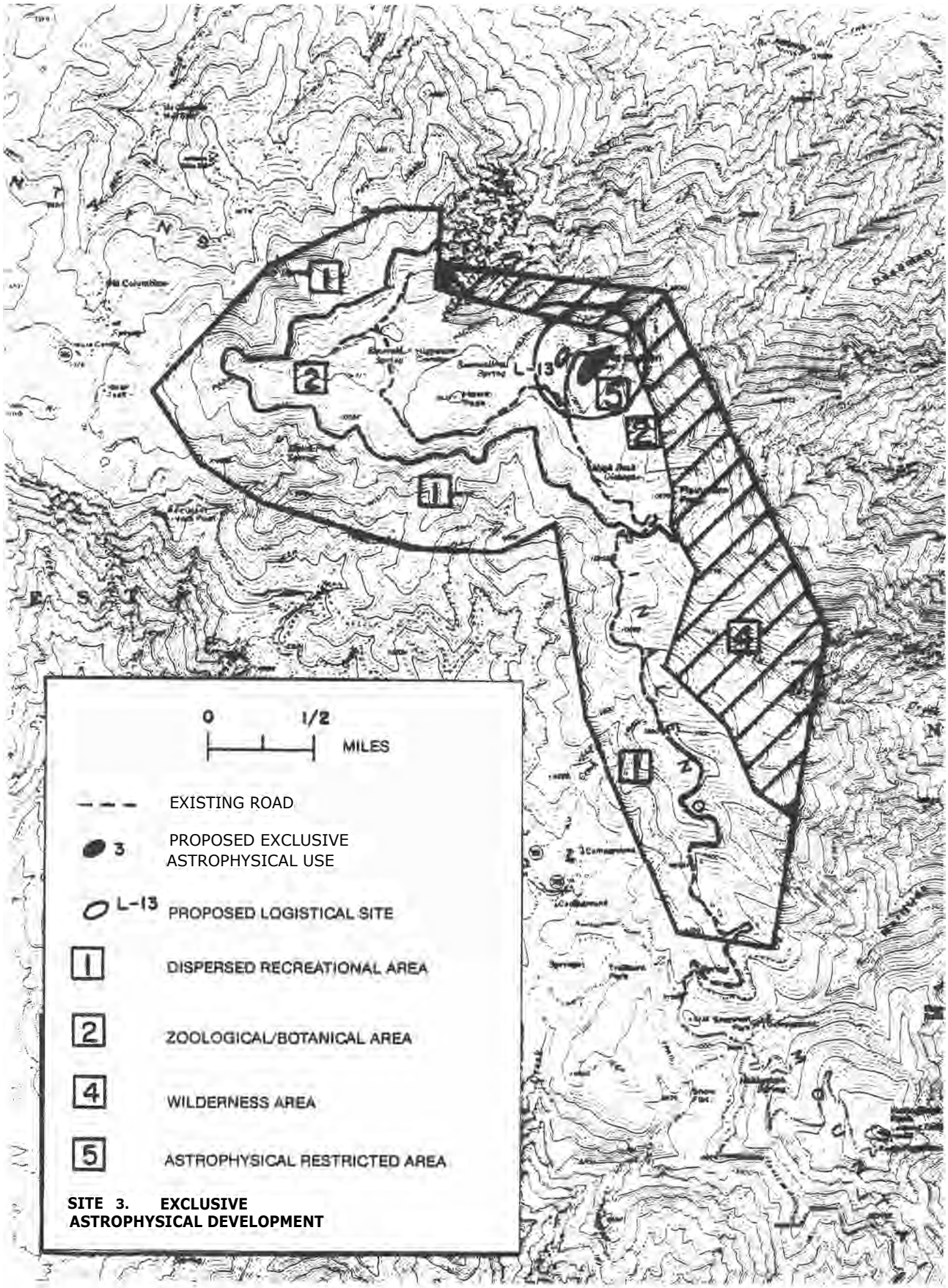

Figure 2-PA FOREST SERVICE PREFERRED ALTERNATIVE

E. ISSUE COMPARISON BY ALTERNATIVE

Selected issues are one of the major factors that drive the planning process. They help determine the scope of the analysis and the nature and range of alternatives considered. An important comparison among alternatives is to compare how well each alternative addresses the selected issues. The following tables compare how each alternative responds to each of the selected issues. More detailed discussions of specific environmental effects can be found in Chapter 3.

Issue 1 - Plant and Animal Diversity

The following table compares changes in the Spruce-Fir and mixed conifer vegetation zones within the primary habitat types on Mt. Graham (see vegetation discussion in Chapter 3 for more detailed habitat type descriptions). The vegetation changes are expressed in terms of total acres of vegetation lost because of the exclusive use allocation and percent change from present acres by decade. A comparison of estimated Mt. Graham red squirrel populations and probability of extinction are presented to show animal diversity changes for each decade.

Estimated Mt. Graham red squirrel populations described below are based only on direct impacts to the one acre home range around each primary midden. Present squirrel population is 114 in the 3,500 acre area.

Table 5 - Diversity and Risk of Extinction

	Alternatives						
Vegetation	A	B	C	D	E	F	PA
Spruce Fir Zone (680 acres above 10,200 feet) (exclusive use acres)	0	0	0	15	31	53	7
Period 1 (% change)	0	0	0	-2%	-2%	-2%	-1%
Period 2 (% change)	0	0	0	-	-3%	-6%	
Period 3 (% change)	0	0	0	-	-	-	-
Period 4 (% change)	0	0	0		-	-	-
Period 5 (% change)	0	0	0	-	-	-	-
Total % change	0	0	0	-2%	-5%	-8%	-1%
Mixed Conifer Zone (2,820 acres) (exclusive use acres)	0	0	0	0	0	7	0
Period 1 (% change)	-0.6%	0	0	0	0	-0.2%	0
Period 2 (% change)	-0.6%	0	0	0	0	0	0
Period 3 (% change)	-0.6%	0	0	0	0	0	0
Period 4 (% change)	-0.6%	0	0	0	0	0	0
Period 5 (% change)	-0.6%	0	0	0	0	0	0
Total % Change	-3.0	0	0	0	0	-0.2	0

Table 5 - Diversity (continued)

Red Squirrel	Alternatives A	B	C	D	E	F	PA
Spruce Fir Zone (680 acres - 92 red squirrels present)							
Period 1 (numbers)	92	92	92	89	89	89	89
Period 2 (numbers)	92	92	92	77	81	69	89
Period 3 (numbers)	92	92	92	77	78	66	89
Period 4 (numbers)	92	92	92	77	78	66	89
Period 5 (numbers)	92	92	92	77	78	66	89
Sub-Total: (numbers)	92	92	92	77	78	66	89

Red Squirrel	Alternatives A	B	C	D	E	F	PA
Mixed Conifer Zone (2,820 acres - 22 red squirrels present)							
Period 1 (numbers)	22	22	22	22	22	22	22
Period 2 (numbers)	22	22	22	22	22	22	22
Period 3 (numbers)	22	22	22	22	22	22	22
Period 4 (numbers)	22	22	22	22	22	22	22
Period 5 (numbers)	22	22	22	22	22	22	22
Sub-Total:numbers (red squirrels)	22	22	22	22	22	22	22
Total red squirrels in 3500 acres (numbers)	114	114	114	99	100	88	111

Red Squirrel	Alternative A	B	C	D	E	F	PA
% Risk of Extinction within 30 Years	20	20	20	45	50	50	35

Vegetation. Development of Mt. Graham as an astrophysical site would require some exclusive use site allocations in the Spruce-Fir vegetation zone (680 acres). The greatest allocation (53 acres) would be required in Alternative F with Alternatives E, D, and PA requiring 31, 15, and 7 acres, respectively. No site allocations in the Spruce-Fir would occur in Alternatives A, B, and C.

No exclusive use allocations in the mixed conifer zone (2820 acres) would occur in alternatives A, B, C, D, E, and PA. Alternative F would require an allocation of 7 acres. Vegetative treatment in the mixed conifer zone would occur in alternative A to meet insect/disease and timber salvage objectives. This small amount of treatment would be accomplished using individual tree selection silviculture and cause small annual changes in age class distributions. This results in a total change of 3 percent in the mixed conifer acreage over 50 years.

Red Squirrel. Current red squirrel popoulations (114 squirrels) would be affected in the Spruce-Fir zone. No direct effects to squirrel populations are noted below the Spruce-Fir zone (10,200 foot elevation). The greatest decline in squirrel populations is estimated for Alternative F where animal numbers fall to 85 by the third decade. Numbers in Alternatives D, E, and PA would reduce to 99, 100, and 111, respectively. Alternatives A, B, and C are not estimated to have any effect on existing population numbers.

An analysis was conducted to predict the risk of Mt. Graham red squirrel extinction within 30 years for each alternative (See Chapter 3 for more detail). In Alternatives A, B, and C the risk of extinction is a twenty percent probability. Development of Mt. Graham as an astrophysical site would increase the risk of extinction. The greater the level of development, the greater the risk. In Alternatives F, E, D, and PA the risks are 50, 50, 45, and 35 respectively.

Issue 2 - Watershed Management

Analysis of watershed effects to water quantity and quality did not reveal any significant environmental effects in any of the alternatives. Water quality would remain high in all alternatives. Water quantity changes would show more variability due to normal seasonal rain and snowfall fluctuations than any direct effects predicted for alternatives. Short-term water quality and quantity effects from astrophysical facility construction (Alternatives D, E, F, and PA) may occur, but for the most part can be mitigated and are considered insignificant (See Chapter 3 for more detailed discussion).

Issue 3 - Recreation Uses and Opportunities

The following table compares the estimated levels of recreation visitor days for the 3,500 acre management area and for the balance of the Pinaleno Mountains. Information is also disclosed as to how recreation opportunity varies by alternative. More detailed discussions of recreation use and opportunities are presented in Chapter 3.

Table 6 - Recreation Uses and Opportunities

Recreation Visitor Days (RVDs) in thousands of RVDs per year (MRVD) for the 3500 Acre Management Area:

	Alternatives						
	A	B	C	D	E	F	PA
Developed Recreation							
Period 1	0	0	0	0	0	0	0
Period 2	0	0	0	7.8	7.8	8.2	7.8
Period 3	0	0	0	9.5	14.8	8.2	9.5
Period 4	0	0	0	11.6	18.0	8.2	11.6
Period 5	0	0	0	14.1	22.0	8.2	14.1
Dispersed Recreation (without wilderness and wildlife RVDs)							
Period 1	5.4	5.4	1.2	2.5	3.6	3.6	2.5
Period 2	6.6	6.6	1.6	1.6	2.2	1.8	1.6
Period 3	8.0	8.0	1.9	1.9	3.0	2.6	1.9
Period 4	9.8	9.8	2.4	2.4	3.7	3.3	2.4
Period 5	11.9	11.9	2.9	2.9	4.5	4.0	2.9

Table 6 (continued) - Recreation Uses and Opportunities

Wilderness Use (without wildlife RVDs)							
Period 1	0	0	.5	1.1	0	0	1.6
Period 2	0	0	.6	.6	0	0	.6
Period 3	0	0	.7	.7	0	0	.7
Period 4	0	0	.9	.9	0	0	.9
Period 5	0	0	1.1	1.1	0	0	1.1
Wildlife Recreation							
Period 1	.6	.6	.2	.4	.4	.4	.4
Period 2	.7	.7	.2	.2	.2	.2	.2
Period 3	.9	.9	.3	.3	.5	.3	.3
Period 4	1.1	1.1	.4	.4	.6	.4	.4
Period 5	1.3	1.3	.4	.4	.7	.4	.4
Total Recreation (3500 acre area)							
Period 1	6.0	6.0	1.9	4.0	4.0	4.0	4.0
Period 2	7.3	7.3	2.4	10.2	10.2	10.2	10.2
Period 3	8.9	8.9	2.9	12.4	18.3	11.1	12.4
Period 4	10.9	10.9	3.7	15.3	22.3	11.9	15.3
Period 5	13.2	13.2	4.4	18.5	27.2	12.6	18.5

Recreation Visitor Days (RVDs) in thousands of RVDs per year (MRVD) for the Remainder of the Pinaleno Mountains:

	Alternatives						
	A	B	C	D	E	F	PA
Developed Recreation							
Period 1	88.6	88.6	88.6	88.6	88.6	88.6	88.6
Period 2	108.0	108.0	108.0	114.3	114.3	112.2	114.3
Period 3	131.6	131.6	131.6	139.3	150.8	136.7	139.3
Period 4	160.5	160.5	160.5	169.8	183.8	166.7	169.8
Period 5	195.6	195.6	195.6	207.0	224.1	203.2	207.0
Dispersed Recreation (without wilderness and wildlife RVDs)							
Period 1	100.7	89.1	91.0	90.1	90.1	90.1	90.1
Period 2	122.8	108.6	110.9	116.3	116.3	113.7	116.3
Period 3	149.6	132.4	135.2	141.8	154.8	138.6	141.8
Period 4	182.4	161.4	164.8	172.8	188.7	169.0	172.8
Period 5	222.4	196.7	200.9	210.6	230.0	206.0	210.6

Table 6 (continued) - Recreation Uses and Opportunities

Wilderness Use (without wildlife RVDs)							
Period 1	0	11.6	12.4	11.9	11.9	11.9	11.9
Period 2	0	14.1	15.1	14.7	14.7	14.5	14.7
Period 3	0	17.2	18.4	17.9	18.9	17.7	17.9
Period 4	0	21.0	22.5	21.8	23.0	21.6	21.8
Period 5	0	25.6	27.4	26.6	28.0	26.3	26.6
Wildlife Recreation							
Period 1	28.4	28.4	28.7	28.6	28.6	28.6	28.6
Period 2	34.6	34.6	35.0	35.8	35.8	35.4	35.8
Period 3	42.2	42.2	42.6	43.6	45.8	43.2	43.6
Period 4	51.4	51.4	52.0	53.2	55.8	52.6	53.2
Period 5	62.7	62.7	63.4	64.8	68.1	64.1	64.8
Total Recreation (Remainder of Pinalenos)							
Period 1	217.7	217.4	220.7	219.2	219.2	219.2	219.2
Period 2	265.4	265.4	269.9	281.1	281.1	275.8	281.1
Period 3	323.4	323.4	327.8	342.6	370.3	336.2	342.6
Period 4	394.3	394.3	399.8	417.6	451.3	409.9	417.6
Period 5	480.7	480.7	487.3	509.0	550.2	499.6	509.0

Recreation Opportunity Spectrum (ROS) in acres for the 3500 Acre Management Area:

	A	B	C	D	E	F	PA
Opportunity ROS							
Primitive	0	0	1053	1000	0	12	1000
Semi-primitive nonmotorized	0	0	2447	0	0	0	0
Semi-primitive motorized	1895	1895		1391	1570	1203	1391
Roaded Natural	1605	1605		1094	1900	2225	1102
Urban	0	0	0	15	31	60	7
Restricted Use Area (Included in above acres)	0	0	0	284	738	1240	123

Recreation Use. Recreation use within the 3,500 acre management area would increase the most in Alternatives D, PA, and E. The increases are directly related to visitation to the telescopes. Alternative F actually provides for more site development but at the same time imposes strict visitation restrictions which reduces total recreation use below what could be expected in Alternatives A and B. Alternative C actually closes off motorized access to the 3,500 acre area, which reduces visitation approximately 66 percent from what currently is expected (Alternative A).

Recreation use in the remaining Pinaleno Mountain area will increase in all development alternatives (D, E, F, PA) over what could be expected in nondevelopment alternatives (A, B, C). The increases would primarily occur in the developed recreation category of use. More overnight camping facilities would be needed to accomodate astrophysical site visitors.

Recreation Opportunity. Acres available for different recreation opportunities would vary for each of the alternatives (see Table above). More primitive and semi-primitive non-motorized opportunities would be available in alternative C. D. and PA. More urban opportunities would be provided in alternatives PA, D, E, and F. In addition, each alternative except C will provide similar opportunities for semi-primitive motorized and roaded natural recreation.

Restricted Use Areas. No areas of restricted recreation use would occur in alternatives A, B, and C. Visitor restrictions would be imposed in all developinent alternatives. The higher the level of development the more acres that would have use restricted. Restricted acres in Alternative PA, D, E. and F would be 123, 284, 738, 1240 acres, respectively.

Issue 4 - Wilderness and Special Area Designations

The following table summarizes acres allocated to wilderness and zoological/botanical area designations. The areas of restricted visitor use and the exclusive use are also depicted.

Allocations to wilderness of the existing roadless area within the 3,500 acre management are recommended in alternatives C, D, and PA. Alternatives E, D, PA, and C would allocate 150, 400, 569, and 680 acres respectively to a zoological/botanical special area designation. Exclusive use allocations for site development would occur in alternatives PA, D, E, and F and range from 7 to 60 acres, respectively. Visitors' use would be restricted in Alternatives PA, D, E, and F on 123, 284, 738, and 1240 acres, respectively.

Table 7 - Wilderness/Special Area Designations

	Alternatives						
Designation	A	B	C	D	E	F	PA
Wilderness Acres	0	0	1000	1000	0	0	1000
Zoological/Botanical Acres	0	0	680	400	150	0	569
Astrophysical Restricted Area Acres	0	0	0	284	738	1240	123
Astrophysical Exclusive Use Acres	0	0	0	15	31	60	7

Issue 5 - Visual Quality

The following table summarizes the visual quality objectives for each alternative. These objectives can be met in all alternatives. Alternative C provides for the most natural-appearing landscape. Landscapes in the other alternatives would show more evidence of man's presence. Alternatives when ranked from low evidence of man to high evidence of man, would line up as follows: C, B, A, PA, D, E, and F.

Table 8 - Visual Quality

	Alternatives						
	A	B	C	D	E	F	PA
	(Acres)						
Visual Quality Objective (VQO)							
Preservation	0	0	1000	1000	0	0	1000
Retention	3500	3500	2500	2201	2732	2200	2370
Partial Retention [1]	0	0	0	284	738	1240	123
Modification/Maximum Modification	0	0	0	15	31	60	7

1 Includes mainly indirectly impacted areas.

Issue 6 - Cultural Resources and Native American Religious Use

Three cultural resource sites have been located in the 3.500 acre management area. The strategies of protection and mitigation of these three sites varies by alternative and is summarized in the Table below. Indian tribes were consulted as to their potential religious use of Mt. Graham. The Zuni Tribe has visited the site. However, no Indian tribes have come forward with information on potential impacts to their religious use of Mt. Graham at this time. Should information become available, it will be included in the final EIS.

Table 9 - Cultural Resources and Native American Religious Use

	Alternatives						
	A	B	C	D	E	F	PA
Sites:	Protect All 3 Sites in place	Same as A	Same as A	Maintain 1 Site in place gather data from 2 sites	Same as D	Gather data from all 3 sites	Same as D

Issue 7 - Astrophysical Values and Benefits

The following table summarizes the proposed astrophysical development for each alternative.

Table 10 - Astrophysical Values and Benefits

	Alternatives						
	A						PA
Astrophysical (Arizona)	None	None	None	5 scopes installed	11 scopes installed (one will be the largest in the world)	13 scopes installed (one will be the largest in the world)	Same as D

Alternatives A, B, and C which would not allow development on Mt. Graham would not contribute to expanded astrophysical research. The world-wide advance of astronomy is not dependent solely on development of Mt. Graham. Other potential sites would continue to be evaluated for locating the proposed telescopes under these alternatives.

Under alternatives A, B, and C Steward Observatory's status as a leader in astronomy would not be enhanced. Steward Observatory scientists work at existing local facilities as well as other national and international facilities and their current program could be maintained without Mt. Graham until Kitt Peak, Mt. Hopkins, and Mt. Lemmon become unsuitable.

Alternatives D, E, F, and PA, which provide for varying levels of astrophysical development, would contribute to expanded astrophysical research. Alternate locations for the proposed telescopes will not need to be found.

In alternatives D, E, F, and PA Steward Observatory's status as a leader in astronomy would be enhanced and research work expanded. Development on Mt. Graham would provide an opportunity to continue work presently being done on Kitt Peak, Mt. Hopkins, and Mt. Lemmon as these sites become unsuitable because of increasing light pollution.

Issue 8 - Social and Economic Values

ALTERNATIVES A, B, AND C

These alternatives would likely have a negligible effect upon the lifestyle and culture of the Gila Valley. Alternative C could have some impact by the closure of roads atop Mt. Graham and the increased wilderness and dispersed recreation uses due to management for wilderness and zoological/botanical area designation.

Over the next 50 years, total employment as a result of increasing recreation on Mt. Graham would increase by 275-290 jobs. (This increase is a total increase figure over 50 years, not an annual increase.)

These would predominantly occur in retail trade and service industries. This is a 4.4% increase over 1985 employment in the Graham County/Willcox area of 6,250.

ALTERNATIVES D AND PA

These alternatives would likely have some effect upon the culture of the Gila Valley, but the effect would be small. The presence of construction workers, and later observatory operation personnel new to the area, would not modify the Gila Valley lifestyle as a whole since the number of new-comers would be relatively small in comparison with the resident population.

Employment effects would result from three types of activities: recreation/tourism, observatory construction, and observatory operations. The first would result in about 330 total additional jobs averaged over 50 years and the last would add about 90 additional jobs (after construction was complete). Construction of the observatory would yield about 100 new jobs during 11 years of this activity. Most of these additional jobs would occur in retail trade and service industries.

ALTERNATIVES E AND F

These alternatives would likely have some effect upon the culture of the Gila Valley, but the local lifestyle would still remain intact. A larger amount of non-locals would be visiting Mt. Graham and the area, possibly increasing conflicts between out-of-area visitors and resident Forest users. Local reactions will likely be negated somewhat if increased use results in increases in expenditures by non-local users. New construction workers and observatory operations personnel would not modify the Gila Valley lifestyle since these would be relatively small in number when compared with the resident population.

Employment effects would result from three types of activities: recreation/tourism, observatory construction, and observatory operations. The first would result in about 400 total additional jobs averaged over 50 years and the last would add about 175 jobs (after construction was complete). Construction of the observatory would yield about 100 new jobs during the 27-to-30 years of this activity. Most of these additional jobs would occur in retail trade and service industries. Details of the socio-economic effects can be found in Chapter 3 and in Tables in Appendix 4.

Issue 9 - Safety/Protection

The 3.500 acre management area in all alternatives is defined as Fire Management Zone 1 as per the final Forest Plan (page 87). The appropriate fire suppression response in this Zone will be predicated upon preventing fires from reaching or damaging high value resources and improvements. When fire danger reaches very high or extreme, fire suppression would be accomplished through maximum use of people and equipment within as short a time as possible.

The following tables summarize strategies for fuels treatment and access management prescriptions for Forest Roads (#507 and 669). State Highway 366 (Swift Trail) and Forest Trails.

Table 11 - Fuel Treatment Acres by Treatment Type

	Alternatives						
Treatment Type[1/]	A	B	C	D	E	F	PA
A	0	0	733	400	150	0	569
B	0	0	1000	1000	0	0	1000
C	0	0	0	15	31	60	7
D	3500	3500	1767	2085	3319	3440	1924

1/ A = No fuels treatment allowed.
B = Treatment allowed to meet wilderness management objectives only.
C = Fuel reduction by pile and burn or removal only.
D = Activity slash hazard reduction allowed.

Table 12 - Summary of Access Management Prescriptions by Alternative

	Alternatives				
	A	B	C	D and PA	E
Access:					
Forest Rd. 507	Dirt rd. No snow removal.	Same as A	Closed (No motorized access).	Improved dirt road. Unscheduled snow removal. Public motorized access daylight hours only.	Paved road. No public motorized access beyond restricted area sign. Unscheduled snow removal.
Forest Rd. 669	Dirt rd. No snow removal.	Same as A	Closed (No motorized access).	Same as A Paved road. Unscheduled snow removal. Public motorized access daylight hours only.	Paved road. No access due to restriction on FR 507 Unscheduled snow removal.
State Highway 366 (Swift Trail)	Paved rd. No snow removal.	Same as A	Same as A No snow removal.	Paved road Unscheduled snow removal.	Same as D Same as D
Trails	Motorized and non-motorized use.	No motorized vehicle use.	Same as B.	Same as B.	Same as B. Same as B.

F. ACRES AVAILABLE

Because alternatives result in different combinations of management prescriptions and different assignments of acreage to management prescriptions, there are differences between alternatives in total acreage available for developed, dispersed and wilderness recreation, zoological/ botanical area protection, or astrophysical development.

Table 13 - Acres Available by Prescription

(Prescription Comparison in Acres)

	A	B	C	D	E	F	PA
Dispersed Recreation	3500	3500	1820	1801	2581	2200	1801
Wilderness Recreation	0	0	1000	1000	0	0	1000
Zoological/Botanical Area (ZBA)	0	0	680	400	150	0	569
Astrophysical Development (includes restricted use area and exclusive use area.	0	0	0	299	769	1300	130
Total Acres	3500	3500	3500	3500	3500	3500	3500

G. COSTS

Forest Service costs of implementing the alternatives are shown in the following table. Dollars are shown in current dollars. In alternatives A, B and C, no costs would be incurred by the project proponent. Proponent costs vary directly with the amount of development characteristic of each development alternative. Information on the proponent costs is not included in the following table but is summarized in the Appendix materials.

Table 14 - Cost by Alternative

Alternatives

	A	B	C	D	E	F	PA
Forest Costs (Dollars per decade):							
Recreation O&M							
Period 1	18,460	Same	50,250	43,000	57,070	69,240	Same
Period 2	19,014		51,757	44,290	58,782	71,317	
Period 3	19,584	as	53,309	45,619	60,545	73,457	as
Period 4	20,172		54,908	46,987	62,361	75,661	
Period 5	20,777	A	56,555	48,397	64,232	77,931	D
Fire							
Period 1	23,400	Same	28,800	32,920	39,900	59,920	Same
Period 2	24,102		29,664	33,908	41,097	61,718	
Period 3	24,825	as	30,554	34,925	42,328	63,570	as
Period 4	25,570		31,471	35,973	43,598	65,477	
Period 5	26,337	A	32,415	37,052	44,906	67,440	D
Wildlife O&M							
Period 1	8,750	Same	24,020	27,020	30,020	36,030	Same
Period 2	9,013		24,741	27,831	30,921	37,111	
Period 3	9,283	as	25,483	28,666	31,849	38,224	as
Period 4	9,562		26,247	29,526	32,804	39,371	
Period 5	9,849	A	27,034	30,412	33,788	40,552	D

Table 14 (continued) - Cost by Alternative

Special Uses							
(Administration)							
Period 1	20.100	Same	0	34.420	42.320	53.300	Same
Period 2	20,703		0	35,453	43.590	54.899	
Period 3	21.324	as	0	36.517	44.898	56.546	as
Period 4	21.964		0	37,612	46.245	58.242	
Period 5	22.623	A	0	38.740	47.632	59.989	D
Other							
Period 1	44,200	Same	33.230	37.930	39.200	47.920	Same
Period 2	45.526		34,227	39.068	40.376	49.358	
Period 3	46.892	as	35.254	40.240	41.587	50.839	as
Period 4	48.299		36.312	41.447	42.835	52.364	
Period 5	49.748	A	37.401	42,690	44.120	53,935	D
Total FS Costs							
Period 1	114.910	Same	136.300	175.290	208.510	266.410	Same
Period 2	118.358		140.389	180,550	214.766	274.403	
Period 3	121.908	as	144,600	185.967	221.207	282.636	as
Period 4	125.567		148.938	191.545	227.843	291.115	
Period 5	129.334	A	153.405	197.291	234.678	299.847	D

H. RECREATION MANAGEMENT SUMMARY

The following table summarizes recreation use, visitor restrictions, facilities, and needed mitigation for recreation management by alternative.

TABLE 15 RECREATION USE AND FACILITY MATRIX

ALTERNATIVES

RECREATION DIRECTION	A			0 and PA		
Recreation Emphasis	-Dispersed Use (Summer, limited winter)	-Dispersed Use (Summer, limited winter)	-ZBA -Wilderness -Dispersed Use (Summer, Limited winter)	-Dispersed Use (Summer and Winter) -Wilderness -ZBA -Astro-Visitor -Snow play	-Astro-Visitor -Dispersed Use (Summer and Winter) -ZBA -Snow play	-Astro-Visitor -Dispersed Use (Summer and Winter)
Visitor Restrictions	- No special restrictions	- No special restrictions	- No hunting in ZBA	Exclusive Use - Astrophysical Area - No camping, hiking or camp fires - Fences contain telescope sites/areas - Roadways blocked at night; Limited daytime public access - Radio transmissions controlled - No hunting	Exclusive Use - Astrophysical Area - No camping, hiking or camp fires - Fences contain telescope sites/areas - Roadways blocked at night; limited daytime public access - Radio transmissions controlled No hunting	Exclusive Use - Astrophysical Area - No camping, hiking or camp fires - Fences contain telescopes sites/areas - Roadways blocked at night; limited daytime public access (by shuttle or walk-in only - Radio transmissions controlled - No hunting

TABLE 15 RECREATION USE AND FACILITY MATRIX (Continued)

				Restricted Use Area - No hunting - No headlights - No campfires(Nighttime) - Radio transmissions controlled - Hiking allowed - Dispersed camping/ picnicking - Public access;daylight drive-in only, restricted wet weather & night driving (all year), FR 507 - FR 669 remains open in the Preferred Altern. Other Areas - No hunting in ZBA,	Restricted Use Area - No hunting - No headlights - No campfires(Nighttime) - Radio transmissions controlled Hiking allowed. no pets. - Designated camping/ picnicking (No permit-no fee) Public access;daylight drive-in only, restricted night driving (all year). Other Areas - No hunting in ZBA.	Restricted Use Area - No hunting - No headlights - No campfires(Nighttime) - Radio transmissions controlled - Hiking allowed. No pets. - Designated camping/ picnicking (Permit only) Public access; prohibited public driving (day-night, all year), Access by road; shuttle or walk-in
New Facilities and Service	- None	- None	- None	- Snow play area - Picnic Site - Scenic viewpoint - Amateur Astronomy Vista	- Same as Alternative D. - Visitor Center off Forest - Shuttle with Stops.	- Shuttle with Stops - Visitor Center off Forest - Picnic Site - Scenic Viewpoint - Amateur Astronomy Vista
Mitigation	- None	- None	- Post boundaries of special designation areas. - Manage wilderness & ZBA for designated use levels. - Forest Roads 507 and 669 closed	- Post boundaries of special designation areas. - Plow parking for snow play. - Manage wilderness & ZBA for designated use levels. - Forest Road 507 widened	- Post boundaries of special designation areas. - Plow parking for snow play. - Manage ZBA for designated use levels. - Forest Road 507 widened and paved.	- Post boundaries of special designation areas. - Forest Road 507 widened and paved. - Shuttle is primary means of public access.

I. SUMMARY OF SIGNIFICANT ENVIRONMENTAL EFFECTS BY ALTERNATIVE

A summary of significant environmental effects identified in Chapter 3 for all alternatives is displayed below.

Chances for survival of the Mt. Graham red squirrel decrease as the level of activity and/or facility development increases due to old growth and potential old growth habitat loss in the long term. The risk increases as the level of man-induced activity increases. Alternatives D, E, and F are more than twice as likely as alternatives A, B, or C to cause extinction of the Mt. Graham red squirrel within 30 years. The Forest Service Preferred Alternative (PA) is less than twice as likely as alternatives A, B, or C to cause extinction of the Mt. Graham red squirrel within 30 years (see Chapter 3, Wildlife Section).

Alternatives D (15 acres), E (31 acres), F (60 acres), and PA (7 acres) would result in a loss in natural character and productivity of the environment over the life of the project and reduce these areas to a single purpose use.

Effects created by long term occupancy of the proposed astrophysical area include human-wildlife conflicts and changes in types and patterns of recreation use. The significance and positive or negative effects of these changes depends on the personal values of the interested and affected publics.

Recreation management in alternative C changes the area to a more natural and primitive environment resulting in an recreation opportunity spectrum (ROS) setting of semi-primitive non-motorized and primitive. Alternatives PA, D, E, and F (in ascending order) all result in increased pockets of urban development and visitation above the current level. The National New Technology Telescope (NNTT) would contribute the greatest share, up to 50,000 visitors per year, in increased visitation to the area. The NNTT is proposed in alternative E and F. Without development of the NNTT, increases in visitation in alternatives E and F would be similar to alternative D and the PA. In the Forest Service Preferred Alternative (PA) and alternative D the carrying capacity is projected to be reached in the Pinaleno Mountains by the year 2019 with 15,000 observatory visitors. In alternatives E and F with the NNTT developed, carrying capacity would be reached in the year 2015 and 2019, respectively. Winter access and snow play opportunities would increase in alternatives D, E, F and the Forest Service Preferred Alternative (PA). With the projected current 2% annual increase in visitation, alternatives A and B would reach capacity of 470,000 RVDs in the Pinaleno Mountains by the year 2022 and alterative C would reach capacity by the year 2023.

Visual quality would be significantly affected in all development alternatives but to a greater magnitude in alternatives E and F with the interferometer and/or NNTT. Even with proper design, siting, and mitigation, natural features would no longer dominate the landscape.

The potential for inadvertent damage to cultural resource sites exists under all alternatives. Alternative C reduces potential cultural resource impacts from that in alternative A because visitation and discovery is less likely to occur. As development and visitation increases from the Forest Service Preferred Alternative (PA) and D to E to F, mitigation measures become increasingly necessary. Development alternatives D, E, F and the Forest Service Preferred Alternative (PA) would adversely impact at least one cultural resource site. Alternatives D, E, F, and PA may not be able to avoid rock cairn site AR-03-05-04-103. In all development alternatives site AR-03-05-04-102 appears to be unavoidable and would be adversely impacted. Both sites occur in the astrophysical exclusive use area for all 4 development alternatives.

Development alternatives D. E. and F and PA could stimulate the growth of the astrophysical community in southern Arizona. The cultural and scientific knowledge pool would increase from the Forest Service Preferred Alternative (PA) and D to E to F. Technological and economic development, engineering applications, new products, and industrial growth would increase in some degree from alternatives PA and D to E to F.

Development alternatives D. E. F and PA increase risk of fire resulting in the hiring of one additional Forest Service fire prevention technician. Increased winter public access increases public risk including: traffic accidents resulting from icy road conditions and inexperienced drivers; delays due to winter storms; hypothermia.

CHAPTER 3 - AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

OVERVIEW

This chapter describes 1) the existing environment of the 3500 acre area in the Pinaleno mountains. and 2) the environmental consequences of implementing each of the alternatives including 4 which allow astrophysical development and 3 which do not. The affected environment and environmental consequences are presented for specific resource elements based upon the issues outlined in Chapter 1. They are discussed as individual units to facilitate description of the environment to be affected by the proposal and the impacts which would occur as a result of implementation of the various alternatives. The environment is discussed in two major sections: Physical and Biological Environments, and Social and Economic Environments.

Environmental consequences are the effects of implementing an alternative on the physical, biological, social, and economic environment. This chapter describes the direct and indirect environmental consequences that result from alternatives considered in detail. Direct environmental effects are defined as those occurring at the same time and place as the initial cause or action. Indirect effects are those that occur later in time or are spatially removed from the activity but would be significant in the foreseeable future.

Analysis and evaluation of the consequences provide the analytic basis for comparison of alternatives. Alternatives considered in detail are described in Chapter 2.

Irreversible and irretrievable resource commitments are noted where appropriate. Irreversible commitments are decisions affecting the nonrenewable resources; soil, mineral, plant and animal species, and cultural resources. Such commitments of resources are considered irreversible because the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense, or the resource has been destroyed or removed. The irretrievable commitments represent opportunities foregone for the period during which resource use or production cannot be realized. These decisions are reversible, but the production opportunities foregone are irretrievable.

Probable adverse environmental effects which cannot be avoided are discussed. Unavoidable adverse effects result from managing the land for one resouce at the expense of the use or condition of other resources. Management prescriptions mitigate most adverse effects by limiting the extent or duration of effects. Mitigation/coordination measures within standards and guidelines further reduce these conflicts.

Short-term uses are those that occur annually within the first ten year period while long-term productivity refers to the capability of the land and resources to continue producing goods and services 50 years and beyond.

Soil and water are the primary resources upon which productivity is based. Short-term uses that damage soils and soil-water relationships impair long-term productivity. Management requirements provide for protection of long-term productivity by requiring that impacts on soils and water from short-term uses be mitigated.

Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

PHYSICAL AND BIOLOGICAL ENVIRONMENTS

A. GENERAL SETTING

The 3500 acre area is located in the Pinaleno Mountains, Graham County, Arizona. The Pinalenos are part of the Basin and Range physiographic province and represent the highest mountains south of the Mogollon Rim. Mt. Graham (elevation 10,720) is the highest peak. The Pinalenos contain about two square miles of land above 10,000 feet with at least 8 promontories or peaks which can be specifically identified along the long ridges. The high elevation ridge line is one feature that makes the mountains so attractive to astronomers, recreationists and for plant and wildlife habitat.

The Pinalenos are surrounded by the Sulphur Springs - Aravaipa valleys on the south and west, the San Simon Valley on the east, and the Gila Valley on the north. The steep relief of the Pinalenos represents the sharpest ascent from desert grassland to Spruce-Fir forest in Arizona. Flora and fauna are quite diverse throughout the elevational range, and this diversity has been a major factor in the mountain's popularity for a variety of activities.

B. GEOLOGY, SOILS, MINERALS

1. Existing Situation

Pleistocene glacial features are present a few hundred feet below the High Peak Summit (Figure 3). A nivation cirque (a deep steep-walled basin high on a mountain characterized by erosion of soil and rock caused by ancient alternate thawing and freezing of melt water) and a "U" shaped valley segment on the east side and slope-segmented active talus patches along the north side have been tentatively identified but lack detailed study. No periglacial features were found on the summit crests or in other parts of the study area.

The cryic temperature regime and udic moisture regime dominate the soils of the 3500 acre area and can be found above 6,500 feet on the Colorado Plateau as well as a few other mountain ranges of the Basin and Range like the Pinalenos. These soils have a mean annual soil temperature below 47^{o}F (8^{o}C) and a mean annual precipitation of approximately 31 to 35 inches (80 to 90 cm) with about one-half falling during winter as snow, sleet or rain. These upland soils are dominately moderately deep (20 to 40 inches), gravelly to very cobbly, sandy loams (i.e. moderately coarse textured soils) on hilly to steep slopes. Rock outcrops vary from zero to 20 percent of the terrain. The dominant soils in the 3500 acre area have been classified as Typic Cryorthents, HSM, 7, -1, and 7, 0, coarse-loamy and loamy-skeletal, mixed, non acid and Typic Cryochrepts, HSM, 7, -1, and 7, 0, fine-loamy and loamy-skeletal, mixed. These soils are associated with 7, -1, : Engelmann spruce, corkbark fir, white fir, Douglas fir and 7, 0, :Engelmann spruce, corkbark fir, quaking aspen (Terrestrial Ecosystem Survey Handbook, Appendix B, January 1985, USFS, Region 3). Unique or rare soils may exist on Mt. Graham because of its southern latitude, relic Spruce-Fir forest and high elevations. The cienega soils (Typic Cryaquoll, fine-loamy, mixed) are limited in extent. They cover less than 20 acres within the 3500 acre area.

The soils of the 3500 acre area are well-anchored to moderate slopes. They have only slight to moderate erosion potential. Limitations to septic tank drainfield installation include depth to bedrock, depth of soil freezing, low available water capacity, and steep slopes. The soils have good permeability.

Surface rock types within the 3500 acre area display virtually no signs of economic ore mineralization. No areas are being actively explored and no ore bodies are known. Mineral potential is low. However, it is important to recognize that mineral potential evaluations are not inventories of mineral resources. Bureau of Land Management records as of May 23, 1986, indicate there are no mining claims within the area. No oil and gas leases are known. The area around High Peak and south along Forest Road 507, has approximately 71 acres currently withdrawn from mineral entry.

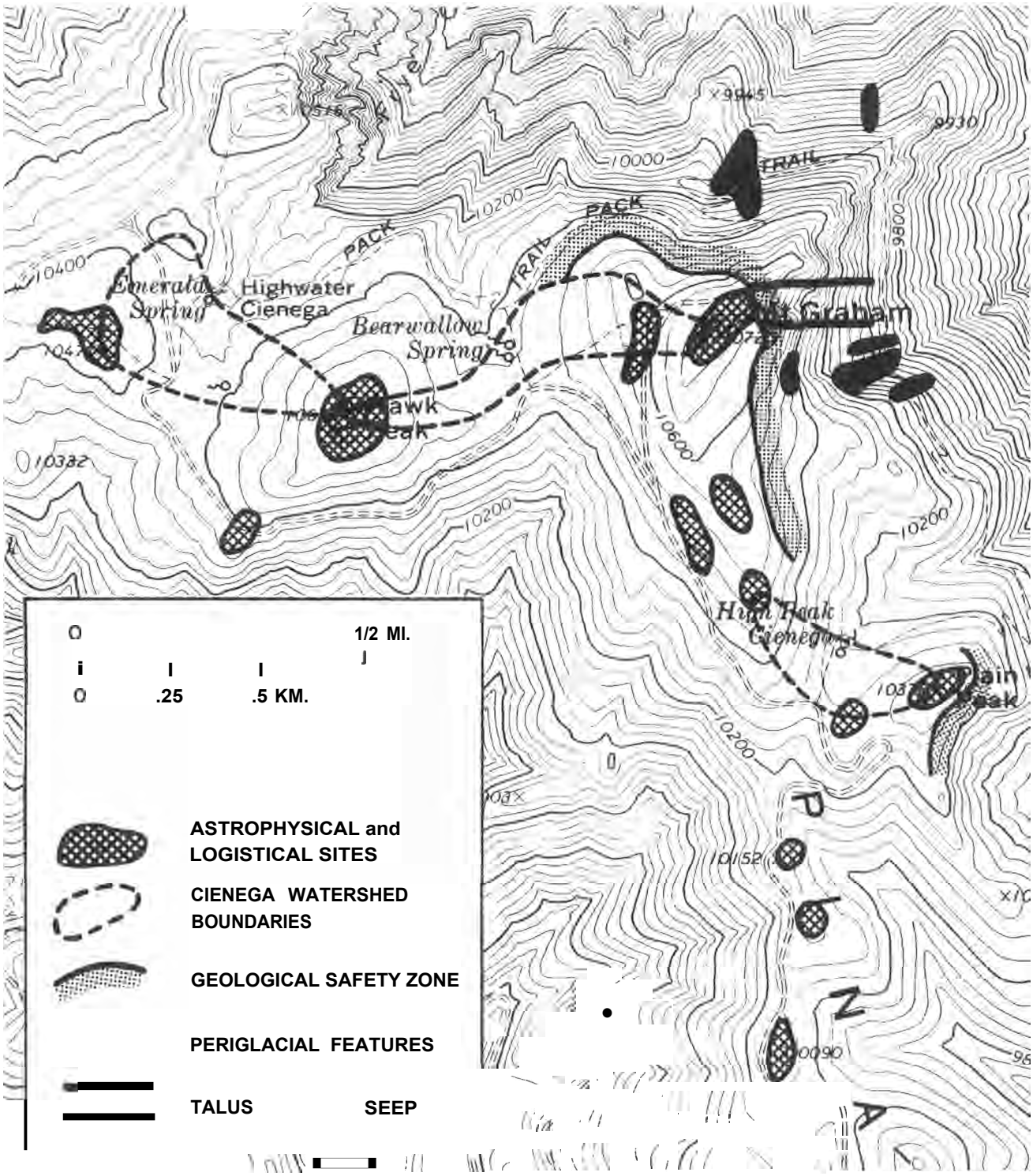

Figure 3 Geological Features and Proposed Astrophysical Sites.

2. Effects of Alternatives

Pleistocene Periglacial Features

Alternatives A, B, and C would have no significant effects on periglacial features.

In any of the development alternatives D, E, F, or Forest Service Preferred Alternative (PA), improper disposal of cut materials and improper stockpiling of maintenance fill could cause artificially induced landslides and destruction of periglacial landforms. Similarly, destabilizing slopes above periglacial features could induce land movement that would bury periglacial features.

Uncontrolled construction that pushes rock or vegetal material over the slopes or down existing talus slopes in the areas designated on the map (Figure 5.1 page#) could destroy these features.

Loss of these periglacial features would be significant since they contain valuable scientific evidence concerning the presence of permanent ice or glaciers during the Pleistocene period at a very southern latitude.

Sites 3, 4, and 6 pose the greatest risks to the Pleistocene periglacial features. Control of all cut material and its stockpiling would prevent damage to these landform features.

Prohibiting bedrock cuts or blasting inside the "safety zone" (Figure 5.1 page#) would prevent damage to these landform features. Blasting or cutting in rock outside the "safety zone" would minimize the risk of landslides that could effect these periglacial features.

Landslides and Mass Movement

Alternatives A, B, and C would have no significant effects on landslides or mass movement.

In any development alternative (D, E, F, or PA), cutting into bedrock for foundation construction, stockpiling of cut materials, and destabilizing mountain slopes by road cuts would be the three human actions that might induce or encourage landslides and land movement. In addition, bedrock must be able to support weight of telescopes and other facilities.

Along forest road 507, moderate slopes with well anchored soils show no evidence of hazardous land movement, solifluction, or landslides that could impair road improvement or pose a threat to keeping access roads open.

Since the management area has low potential for mass movements and landslides, there is little significant harm expected from human actions on bedrock. The bedrock appears adequate for dome foundations and weight. The bedrock is metamorphic (gneiss).

Although landslide and mass movement hazards cannot be quantified, hazards would be minimal because of mitigation measures and low natural potential.

Without mitigation, use of High Peak (Site 3) could cause the greatest geological concern because of downslope periglacial features and nearby talus slopes.

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In alternatives A, B, or C, no significant soil loss occurs. Soil types are not affected.

In alternatives D, E, F and PA (development alternatives) construction of facilities and roads would remove or bury soil types. Alternative D would remove or bury up to 15 acres. Alternative E would remove or bury up to 31 acres. Alternative F would remove or bury up to 60 acres. PA would remove or bury up to 7 acres. These areas are rather insignificant when compared to the thousands of acres of these soil types in the Pinaleno Mountains. Soil loss would be eliminated onsite by hardening of surfaces (paving, etc.). Runoff would be either dispersed or discharged into drainages so that existing soil loss rates would not be exceeded. During construction phases, areas would be cleared only for construction planned for in that year.

Minerals

Alternatives A, B, and C would have no significant effects on mineral entry, oil and gas leasing, or common variety minerals.

Because of the nature of the astrophysical development, alternatives D, E, F, and PA would recommend withdrawing the entire 3500 acre area to mineral entry and oil and gas leasing. Within the 3500 acre area around High Peak and south along Forest Road 507, approximately 71 acres are currently withdrawn from mineral entry.

C. VEGETATION

1. Existing Situation

The steep relief of the Pinalenos with its graded climate has created the sharpest ascent from desert grassland to Spruce-Fir forest in Arizona. Two major life zones are present within the 3500 acre area: mixed conifer and Spruce-Fir. Within each life zone are smaller habitats modified by water, sun exposure, soils, and human disturbance. Within the Spruce-Fir forest: the Mt. Graham spruce is a Mexican variety not found north of these mountains. The tree appears to live longer and reach greater diameters than the northern relative. It also has a broader crown. This tree makes the Mt. Graham Spruce-Fir community even more unique. In addition, within each habitat of the Pinalenos there exists genetically isolated flora called "endemics" because of their uniqueness to a small geographical area and, at times, small populations.

Vegetation at elevations above 9,600 feet in the Graham Mountains consists of both forests and non-forest vegetation. Non-forested areas consists of natural parks, cienegas, cliffs, and scree.

1. Forests. Spruce-Fir forests are found in the Mount Graham study area and in the vicinity of Heliograph Peak. There are three principal forest associations (or habitat types). Collectively, these comprise about 3,060 acres in the Mount Graham study area. The corkbark fir/moss association (680 acres), a comparatively cold and dry forest of summits, ridgetops, and southerly mid and upper slopes. Either or both Engelmann spruce and corkbark fir are invariably present. At highest elevations in this association, aspen may be common, and Douglas-fir is minor or absent. This association is commonly called Spruce-Fir throughout this document.

The following vegetative associations are commonly referred to as mixed conifer throughout this document.

At lower elevations the corkbark fir/moss association Douglas fir phase (about 2000 acres) is dominant. Along with Engelmann spruce and corkbark fir, aspen, Douglas-fir, Southwestern white pine, and white fir are common, and ponderosa pine is occasional on the warmest sites. The distinguishing features of the

understory in mature stands of the corkbark fir/moss association and in the Douglas fir phase are the conspicuousness of forest litter, mosses and lichens on rock and soil surfaces, and a sparse cover of herbs and shrubs.

The coldest and wettest association found in the Mount Graham study area is the corkbark fir/myrtle leaf huckleberry association. This association, covering about 300 acres, is found in sheltered canyons, north and east-facing slopes, and sites of the heaviest snow accumulation with persistence of snow into late spring or early summer. Engelmann spruce and corkbark fir are usually both present. Aspen is locally common, and Douglas-fir occurs only at lower elevations. Shrubs such as myrtleleaf huckleberry, Utah honeysuckle, currents, and waxflower are well-represented in the understory. Numerous species of herbs may also be conspicuous; among these are various pyrolas, one-sided wintergreen, canada violet, osha, and various sedges and high-elevation grasses.

The corkbark fir/fony sedge association is unique and found only on Mount Graham and occupies about 80 acres. Engelmann spruce is the major tree, but corkbark fir can be present, especially as seedlings or saplings. Aspen is locally abundant, and Douglas-fir is minor or absent. Most characteristic of this association is the well-developed turf of sedges and grasses found in mature stands. Important plants of this turf include fony sedge (Carex foenea), Hood's sedge, muttongrass, forest fescue (Festuca sororia), and fringed brome (Bromus ciliatus). Numerous species of broad-leafed herbs can also be common in this understory turf. The corkbark fir/fony sedge association borders cienegas and occupies soils that may be well-watered from upslope snowmelt or rainfall runoff.

No other summit in mountains of the Mexican Highlands section of the Basin and Range physiographic province contains such extensive associations of corkbark fir/moss, corkbark fir/moss Douglas fir phase, corkbark fir/myrtle leaf huckleberry, and corkbark fir/fony sedge. The Chiricahua Mountains contain perhaps 400 acres of the corkbark fir/moss association.

The Douglas-fir/screwleaf muhly and Douglas-fir/fringed brome associations, occurring on respectively drier and moister sites as determined by soils and topography occupy about 400 acres. These forests occupy comparatively warm, south or west-facing upper slopes and ridgetops. Principal trees are Douglas-fir, Southwestern white pine, and sometimes aspen. Ponderosa pine is occasional, and in wetter sites white fir may be found. However, both Engelmann spruce and corkbark fir are absent. Common understory species are grasses such as screwleaf muhley (Muhlenbergia virescens) and fringed brome and sedges (Carex roxsil and other Carex species).

The forests exist in a variety of successional conditions within the Mount Graham study area. The principal successional stages are meadows (usually created by clearcutting along major roads), aspen stands, pole conifer or mixed aspen-pole conifer stands (a pole is a tree between 4-12 inches diameter at breast height or less than about 150 years old), mature stands (usually mixes of poles and older trees), and old growth (mixes of poles, older trees, and dead trees from natural mortality).

2. Non-Forested Vegetation. Cienega watersheds occupy only about 40 acres within the Mount Graham study area. Despite limited acreage, they are extremely important habitats characterized by perennial springs and yearlong saturated soils. Vegetation is herbaceous, dominated by sedges, rushes, buttercups, and water-demanding violets, onions, and many other plants restricted to wet soils.

Parks are permanent grass-shrub openings of soils not receiving additional water from springs or seepages. Parks are found in the Mount Graham study area. Principal plants in these parks are grasses and sedges, including mountain muhly, Arizona fescue (at its southernmost geographic limit), pine dropseed, muttongrass, various bromes, fony sedge, Hood's sedge. Many species of broad leafed herbs also occur in these parks, including some (such as Potentilla albiflora) that are endemic. Some shrubs within the parks are pine current (Ribes pinetorum), wild raspberry, and sometimes snowberry (Symphoricarpos oreophilus).

Cliffs and scree comprise the remaining non-forested vegetation above 9,600 feet in the Graham Mountains. A surprising variety of trees, shrubs, and herbs grow on fissures and cracks of cliffs. However mosses and lichens are more common and extensive. These plants use the rock as substrate and derive their nutrients from precipitation and runoff waters. The cliff botany at Mount Graham is not fully known.

Scree consists of rocky, bouldery rubble often at the base of cliff, but also on steep slopes more distant from cliffs. Lichens are common on the rocks. Numerous shrub species also grow in this rubble, including waxflower, oceanspray, Rocky Mountain maple, forest willow, snowberry, and currants. Very open stands of trees may include aspen, Douglas-fir, and Engelmann spruce.

The 3500 acre area contains the only location in the Pinalenos where pure Spruce-Fir stands occur. The vegetation type comprises Engelmann spruce and subalpine fir and/or corkbark fir growing in association or in stands where one or the other dominates. In the project area, the pure Spruce-Fir is found at elevations ranging from 10,000 to 10,720 feet on level, northeast and southwest facing slopes. Isolated stands also occur at lower elevations within the project area. Like all old growth forests, the Spruce-Fir forest has relatively few other plant species.

The Spruce-Fir forest, the rocky outcrops and the cienegas are the major biological zones of concern. Rare, unique, endemic or classified plants that may possibly be affected by the 3500 acre area are a major species concern.

Mt. Graham supports a large number of genetically distinct species. This is because the Pinalenos are isolated from similar gene pools in the Southern Rockies and the subtropics in Mexico. Many unique species are endemic, occurring only in the Pinalenos. Others are simply isolated small populations peripheral to larger gene pools where the represented life zone is more widespread. Plants of specialized habitats in the Pinalenos such as seeps or springs may have wide distribution in other areas of their range, but their range extends no further north or south. Endemics (Table 16), which illustrate the genetic uniqueness of these mountains include: Echinocereous Ledingii, Graptopetalum Rusbyi, Plummeria ambigens, Mammalaria viridiflora, Sophora arizonica, a variant of Perityle lemmonii, a variant of Rumex orthoneurus, and Potentilla albiflora. (This list is not exhaustive).

Several plant species are located on Mt. Graham which have either State of Arizona or Federal protection status (Table 16). In addition, four candidates for federal listing, Allium Goodingii, Erigeron pringlei, Polemonium pauciflorum var. Hinckley, and Senecio huachucanus potentially occur on Mt. Graham because they occur on nearby mountains at similar elevations, but have not yet been collected on Mt. Graham.

The botanical importance of Mt. Graham is a result of: 1) its exceptionally rich mixture of plant species and subspecies with ties to northern and southern origins; 2) its relic Pleistocene Spruce-Fir forest; (3) its isolation from other mountain ranges which has led to the evolution of endemic species and subspecies of plants; (4) its very condensed number of life zones on one small, rugged mountain range creating a rich, multiple food source for birds and large game mammals that migrate altitudinally; and (5) two small habitats, the cienegas and rock outcrops, that support unique floral micro-communities because of Mt. Graham's altitude, isolation and biogeographic position in North America.

Table 16

Plants of Special Interest to the Proposed Mt. Graham Astrophysical Area

Species	Status
1. Species with legal protection found within the proposed Mt. Graham Astrophysical Area	
Erigeron pringlei	U.S. Fish & Wildlife Service (USFWS) category C-2
Corallorrhiza maculata	Arizona Agriculture and Horticulture Commission protected species (Arizona Native Plant Law)
C. striata	
Habenaria hyperborea	
H. saccata	"
Dodecatheon Ellisae	"
Primula Rusbyi	"
Veratrum lanatum	
2. Species found in the 3500 acre area whose distribution contribute to the unique character of the Pinaleno Mountain flora, but which lack legal status.	
Potentilla albiflora	Endemic to Mt. Graham
Perityle Lemmoni	Restricted to rock crevices on cliffs; this species exhibits substantial variation between isolated populations such as the Pinalenos, but varieties have not been described.
Erysimum Wheeleri	Previously a high elevation variety of E. capitatum; Mt. Graham is the only Arizona location and is the southern edge of distribution.
Abies lasiocarpa	Southern edge of distribution
Physocarpus monogynus	Southern edge of distribution
Pinus leiophylla var. arizonica	Northern edge of distribution
3. Species found on the Pinaleno Mountains below the 3500 acre area whose distribution contribute to the unique character of the Pinaleno flora.	
Tecoma stans	Northern edge of distribution
Macrosiphonia brachysiphon	Northern edge of distribution
Plummera ambigens	Endemic to Pinalenos
Sophora formosa	Endemic to Pinalenos; previously included within S. arizonica but recognized by Lehr
Mammillaria viridiflora	Endemic to Pinalenos; recognized by K.&P. and Lehr, but included with M. wrightii by Benson
Echinocereus Ledingii	Endemic to southeastern Arizona; only collections from Pinalenos
Graptopetalum Rusbyi	Endemic to Arizona; restricted to rock outcrops on isolated mountains*

* Arizona Agriculture and Horticulture Commission protected species

2. Effects of Alternatives

Alternative A

The activities expected in this alternative would have no significant effects on the Spruce-Fir zone (680 acres). Maintenance of the fuelbreak along Forest Road 507 by permitting Christmas tree cutting and fuelwood harvest foregoes the opportunity to increase old growth species in the fuelbreak. Tree resources managed under uneven-aged management to remove the older age classes would decrease old growth acres in the mixed conifer zone.

Alternative B

The activities expected in this alternative would have no significant negative effects on vegetation in the 3500 acre area. The number of acres of old growth would be maintained or increased slightly over time.

Alternative C

The activities expected in this alternative would have no significant negative effects on vegetation on the 3500 acre area. The number of acres of old growth would be maintained or increased slightly over alternative B because of natural tree regeneration in road ways and less human disturbance. The vegetative resources of the mountain would be preserved.

Alternative D

The astrophysical development of 15 acres would directly eliminate 200 to 350 Spruce-Fir trees; approximately 50 additional trees would be lost due to windthrow around the 5 sites (sites 3, 6, 7 and L-12 or L-13). All vegetative resources would be removed on up to 15 acres. Endemic cinquefoil, Potentilla albiflora, southwestern endemic fleabane, Erigeron rusbic and a periphecal forest shrub Physocarpas malvaceons are noteworthy plants that would be disturbed by construction in the High Peak area. Vegetation vigor, species composition and density would decline in portions of the 284 acre restricted use area as waterflow is altered and trampling increases.

The Zoological-Botanical designation in the Hawk Peak-Emerald Spring area would provide protection to the cienegas. The remaining 1000 acres recommended for wilderness designation and the 1801 acres receiving dispersed recreation emphasis would allow for adequate coordination to sustain vegetative resources in this area. Old growth acreage would increase over time with the elimination of commercial sawtimber and fuelwood harvest.

Alternative E

The astrophysical development of 31 acres would result in a direct loss of approximately 400 to 700 Spruce-Fir trees and all other plant species occuring on the 31 acres developed in the High Peak and Emerald Spring areas (sites 3 and 1). Additional losses may occur from wind throw on 5 acres (50 to 100 additional trees.) Portions of the vegetation resources within the 738 acres of restrictive use would be negatively impacted. These impacts are not quantifiable but would reduce overall vigor, species composition and density, in all vegetative resources including Spruce-Fir, cinquefoils, fleabane, shrubs, grasses, and sedges as waterflow is altered and trampling increases.

The 150 acre Zoological-Botanical Area (ZBA) would provide recreational and educational values while sustaining vegetative resources.

The remaining 2582 acres would be managed with dispersed recreation emphasis. Old growth acreage would increase over time with the elimination of commercial sawtimber and fuelwood harvest.

Alternative F

Direct loss of Spruce-Fir and to a lesser extent other tree species and other vegetation would occur on 60 acres (approximately 550 to 800 trees.) The most sensitive sites, High Peak and 2 or 3 of the following: Emerald, Hawk, Plain View and/or Plain View Southwest would be developed.

Throughout the remaining 1,240 acres in the restricted use area there would be indirect negative impacts on the vegetative resources due to alterations in waterflow and increased trampling. The extent of the impacts would range from significant in the heavy use areas to no significant impact in non use areas.

The impacts on the directly and indirectly affected acres would affect natural vegetative processes and may preempt expansion of plants with limited distribution such as the Category II daisy, Erigeron pringlei. The species may not sustain itself as a result of these long term unquantifiable impacts.

The remaining 2200 acres would be managed with dispersed recreation emphasis. Old growth acreage would increase over time with the elimination of commercial sawtimber and fuelwood harvest.

Forest Service Preferred Alternative (PA)

The astrophysical development of 7 acres would directly eliminate 100 to 175 Spruce-Fir trees; approximately 10 additional trees would be lost due to windthrow around the 2 sites (sites 3 and L-13). All vegetative resources would be removed on up to 7 acres. Endemic cinquefoil, Potentilla albiflora, southwestern endemic fleabane, Erigeron rusbic and forest shrub Physocarpas malvaceons are noteworthy plants that would be disturbed by construction in the High Peak area. Vegetation vigor, species composition and density would decline in portions of the 123 acre restricted use area as waterflow is altered and trampling increases.

The zoological/botanical designation (569 acres) would provide protection to the cienegas. The remaining 1000 acres recommended for wilderness designation and the 1801 acres receiving dispersed recreation emphasis would allow for adequate coordination to sustain vegetative resources in this area. Old growth acreage would increase in the long term with limited commercial sawtimber and fuelwood harvest.

D. WILDLIFE

1. Existing Situation

The high mountain Spruce-Fir peaks of the Pinaleno Mountains are unique biological habitats endowed with diverse plants and animals. Vegetation and wildlife have endured through time relatively unchanged because of long term spacial isolation.

Above 9,000 feet elevation, there are historic records of 21 species of mammals, 8 reptiles, 50 birds (see Appendix 2), and an unknown number of other invertebrates. Mt. Graham is the headwater of 8 streams supporting species of fish.

Of the 21 species of Mt. Graham mammals, two are now extinct in the Pinalenos: the Mexican gray wolf exists only in a captive-breeding population (Hoffmeister, 1956. Cockrum, 1961. Lowe, 1964) and is not considered in this EIS. The Long-tailed weasel, seen but not captured by Hoffmeister in the Mt. Graham area and was not recorded in a later survey (Brown, 1969); it is not considered in this EIS. Two species, beaver and Aberts squirrel, have been introduced.

Three species of mammal have been given special consideration because of their rarity. The Mt. Graham red squirrel is a unique, insular, subspecies proposed by the U.S. Fish & Wildlife Service as an endangered species and is also listed by Arizona Game and Fish Department as vulnerable (Group 4).

No other mountain range in southern Arizona supports a species of Tamiasciurus (Mt. Graham red squirrel). The white-bellied vole, another insular subspecies of Mt. Graham, is on the Arizona Natural Heritage Program's Special Element List and classified as Category 3C by the U.S. Fish and Wildlife Service, Endangered Species Program. A unique subspecies of the Western pocket gopher also occurs in the Pinalenos but has not been placed in any special category.

Snakes and lizards are more diverse and probably more abundant in the Pinalenos than any other mountain range in southern Arizona. None of the eight species found above 9,000 feet are considered endangered. The twin-spotted rattlesnake is considered a rare species in the United States. The bulk of the population is located in the Sierra Madre Occidental Mountains of Mexico. The twin-spotted rattlesnake and the Sonoran mountain kingsnake are protected by the State of Arizona. Collectors prize these two species and they have suffered at the hands of poachers.

Of the fifty probable bird species inhabiting the high elevations of the Pinalenos, four are of official concern: the spotted owl, the wild turkey, the Apache goshawk and the peregrine falcon. Because of their nesting and hunting habits, the peregrine would not be affected by any alternatives considered in this document. Spotted owls have *been* heard in the canyons of the mixed conifer within 1,000 feet elevation of the project area. No roosting, breeding, or feeding areas have been found. The turkey population is considered small.

The Pinalenos lie within Unit 31 of the Arizona Game and Fish Commission. Huntable species include the white-tailed deer, javelina, bear, band-tailed pigeon, mountain lion, Aberts squirrel and other small game (bobcat, skunk, fox, coyote) (see Appendix 2). The Pinalenos support the largest bear population and mountain lion population south of the Mogollon Rim. Species of major concern to wildlife management and hunters are bear, lion, and deer. The deer population has shown wide fluctuations in population size for unknown reasons. The bear population is perhaps the best managed in the southwest and has grown to 150 animals.

Fish populations on Mt. Graham are below natural potential. Seventeen species exist or existed in the Pinaleno Mountains and valleys surrounding them. Of the seventeen, only three native forms are known. On Mt. Graham, two of these three forms are probably extinct. Twelve species live too far downstream from the project area to be affected by the proposed project and are not considered in this EIS.

The Salt River form of the Apache trout has been introduced to Ash, Deadman, Gibson, Marijilda, Moonshine, Post, Crazy Horse, and Grant Creeks as well as Hospital Flat, Soldiers and Riggs with some successful reproduction in the upstream reaches and less successful in lower reaches. In some creeks, the Apache has hybridized with rainbow trout. Apache trout has threatened status (Federal; Group III, Arizona). The fish needs tiny, high-gradient brooks where summer temperatures rarely exceed 60^{O}F. Winter conditions may include anchor ice. A closed forest canopy covering the stream appears to be crucial.

The speckled dace has been found in Grant Creek in 1961 and 1965. It is now considered extinct because of past treatment of the creek to kill unwanted forms of trout. The Gila mountain-sucker was caught in Grant Creek in 1961. Minckley believes it may have been introduced by accident with trout (Minckley, 1969). The status of this native fish is presently unknown. Two species of stocked trout (the brown trout and the brook trout) have established naturally reproducing populations in upper and middle reaches of Marijilda Creek.

Two endemic fightless beetles. Diplotaxis saylori, a scarab found mostly below 9,000', and Scaphinotus petersi grahami Van Dyke, a carabid that has been collected as high as Heliograph Peak have been found within the project area. Another carabid. Trechus arizonae Casey, is also an endemic found within the cienegas (above 10,000 feet) within the project area.

Ten species of insects found within the study area may be endemic to Mt. Graham (Table 36, Appendix 2). These species have been found only on Mt. Graham. No other specimens have been found in the University of Arizona entomology collection and no references to them appear in the literature on Arizona invertebrates.

Two large snails and seven small mollusks (three determined only to the generic level) can be found within the project area (see Appendix 2). The two large snails are endemic to the Pinalenos. There are no mollusks endemic only to the project area. None of the mollusk populations are considered rare nor endangered within the proposed project area. Sonorella favors steep, rock slides and talus slopes which would not be affected by the proposed project.

2. Effects of Alternatives

General Comments

Alternatives A, B, and C all maintain animal diversity within the 3500 acre area. The long term effect of Alternative A could be the reduction of conditions needed for old growth dependent species to maintain their populations, including the Mount Graham red squirrel. In addition, species dependent on high densities of vegetation may also suffer some habitat reduction.

Alternative B has increased emphasis on dispersed recreation activities which would be coordinated to maintain and improve wildlife habitats. There would be long term increases in old growth acres and quality through natural succession which would enhance habitats for dependent species.

Alternative C allows opportunities for enhanced wildlife habitat by designation of 1000 acres of wilderness and 680 acres of Zoological/Botanical Area (ZBA). These designations would actively contribute towards the management of old growth forest characteristics and therefore, sustain or enhance the habitats for dependent species.

Under all three non-development alternatives, there is a 20% risk of the Mount Graham red squirrel becoming extinct within 30 years. (See Appendix 2 for a discussion of the population risk analysis.)

While direct habitat losses would occur from the development alternatives for many wildlife species, these adverse impacts would alter the habitat capability by less than 15% for most of the species found within the 3500 acre management area based on the habitat capability model (see Appendix 2). The effect of this loss on current populations is not thought to be significant. These alternatives do have the potential to significantly effect Mt. Graham red squirrel and black bear populations in the area and will be discussed in more detail below.

Threatened, Endangered, or Sensitive Species

Alternatives A and B would have no significant adverse effects on Arizona (Apache) trout, peregrine falcon, southern spotted owl, or twin-spotted rattlesnake. Under alternative C, beneficial effects can be expected for these species with each activity or management decision that increases the protection of the area from human disturbance and allows vegetation to age and thicken. The effects of the other alternatives are shown below.

A. Arizona (Apache) Trout - (Federal Threatened)

All water is being hauled for alternatives D and PA. For alternatives E and F, water captured for astrophysical project use within Deadman Creek would reduce the quantity of water for fish habitat. The project would also impact the headwaters of Grant Creek to the southwest. Presently, plans are to capture water in such a way and during high runoff times that there would be no significant effect on quantities in the Arizona Trout habitats.

While water quality during construction would be protected by strict adherence to construction specifications, the increasing amounts of construction and subsequent increase in traffic on the unsurfaced roads would mean slightly greater potential for sediment production for each of the development alternatives in order of acres impacted. Water quality during storm runoff would be protected by capturing runoff. (See Chapter 3 Section E for discussion of these factors).

Management in the ZBA, Wilderness, and Dispersed Recreation areas would not affect Arizona Trout or their habitat.

The net affect would be no significant impact on Arizona Trout, stream organisms, and trout habitat.

B. Peregrine Falcon (Federal - Endangered)

In alternative D, the direct loss of habitat at sites 3, 6, and 7 (15 acres), including a logistics site and the loss of 14 acres (retention, widening, and realignment of Forest Road 507) would reduce the food base for band-tailed pigeon, a staple or preferred peregrine food. The population of birds of the old growth (woodpeckers, etc.) would also decline due to the loss of these acreages. Other indirect affects would bring about a change in bird species composition. Actual quantity of birds available as prey for peregrine may not be significantly changed. This change may produce fewer large bird prey species (band-tailed pigeons, woodpeckers) requiring greater effort by the peregrine (more catches) to meet its daily needs.

Each subsequent alternative would then effect an increased amount of acreage designated for it's needs. In addition, increased human presence in the development alternatives would increase the likehood of disturbances to both feeding habitats and eventually some potential nesting sites.

The PA, with a smaller acreage (7 acres) being directly impacted, would have a decreased impact on both food and disturbance compared to the other development alternatives.

Additional studies are needed to quantify this food base alteration and possible reduction. While these changes are a negative impact at this time, it is believed they would have no significant effect on peregrine falcon population.

Management within the ZBA, the wilderness, and dispersed recreation areas would have no significant effect on the peregrine.

<u>Summary of Impacts on State Listed Forest Service Sensitive and Federal Candidate Species - Category 2</u>

A. Southern Spotted Owl

For alternative D, the total direct habitat loss of 39 acres including 15 acres of astrophysical exclusive use is a negative impact. However, loss to spotted owl cannot be quantified because data is not available to determine the level of use of these acres.

Suitability of the habitat in the restricted use area (284 acres) would be partially sustained for spotted owl due to restricting negative campfires and vehicles.

In alternative E, the total direct habitat loss of 71 acres including 31 acres of astrophysical exclusive use is a negative factor. However, loss to spotted owl cannot be quantified because data is not available to determine the level of use of these acres.

Suitability of the habitat in the restricted use area (738 acres) would be partially sustained for spotted owl due to restricting nighttime campfires and public vehicle access at night.

In alternative F, the total direct habitat loss of 105 acres including 60 acres of astrophysical exclusive use is a negative factor. Suitability of the habitat in the restricted use area (1240 acres) would be partially sustained for spotted owl due to restricting nighttime campfires and public driving access day-night all year.

In the PA, the total direct habitat loss of 23 acres including 7 acres of astrophysical exclusive use is a negative factor. This loss to spotted owl cannot be quantified because data is not available to determine the level of use of these acres.

Suitability of the habitat in the restricted use area (123 acres) would be partially sustained for spotted owl due to restricting campfires and vehicles.

In the remaining 3500 acres:

Management activities in the remaining areas, ZBA, and dispersed recreation would have little or no significant effect on spotted owl over the short term. Over the long term, increasing recreation uses would need to be monitored to detect any significant impacts.

The net affect is a loss of habitat which with our present data cannot be quantified. If a development alternative is selected, additional data on spotted owl numbers, preferred habitats, movement, etc. would be needed to understand and mitigate any losses.

B. Twin-Spotted Rattlesnake

Twin-spotted rattlesnake habitats would not be significantly impacted by construction activities for any alternative for the project. Increasing numbers of visitors could impact the species through illegal killing and/or capturing specimens and accompaning habitat disturbance and therefore the potential for impact does increase for each alternative that attracts or brings more visitors or residents to the mountain.

Management of visitor uses, numbers, locations of camp areas, etc. throughout the ZBA, wilderness, and dispersed recreation areas can be coordinated to sustain habitats for this species.

The net result is little or no significant effect upon Twin-spotted rattlesnake over the long term.

C. Other Species and Special Habitats

Astrophysical development would produce direct habitat losses on disturbed and occupied sites. With the present level of knowledge, the species impacted, the significance of losses and other indirect impacts cannot be quantified. What is known is that urbanization of these highest mountain tops in southeast Arizona, with its unique assemblage of plants, animals, climate, and location, evolving over time into a special one of a kind ecosystem, would be forever altered. Alternatives that have more construction associated with them would increase the relative effects on natural changes, adaptations, specialization, genetic diversification; processes could be disrupted, halted completely or altered in unknown ways. These near natural conditions and the opportunity to describe and understand the various species and their interrelationships potentially may be lost with the project. This lost opportunity for knowledge of existing conditions, and knowledge which could be gained in future studies and observations is irretrievable and irreversible with the project.

Habitat restoration after the life of the project could restore many plant species and recolonization by animal species from adjoining areas would occur but would not duplicate the present ecosystem.

The net result is the potential loss of a special ecosystem and the information it holds.

Mt. Graham Red Squirrel (Proposed Endangered Species)

This small squirrel population is more vulnerable to natural decimating events such as drought, fire, insect epidemics, and windthrow than most wildlife species because it consists of a relatively small population in limited habitat and is completely isolated from other red squirrel populations. See Spicer's "Status of the Mt. Graham Red Squirrel of Southeastern Arizona", August 1985. Its vulnerability has been further increased over the last 100 years through loss of habitat from human related activities such as timber harvest, road and fuelbreak construction, and possibly the introduction of the tassel-eared (Aberts) squirrel.

Red squirrel middens (cone caches) are the indicator used to assess the squirrel population and predict the effects of the alternatives on the squirrels.

Middens were counted and mapped in May and June 1986. Middens counted as lost are those where construction of roads, buildings, tree cutting, etc. would take place within a one acre circle around the midden. Middens were mapped on reproductions of aerial photographs showing project locations, as shown in the May 1, 1986 Site Development Plan (Steward Observatory, 1986). Due to possible mapping errors of these midden locations, numbers of middens lost are an estimate, rather than an actual count. Loss of additional middens due to projected windthrow, increased temperatures and resulting dryness adjacent to project construction tree clearings may occur. (See Appendix 2 for more detail on the midden search).

Studies have shown that a midden is defended by one Red Squirrel regardless of sex, and that home range and territories around the midden tend to be circular. Home ranges vary in size from less than one acre to several acres (Smith, Christopher C. 1968 and 1981 also Flyger and Gates 1982). Home ranges on Mt. Graham, therefore, are considered to range from one to four acres. Midden locations were mapped showing both one acre and four acre circles.

Middens would be directly (lost) or indirectly affected by being obliterated, by the loss of the nest tree, by the loss of the primary cone producing trees, by altering the cool moist conditions at the middens which conserve the cones and by man's presence and activities, or combinations of all these factors.

Opening the timber stand on the ridge top may bring additional windfall losses of trees in the adjoining areas. (Alexander, 1986). Additional windfall losses could occur along FR 507 as the road width is increased. All windfall habitat losses could mean a loss of from two to twenty acres total.

The direct and indirect loss and/or degradation of the habitat occurs mostly in the best Red Squirrel habitat. Eighty one percent of the middens located in the 3500 acre management area are in Spruce-Fir habitats above 10,200 ft.

Alternatives that have increased human activities increase the effects on Mt. Graham red squirrel habitat and population. Effects on the red squirrel population was estimated by using habitat and population simulation models. (See Appendix 2).

Alternatives A, B, and C do not propose additional activities which would adversely affect the number of squirrel middens directly or indirectly. Alternatives B and C would result in long term enhancement of red squirrel habitat. However, because of existing limited habitat all three alternatives have a 20 percent risk of the species becoming extinct within 30 years. (See Appendix 2 for a detailed discussion of the population risk analysis).

In Alternative D, it is estimated that fifteen Mt. Graham red squirrel middens would be directly affected. These middens are considered lost to the population (based on the one acre area of influence for each midden mentioned above). The loss of these 15 middens is significant because not only is a cone cache eliminated and an individual squirrel displaced, but it is unknown whether another site can be found with all the necessary conditions for the establishiment of a new midden. The presence of many large middens indicates that each has existed for a long period of time and has been occupied by a succession of individual squirrels. Such persistence suggests that these locations may be the best locations for the placement of middens. Thus the 15 sites may be irreplaceable.

Four other middens would be indirectly affected. Indirectly affected middens are those where the construction activity falls within the four acre circle.

Construction at Sites 3, 6, and 7 may not directly or indirectly impact middens but are lost as potential habitat for the life of the project.

Table 17 - Habitat Losses - Alternative D

Direct Habitat Losses		
Astrophysical Sites 3, 6, and 7 and Logistics Site 12 or 13	15	acres
Retention and widening of FR 507	14	acres
Windfall at sites and along FR 507	10	acres approx.
	39	acres total (direct)
Indirect Habitat Losses or Degradation in:		
Perimeter areas affected around Sites 3, 6, and 7	8	acres
Habitats 100 ft. either side of FR 507	116	(50 ac. above 10,200')
	124	acres total (indirect)

The direct loss of 39 acres and indirect loss of 124 acres, including approximately 100 acres in the best Red Squirrel habitat, is a significant loss. Such loss places the Red Squirrel in even greater jeopardy of extinction and compounds the problems of improving its habitat and increasing its numbers to remove it from jeopardy.

The risk analysis of Alternative D indicates that over a 30 year period there is a 45 percent probability of extinction.

In Alternative E, it is estimated that 14 Mt. Graham red squirrel middens would be directly affected. These middens are considered lost to the population as a result (the number lost is based on the one acre areas mentioned above). The loss of these 14 middens is significant because not only is a cone cache eliminated and an individual squirrel displaced, but it is unknown whether another site can be found with all the necessary conditions for the establishment of a new midden. The presence of many large middens indicates that each has existed for a long period of time and has been occupied by a succession of individual squirrels. Such persistence suggests that these locations may be the best locations for the placement of middens. Thus the 14 sites may be irreplaceable.

High Peak (site 3) has some man caused disturbance while Emerald Peak (site 1) is a relatively undisturbed old growth Spruce-Fir habitat. Up to 31 acres of habitat in this alternative would be converted to roads, buildings, observatories, etc. and would no longer be habitat for the red squirrel or any other species. Seven middens would be directly affected at sites 1 and 3. Seven additional middens would be directly affected by the road widening and construction for the interferometer.

One other midden would be indirectly affected. Indirectly affected middens are those where the construction activity falls within the four acre circle. There could be three other possible middens affected in a worst case scenario.

Other areas at sites 1 and 3 where construction occurs may not directly or indirectly impact middens but are lost as potential habitat for the life of the project.

Table 18 - Habitat Losses - Alternative E

Direct Habitat Losses		
Astrophysical Sites 1 and 3 and Logistics Sites 12 or 13	31	acres
Retention and widening of FR 507, 669 including the interferometer	25	acres
Windfall at sites and along roads	15	acres approx.
	71	acres total (direct)
Indirect Habitat Losses or Degradation in:		
Perimeter areas affected around Sites 1 and 3	10	acres
Habitats 100 ft. either side of FR 507/669	141	(50 ac. above 10,200')
	151	acres total (indirect)

The direct loss of 71 acres and indirect loss of 151 acres, including approximately 100 acres in the best Red Squirrel habitats, is a significant loss. Such habitat losses place the Red Squirrel in even greater jeopardy of extinction and compounds the problems of improving its habitat and increasing its numbers to remove it from jeopardy.

The risk analysis of Alternative E indicates that over a 30 year period there is a 50 percent probability of extinction.

In Alternative F, it is estimated that twenty-four Mt. Graham red squirrel middens would be directly affected. These middens are considered lost to the population as a result. The loss of these 24 middens (based on the one acre areas mentioned above) is significant because not only is a cone cache eliminated and an individual squirrel displaced, but it is unknown whether another site can be found with all the necessary conditions for the establishment of a new midden. The presence of many large middens indicates that each has existed for a long period of time and has been occupied by a succession of individual squirrels. Such persistence suggests that these locations may be the best locations for the placement of middens. Thus the 24 sites may be irreplaceable. Seven of the 24 middens are directly affected by the road widening for the interferometer.

Ten other middens would be indirectly affected. Indirectly affected middens are those where the construction activity falls within the four acre circle. There could be eight other possible middens affected in a worst case scenario.

Other areas at sites 1 through 11 where construction occurs may not directly or indirectly impact middens but are lost as potential habitat for the life of the project.

Table 19 - Habitat Losses - Alternative F

Direct Habitat Losses		
Astrophysical Sites 1 through 11 and Logistics Sites 12, 13, or 14	60	acres
Retention and widening of FR 507/669 and the interferometer	25	acres
Windfall at sites and along FR 507/669	20	acres approx.
	105	acres total (direct)
Indirect Habitat Losses or Degradation in:		
Perimeter areas affected around Sites 1 through 11	33	acres
Habitats 100 ft. either side of FR 507/669	141	(50 ac. above 10,200')
	174	acres total (indirect)

The direct loss of 105 acres and indirect loss of 174 acres, including approximately 100 acres in the best Red Squirrel habitats, is a significant loss. Such habitat loss place the Red Squirrel in even greater jeopardy of extinction and compounds the problems of improving its habitat and increasing its numbers to remove it from jeopardy.

The risk analysis of Alternaitve F indicates that over a 30 year period there is a 50 percent probability of extinction.

In the Forest Service Preferred Alternative (PA), it is estimated that four Mt. Graham red squirrel middens would be directly affected (based on the one acre area of influence). These middens are considered lost to the population as a result. The loss of these four middens is likely insignificant but loss of these middens would cause adverse modification of proposed critical habitat. It is unknown whether other sites for middens can be found with all the necessary conditions for the establishment of new middens. The presence of many large middens indicatesthat each has existed for a long period of time and has been occupied by a succession of individual squirrels. Such persistence suggests that these locations may be the best locations for the placement of middens. Thus the four sites may be irreplaceable.

Two other middens would be indirectly affected. Indirectly affected middens are those where the construction activity falls within the four acre circle.

Other areas at site 3 where construction occurs may not directly or indirectly impact middens but are lost as potential habitat for the life of the project.

Table 20 - Habitat Losses - Alternative PA

Direct Habitat Losses		
Astrophysical Site 3 and Logistics Site 13	7	acres
Retention and widening of FR 507	14	acres
Windfall at sites and along FR 507	2	acres approx.
	23	acres total (direct)
Indirect Habitat Losses or Degradation in:		
Perimeter areas affected around Site 3	4	acres
Habitats 100 ft. either side of FR 507	116	(50 ac. above 10,200')
	120	acres total (indirect)

The direct loss of 23 acres and indirect loss of 120 acres, including approximately 80 acres in the best Red Squirrel habitats, is a significant loss. Such loss places the Red Squirrel in even greater jeopardy of extinction and compounds the problems of improving its habitat and increasing its numbers to remove it from jeopardy.

The risk analysis of the PA indicates that over a 30 year period there is a 35 percent probability of extinction.

Black Bear

Alternatives A and B would have no significant effects on black bear habitat. Alternative C would be highly beneficial.

The development alternatives (D, E, F, and PA) would cause direct habitat loss in the exclusive astrophysical use areas.

These areas produce food for bear during the spring from snowmelt when lower habitats are drying up. These highest centrally located areas in the Pinalenos are available to bear from every direction and are critical in providing food shortly after bear emerge from hibernation. Bear would return to these habitats again in the fall, after the summer rainy season has produced berries, grubs, grasses, etc. (again lower elevations would be drying up with decreasing food values).

Use of fences in or around the exclusive use areas would restrict bear movement and interfere with their needs and reducing habitat available for bear.

The development alternatives would also cause some additional indirect habitat losses. Man's presence, buildings, more roads, noises of many kinds, lights, dogs, autos, and other activities in effect urbanizes a limited but key bear habitat type which represents an integral part of the surrounding bear habitats and would cause change in bear behavior. The limited area of high elevation habitat concentrates bears during the spring in the proposed project areas. Bear accommodations to these intrusions would alter bear-to-human relationships, bear home ranges, movements, and would ultimately displace individual bear and reduce bear density. Individual bear who become adapted to these factors and conditioned to man's intrusion would be more vulnerable to loss. Adapted bears are usually lost from hunting, translocation (nuisance bears) and illegal kills usually the first year after they become "adapted." As adapted bear are lost from the urbanized-preferred key habitats, they would be replaced by other bear, and the cycle would repeat. This would affect a much larger portion of the bear habitat and bear population than is represented by the project acreage. Over time this could adversely affect the entire bear population. This is a critical factor since the Pinaleno bear population is geographically isolated and replacement from adjoining bear populations would not occur. As the number of visitors to the area increase, these adaption losses would increase.

The net effect is a direct loss of habitat and creation of an urbanized intrusion into unique bear habitat, which insidiously would deplete bear numbers over time. Adaptation bear losses would increase as astrophysical project activity increases and as visitor numbers and activities increase. Intensive studies of bear movements, habitat utilization, and adaptive behavior patterns would seek ways to mitigate bear losses if a development alternative is selected.

The habitat losses would not only be the direct types but also there would be a loss of effectiveness due to the types of disturbances mentioned above. Based on the factors in the Habitat Capability Model (see Appendix 2) for this area, the total loss of effective habitat for the total black bear population would lead to a reduction of at least 2% in habitat capacity for the PA, 5% for alternative D, 7% for alternative E, and more than 10% for alternative F.

Table 21 Summary of direct effects of Alternatives D, E, F, and PA.

Table Habitat Losses Alternatives D, E, F, PA

	Exclusive Use Area	Road 507/669	Wind Fall
Alternative D:	15 acres	14 acres	10 acres
Alternative E:	31 acres	25 acres	15 acres
Alternative F:	60 acres	25 acres	20 acres
Alternative PA:	7 acres	14 acres	2 acres

E. WATER QUANTITY, QUALITY, AND CIENEGAS

1. Existing Situation

Water Quantity

The rain/drought precipitation pattern limits water quantity. Of an average 35 inches of precipitation per year, about 60 percent falls as snow. The remaining 40 percent is rain, and generally falls in July, August, and September. There are dry periods in both spring and fall. The six streams that head up along the crest of the Pinalenos are small. Marijilda, Deadman, Frye, and Ash creeks drain towards the Gila River. Grant and Big creeks drain into the Sulphur Spring Valley. Their existence is due in part to the heavy snow accumulation that feeds water to the streams late into the spring drought. The lowest flows occur in years of low snowfall, years with small summer rains, or years of late summer drought. Most of these streams appear to originate in springs and seeps which may be controlled by local faults or relatively shallow joint sets but are commonly associated with a steepening of the gradient and/or basal contact of soil and alluvium with the underlying bedrock. The channels are generally in bedrock for most of their length.

Water quantity measurements show that total volumes are low. Those measurements, taken by the USDI Geologic Survey, were at downstream locations in Frye, Deadman, and Marijilda Creeks. No records of flow have been kept at mountaintop locations, except for single readings in the Fall of 1984 that serve to put volumes of flow in perspective.

Water Quality

Water quality in the Pinalenos is high. Testing for fecal coliform bacteria indicates that levels of contamination are well within the standards for all uses except direct domestic uses. Simple purification methods would allow achieving those standards. Testing for a variety of chemical constituents also indicates that standards for all uses would be met. These tests were performed on Marijilda, Ash, and Big Creeks at points in recreation areas below the headwaters and at the base of [illegible] mountain over a period of years. Recent tests on water in springs, streams, and creeks have been performed and they indicate exceptionally high water quality in the headwater areas as well.

Cienegas

The north and east facing slopes contain three cienegas or alpine meadowlands unique to southern Arizona (Figure 3, section B). These cienegas are unique because they produce perennial surface water at the headwaters. This water surfaces as a result of a large accumulation of snowmelt in bowl-shaped watersheds (as opposed to surfacing at a point associated with steepening gradient as in other springs on the mountain). The cienegas occur between 10,200 and 10,400 feet in the Pinalenos. They are characterized by low relief and broad depression in an otherwise mountainous area, extensive soil development in an otherwise rocky terrain, unique soils which alternately freeze then thaw, become seasonally anoxic-reducing, have high organic content and slow percolation rates, and a unique bog-like vegetation that supports a richer variety of flora and fauna than the surrounding conifer forest. They may also contain a valuable record of pollen useful in reconstructing Pleistocene climatic change.

2. Effects of Alternatives

Water Quantity

There would be no significant effects on water quantity within the streams, in cienegas, or in springs for Alternatives A, B, and C.

Water quantity (flow in the streams) would be altered by alternatives D, E, F, and PA. Construction and continuing operation of proposed facilities would cause hydologic impacts of various kinds. The constructed facilities and associated activities that would initiate such impacts would be as follows:

1. vegetative clearing
2. road clearing, overuse and/or use during poor road conditions
3. parking areas and turnouts
4. buildings
5. water storage and treatment facilities
6. wastewater disposal areas

In alternative D, approximately 15 acres would be cleared, for alternative E, approximately 31 acres, for alternative F. approximately 60 acres, and for PA approximately 7 acres.

Forest Road 507 would be paved from the turnoff at Swift Trail for alternatives E and F, with runoff being rerouted using culverts and inslope drainage in all development alternatives. In general, increased runoff from roads and parking areas can be controlled by an appropriate design which would discharge the water at a series of points to disperse the runoff and not concentrate an excessive amount at any one locality. In road and building construction, earth embankments would be formed and maintained to best enhance stabilization and revegetation. On High Peak, existing vegetation would be preserved to the maximum extent possible, and revegetation would be done in intervening areas. If erosion producing runoff occurs, it would be directed downslope (northward or eastward, to avoid cienega areas) to established watercourses for added flow or to talus slopes for absorption.

Similarly, runoff generated by parking lot surfaces and building roofs would be directed by the finished grade toward a low side or a low corner from which the collected runoff again must be dispersed so as to avoid undue erosion below. An option is to consider the parking area or roof as a water catchment, and retain the collected runoff for subsequent use.

The size of the cleared area, when compared to the watersheds of the associated cienegas and streams, is small for all development alternatives. Total runoff increases would average no more than 1 percent for Ash Creek watershed within the 3500 acre management area. 9 percent for Frye Creek watershed within the management area, 10 percent for Deadman Creek watershed within the management area, 3 percent for Marijilda Creek watershed within the management area, and 6 percent for Grant Creek watershed within the management area (see Table 22 for estimates of increase by alternative). These increases would be most noticeable during years of low summer precipitation, when storms would produce direct runoff from developed areas while undeveloped would tend to intercept the majority of the rainfall through infiltration into the soil. During years of high precipitation when large amounts of water would be contributed from every acre, the increases due to clearing would be less noticeable. In these bedrock channels, no adjustments in channel gradient wouldoccur due to these increases.

Table 22 Estimates of Water Yield Increase by Alternative

Acre-Feet Water Yield Within the 3500 Acre Management Area
%Increase

Watershed	Current Yield	Alt D Yield	Alt E Yield	Alt F Yield	PA Yield
Ash	238	238 (0%)	241 (1%)	241 (1%)	238 (0%)
Frye	222	234 (5%)	238 (7%)	243 (9%)	230 (4%)
Deadman	166	179 (8%)	171 (3%)	183 (10%)	171 (3%)
Marijildal	562	569 (1%)	569 (1%)	581 (3%)	562 (0%)
Grant	602	611 (1%)	624 (4%)	642 (6%)	603 (<1%)

At the same time that increases in water flow is an insignificant item, the concern of water flow reduction due to withdrawals for the development and management of the sites must be dealt with. There would be no impacts for the period of time that water is hauled from the City of Safford diversion on Deadman Creek. Should Steward Observatory succeed in transferring the point of diversion from its downstream location to some point within the 3500 acre area, the diversion would have the following effects. At the downstream location (Safford's withdrawal point), the quantity of water needed would amount to up to 7 percent of the total water yield during low flow years. At the 3500 acre management area boundary, it would amount to 35 percent. Up high in the watershed, the quantity of water needed could amount to 22 percent of the flow of High Peak Cienega, the headwaters of Deadman Creek. These amounts would be critical when considering wildlife and plantlife downstream from the withdrawal point. Such a rate of depletion may contribute to the drying up of some reaches downstream during periods of low flow, resulting in deprivation of adequate moisture for sustaining the existing riparian plant life, fish, or other aquatic life in or adjacent to the streams. This situation would be mitigated by devising a method that would not divert water when flows are below the level necessary for maintenance of the aquatic life (see wildlife and vegetation sections C and D). No water should be withdrawn from any sources other than Deadman Creek because of the water rights problems and resource problems associated with multiple facilities as opposed to confining the potential damage to one watershed. If more water is required, cisterns, rooftop collection systems, etc. should be considered before seeking water from other surface water sources.

Water Quality

There would be no significant effects on water quality in any of the streams, springs, or cienegas in alternatives A, B, and C.

For the development alternatives (D, E, F, or PA), runoff generated by paved surfaces traversed by motor vehicles, such as roadways or parking areas, commonly contains dissolved organic compounds such as those from petroleum derivatives, as well as trace metals. These quality factors must be considered carefully if the collected runoff is to be salvaged and used.

The projected construction and operational activities of the development alternatives would cause no significant increase in sedimentation. Possible impairment of water quality in downstream waterways could take the form of dissolved organic compounds and/or trace metals from petroleum products, paint, etc., during construction, but would have minor significance in terms of total volume/concentration. Discharges from water treatment facilities and wastewater disposal areas would take the form of nutrients, trace elements, or dissolved organic and inorganic compounds.

Buried water or power lines tend to cause runoff to follow the alignment downslope, cutting into the disturbed earth, the trench, and the backfill in the trench. The impact of trench erosion along buried lines would be minimized when working on a steep slope. Methods include varying the alignment on a

zig-zag course and installing herringbone type water bars, cutting a trench of minimal width to accommodate the buried line, and backfilling the trench with fine material topped with a ridge of courser conglomerate which would tend to shed rainfall and runoff toward the sides and prevent gullying along the alignment.

Water quality degradation would be mitigated by controlling storm runoff from potentially contaminated surfaces such as parking areas, and either concentrating such runoff in a wastewater treatment system; or diluting and dispersing the runoff in nonsensitive areas away from watercourses.

Cienegas

There would be no significant effects on water quantity/ quality in cienegas in alternatives A, B and C.

The development alternatives (D, E, F,or PA) could cause adverse impacts by any interruption of the soil zone by cutting into the cienega watershed surface, any pumping of water from the groundwater basin of the cienega or any diversion of surface flow above the outlet of the cienegas. Avoidance of impacts on water quality and quantity in cienegas can be accomplished by locating construction and operational activities outside of the cienega watersheds.

Increased visitation may have some effects on cienegas. Trampling of vegetation may destroy vegetation. Trampling includes off-road vehicle parking, horses, and off-trail hiking. Plant collecting may impact endemic, rare or unique species.

The specific risks of impact for alternative D would be that site 7 cuts into the watershed of High Peak Cienega, and the existing road to site 3 cuts through the watershed of Bearwallow Cienega. The effects of the road to site 3 have already occurred. Construction or use of the portion of site 7 would be avoided and no significant effects are anticipated.

The specific risks of impact for alternative E are that site 1 would cut into the watershed of Emerald Spring Cienega and the existing road to site 3 and the interferometer cuts through the watershed of Bearwallow Cienega. The effects of the road to site 3 have already occurred, and no additional effects due to the road are anticipated. Construction in or use of the critical portion of site 1 would be avoided to the extent there would be no significant effects. The interferometer construction in the watershed of Bearwallow Cienega would be avoided to the extent there would be no significant effects.

The specific risks of impact for alternative F are that sites 1 and 2 cut into the watershed of Emerald Spring Cienega, but construction in or use of those portions would be avoided to the extent that there would be no significant impact. The existing road to site 3 cuts through the watershed of Bearwallow Cienega. The effects of the road have already occurred, and no additional effects are anticipated. Sites 2, 3, and the interferometer also cut through the watershed of Bearwallow Cienega, but construction in or use of those portions would be avoided to the extent that there would be no significant impact. Sites 4, 5, and 7 cut into the watershed of High Peak Cienega, but construction in or use of those portions would be avoided to the extent that there would be no significant impact.

The specific risk of impact for the Forest Service Preferred Alternative (PA) would be that the existing road (FR 507) to site 3 cuts through the watershed of Bearwallow cienega. The effects of the road to site 3 have already occurred and no additional effects are anticipated. Logistics site L-13 would be moved out of the Bearwallow cienega watershed.

F. AIR QUALITY

1. Existing Situation

Current air quality conditions on Mt. Graham are very good. Natural additions to the air come from forest fires, decaying vegetation, turpenes from conifers, dust from wind action, spores, and pollen.

The major source of unnatural air pollutants is dust and exhaust from recreational vehicles. Vehicle emissions are currently estimated as displayed in Table 23. Mt. Graham is approximately 40 to 50 miles from major sources of industrial pollutants. Copper smelters are the largest source of pollutants in the region. Mt. Graham is centrally located between four smelters: Douglas (80 miles to the south), San Manuel (45 miles to the west), Hayden (60 miles to the northwest), and Morenci (40 miles to the northeast). Copper smelters may contribute up to 50 percent of atmospheric sulfates at distances of up to 350 miles from any smelter source, and larger percentages at nearer sites (Eldred, et. al., 1983). Mt. Graham is well within the zone within which smelter emissions can reduce air quality. However, the usual level of the atmospheric inversion is several thousand feet below the summit at 6,000 to 8,000 feet and air quality at the peak is generally not affected by smelter emissions.

TABLE 23
EMISSION ESTIMATES[1]

Pollutant	Emission Factor (g/mi)	Emissions (lb/day)
CO	15.65	136.0
NOx	2.08	30.4
SO2	0.24	2.4
Particulates	0.34	3.2

Environmental Protection Agency. 1977. Compilation of air pollution emission factors, supplements 1-14. Publication AP-42.

2. Effects of Alternatives

There would be no significant effects on air quality for alternatives A, B, and C.

The construction of the project for alternatives D, E, F or PA would contribute the largest amount of air pollutants. Increases in air pollutants are expected to have no significant effects.

The major air pollution emissions during construction of the proposed observatory would be fugitive dust and construction equipment exhaust emissions associated with grading, filling and clearing land. Exhaust emissions would be dispersed along State Highway 366 and Forest Road 507 and would include carbon monoxide (CO), Sulfur oxides (SO), nitrogen oxides (NO_x), total suspended particulates (TSP), and hydrocarbons (HC). Emissions were calculated using Environmental Protection Agency AP-42 emission factors (Environmental Protection Agency, 1977). Exhaust emissions estimates are presented in Table 24. Fugitive dust emission was estimated using AP-42 emission factor of 1.2 tons of particulates per acre-month and assuming a maximum of 20 acres cleared at one time.

The major air pollution emissions during operation of the observatory would result from exhaust emissions from passenger vehicles transporting employees and visitors to the observatory along State Highway 366 and Forest Road 507. The emission factors used to estimate emissions are the same as those presented above. A maximum number of 17,000 vehicle round trips for both personnel and visitors, for a total of 5,830 miles per day would result in the following estimated daily emissions during the peak visitor season: CO. 201 lbs.; NO 45 lbs.; SO_2, 3 lbs.; and TSP, 4 lbs.

TABLE 24

ESTIMATED CONSTRUCTION EMISSIONS FOR THE PROPOSED MT. GRAHAM ASTROPHYSICAL DEVELOPMENT[1]

Equipment	Work-Days Required	Fuel Required Gal/Day	Fuel Required Total Gal.	Total Emissions (lbs) CO	NOx	SO_2	TSP
Bulldozer/-Grader	25	90	2,250	214	832	61	29
Truck. Semi-Trailer	60	72	4.320	410	1,598	130	56
Truck. 2-Ton Utility	400	68	27,200	2,584	10.064	816	354
Air Compressor	100	20	2,000	190	740	60	26
Truck. Welder	40	45	1,800	171	666	54	23
Total				3,569	13.900	1,121	488

Calculations assume diesel fuel used in all vehicles with 0.25 weight-percent sulfur or less.

G. VISUAL QUALITY

1. Existing Situation

The naturally established landscape being viewed in the 3500 acre area has common visual characteristics throughout. There is one characteristic landscape. The visual quality objective is retention.

The land form is steep mountain slopes with rocky ridgetops apparent. Rock outcrops are obvious on the tops of ridges and peaks. The outcrops provide variety in form and contrast with the terrain of the forest floor.

When viewed as foreground, the strongest visual element is the repetition of the vertical lines of the Spruce-Fir vegetative type. Other evidences of line are the edges of the clearings and the line formed by the tree tops being viewed with the sky as the backdrop. Clearings occur throughout the area. Natural openings surround the three cienegas. Other openings were caused by timber harvesting and roads. Changes to the vertical lines of the spruce and fir and to the horizontal line formed by the tree tops would be very obvious due to the constrast between the dense tree color and the sky. Introduced changes to the line of the edges of the clearings could be absorbed if done in naturally occurring patterns and if no structures were permitted to dominate the open areas.

When viewed as middleground the area is characterized by the fine vegetative texture that appears uninterrupted. Individual tree forms are not discernable. When viewed as middleground or background. small vegetative clearings could be cut without visually dominating the natural character. However, the landscape could not visually absorb large clearings.

When the area is viewed as background, there is uniform color during some of the year. In the fall the change of leaf color in the broadleaf trees assumes temporary strength as a visual dominance element and dominates the scene. In the winter the blanket of snow causes the landscape to have little color

variation and the forms dominate. In spring the wildflowers add variety and color to the open areas. The change in color and texture is obvious at the riparian areas and the three cienegas. Here vegetation color and form changes visually throughout the year due to the growth cycles of the forbs and grasses, and due to the weather and moisture patterns. Changes in moisture patterns can cause changes in species diversity and/or vigor affecting the visual variety of the area.

In the National Forest Visual Management System, Variety Classes are obtained by classifying the landscape into different degrees of variety. This determines those landscapes which are most attractive and those which are least attractive from the standpoint of scenic quality. The classification is based on the premise that all landscapes have some value, but those with the most variety or diversity have the greatest potential for high scenic value. There are three variety classes which identify the scenic quality of the natural landscape; Class A - Distinctive, Class B - Common, and Class C - Minimal. The 3500 acre area has been inventoried as Class A. Class A refers to those areas where features of landform, vegetative patterns, water forms and rock formations are of unusual or outstanding visual quality. These Class A areas are usually not common in this character type. Class A features usually exhibit a great deal of variety in form, line, color, and texture. Large old-growth timber is present. There is also a rich diversity in plant species in the 3500 acre management area.

Sensitivity levels are a measure of people's concern for the scenic quality of the National Forest. Sensitivity levels are determined for land areas viewed by those who are traveling through the Forest on developed roads and trails, and those using areas such as campgrounds and visitor centers, or are recreating at lakes, streams, and other water bodies. Three sensitivity levels are employed. Each identifies a different level of user concern for the visual environment; Level 1 - Highest Sensitivity, Level 2 - Average Sensitivity, and Level 3 - Lowest Sensitivity. The Sensitivity Level for most of the 3500 acre area is Level 1.

By combining the public's concern for visual quality (sensitivity levels) with the diversity of the natural features (variety classes) a visual resource management goal called visual quality objective (VQO) is determined. (See Glossary "Visual Quality Objective").

2. Effects of Alternatives

There would be no change in visual quality objectives in alternatives A and B. The visual quality objective (VQO) is retention on 3500 acres. In alternative C, VQO on a 1000 acre block would be changed to preservation. The VQO on the remaining 2500 acres would remain retention. In alternative C, there would be no significant impacts to visual quality other than natural processes.

In alternative D, VQO on a 1000 acre block would be changed to preservation. VQO on 2201 acres would remain retention. Two hundred and eighty four acres would be changed to partial retention and up to 15 acres to modification/maximum modification. Structures would be visible from distant viewpoints.

In alternative E, VQO on 2732 acres would remain retention. Seven hundred and thirty eight acres would be changed to partial retention and up to 31 acres to modification/maximum modification.

In alternatives E and F, the NNTT with a height approximating a 11 story building (110 feet), would extend above the average tree top height. The interferometer would be located immediately adjacent to Forest Roads 507 and 669. This visual impact could not be screened. The 6 separate telescopes of this array would be able to move along the roadway and could be located at up to 6 of 9 road side turnouts of approximately 1300 square feet each with mounting piers to be used as stations (see Figure 13, Interferometer, Appendix 1). Structures would be visible (and with the NNTT would dominate) from distant viewpoints and would be more obvious than in alternative D.

In alternative F, VQO on 2200 acres would remain retention. Twelve hundred and forty acres would be changed to partial retention and up to 60 acres to modification/maximum modification.

In alternative F, the NNTT and/or interferometer impacts are the same as in alternative E above. Structures would be visible (and with the NNTT would dominate) from distant viewpoints and would be most obvious in this alternative. The visual diversity of the area would increase but not to the extent of alternative D.

In the Forest Service Preferred Alternative (PA), the VQO on a 1000 acre block would be changed to preservation. VQO on 2370 acres would remain retention. One hundred and twenty three acres would be changed to partial retention and up to 7 acres to modification/maximum modification. Structures would be visible from distant viewpoints.

The effects on visual quality of a buried powerline in all development alternatives would be minimal and of short duration. In the long term, natural revegetation would minimize evidence of its presence. No significant adverse long term effects are expected on visual quality.

H. CULTURAL VALUES AND INDIAN RELIGIOUS VALUES

1. Existing Situation

Cultural resource surveys have been completed for areas where Steward Observatory proposes to conduct ground disturbing activities (Figure 4). These surveys were conducted by the Arizona State Museum at the University of Arizona (Forest Service Report Nos. 1985-066, 066A, 066B, 066C) and were carried out between October 1984 and October 1985. The surveys were confined solely to those areas specifically identified by Steward Observatory for development (e.g. telescope and facility sites, roadways, powerline corridor).

Three cultural resource sites have been located. Sites AR03-05-04-101 and AR03-05-04-102 are prehistoric artifact scatters with associated rock features. Site AR03-05-04-103 represents two small rock cairns of unknown age. Sites AR03-05-04-101 and 102 contain a clustering of plain brown and corrugated brown pottery along with a few decorated wares dating to the 11th and 12th centuries. They are small special use sites which may have been prehistoric "shrines".

Cultural resource clearance has been approved by the Forest Service for the areas surveyed provided that 1) the three sites would not be impacted by proposed astophysical developments, and 2) archaeological testing (clearing of forest ground cover) at Plainview Peak and Emerald Peak be conducted prior to proposed construction. The second requirement was made because of poor ground visibility at these locales and the possible existence of archaeological sites. The Arizona State Historic Preservation Officer (SHPO) has been consulted and concurs with these provisions. In addition, sites AR03-05-04-101 and 102 have been determined eligible for the National Register of Historic Places in consultation with the SHPO.

Native American tribes in Arizona and the Zuni Tribe in New Mexico were contacted by the Office of Arid Land Studies regarding possible cultural or religious use of the Mt. Graham area *(see* Chapter 5 for list of tribes contacted). The Zuni Tribal Council have responded that the archaeological sites may have played a role in Zuni traditional religious practices and beliefs. They requested that the sites be avoided and that their religious leaders visit the sites. The Zuni's visited the sites in late May 1986.

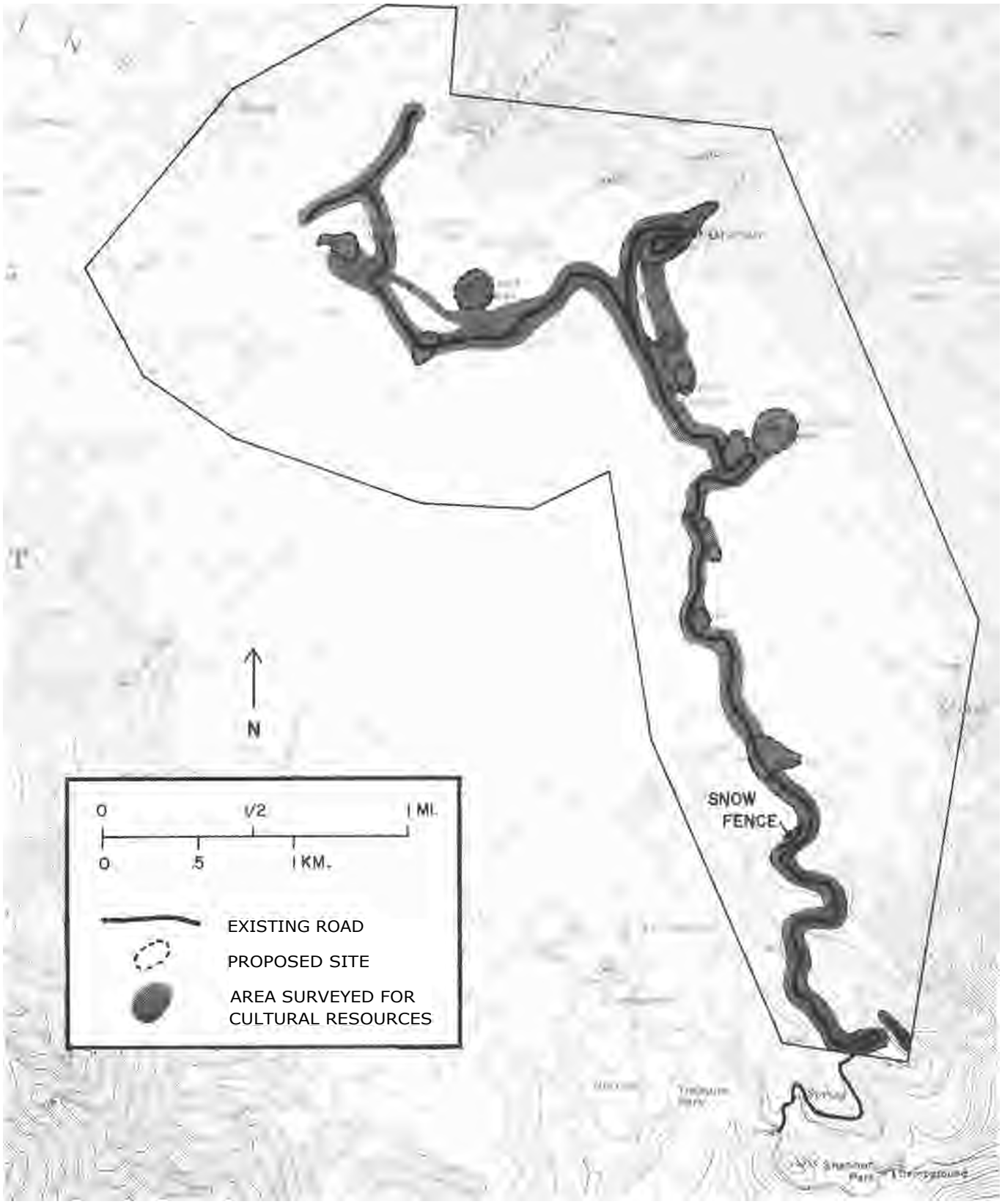

Figure 4 Area Surveyed for Cultural Resources.

2. Effects of Alternatives

Implementation of the nondevelopment alternatives (A, B, C) would not impact cultural resource sites located on Mt. Graham. Unauthorized disturbance of cultural resource sites is most likely to occur in alternative A than in either alternative B or C due to possible off road vehicle use. The Forest would, however, provide for increased protective measures at the sites. The publicity and locational information available as a result of the environmental analysis for proposed astrophysical development may increase the potential for disturbance or damage to the sites.

The rock cairns (AR03-05-04-103) lie within the astrophysical restricted area of alternatives D, E, F, and PA. Direct impacts to the site may occur if the location of a proposed spur road is not modified. Avoidance of the site should be possible. The rock cairns have not been formally evaluated in terms of the National Register of Historic Places eligibility criteria. If avoidance of them is not possible they must be more fully examined, i.e. evaluated. This evaluation could include a thorough search for other cultural materials in the area, dismantling of the cairns to determine internal contents and composition, and examination of the cairns in terms of possible trail markers.

The site in the vicinity of Hawk Peak (AR03-05-04-101) lies within the exclusive use area for astrophysical development in alternative F. Development would not impact the site because avoidance of the site area would be required. Even though the site would not be directly impacted by development activities, periodic monitoring would be necessary to determine if indirect effects to the site occur.

The site in the vicinity of Mt. Graham (AR03-05-04-102) lies within the exclusive use area for astrophysical development in all development alternatives (D, E, F, and PA). Avoidance of impacts to this site is more difficult than for the other site. The site is larger and its boundaries are difficult to determine because of previous disturbance and scattering of cultural material. Steward Observatory feels that impacts to the site can not be avoided if development occurs. A specific course of action to mitigate impacts to this significant site would be finalized only after Zuni religious leaders have further opportunity to comment. Final clearance, with mitigation plans, would be granted by the Forest only after consultation with the State Historic Preservation Office, the Advisory Council on Historic Preservation, and concerned Indian groups.

Presently no known impact on Native American religious use exists.

I. FIRE POTENTIAL

1. Existing Situation

The Spruce-Fir and mixed conifer forest at elevations above 9,500 feet is considered to be less flammable compared to other forest types at lower elevations. But, especially during late May and June, fire hazard is considered high on Mt. Graham. From 1970-1984, 13 fires occurred in this area. Ten were lightning caused fires, one was a recreational fire, and 2 were incendiary fires. Twelve of these were less than 1/4 acre, with the one incendiary fire burning a total of 10 acres. Large fires have occurred on Mt. Graham in the past. In 1956, the Nuttle Burn covered 5,000-6000 acres.

Two fire suppression areas are present in the Safford Ranger District. Mt. Graham lies within fire zone 1 in which fires are prevented from reaching or damaging high value resources and improvements. Few prescribed burns have been done within the 3500 acre study area and there are no immediate plans for future burns because the number of fires and their sizes indicates that the hazard does not warrant it.

Forest road 507 forms a fire break along the ridge from about one mile above the Shannon Park turnoff to the summit of Mt. Graham. Its borders are managed as an unforested meadow through fuelwood harvesting of dead and down logs, and Christmas tree cutting, both on a permit basis. The road to Emerald Spring (Forest Road 669) has no fire break.

2. Effects of Alternatives

Alternatives A, B, and C would have no significant effect on the fire hazard as described in the existing situation above.

The fire hazard would increase in alternatives D, E, F, and PA due to more people, equipment, storage, etc. This could be reduced by following all State and Federal fire codes and FS policies. These include, but would not be limited to, education of personnel as to fire danger, designation of restricted smoking areas, routine examination of electrical wiring, provision of fire fighting equipment, installation of smoke detectors and automatic sprinkler systems, installation of spark arresters in all equipment, placement of fire extinguishers, axes and shovels in all buildings and vehicles, and close coordination with Forest personnel. Other than in the vicinity of any development, the fire hazard would be the same as in alternative A.

J. RECREATION USES AND OPPORTUNITIES

1. Existing Situation

Mt. Graham, an "Island in the Desert," is one of the most popular outdoor recreation areas in southeastern Arizona. It provides climatic relief to desert dwellers and an opportunity to recreate in a cool coniferous forest environment. The Pinalenos, which include Mt. Graham, are one of only two mountain ranges in southeastern Arizona with paved road access above 7000 feet in elevation--the other being the very heavily used Mt. Lemmon area. The area proposed for astrophysical use is along an unpaved road where there are no developed sites. The area has been generally inaccessible during winter months due to closure of roads by deep snow which has not been plowed.

Currently, the 3500 acre area is managed by the Forest Service for dispersed recreation activities includeing hunting (big and small game), gathering forest products (fuelwood, berries), auto-, trailer-, and tent- camping, day hiking, overnight backpacking, picnicking, auto-site-seeing, observing (nature, scientific and education), and winter recreation. Hunting, fuelwood gathering, Christmas tree cutting and timber harvest all require permits. Day hiking, picnicking and, especially auto-site-seeing are limited by the condition of the road (Forest Road 507). Wintertime recreation is limited by road conditions. Figure 5 shows locations of trails, campsites, and other recreational activities. There are no existing or Forest Service planned developed recreation sites within the 3500 acre area.

Dispersed Camping: The only overnight recreational activity within the 3500 acre area is dispersed camping. High Peak contains about 18 percent of all the current dispersed camping sites above 7,000 feet and none of the developed campsites.

Auto-site-seeing and auto-based recreation: During peak summer weeks, the 3500 acre area receives about 20 auto, trailer and tent campers or site-seers per week. In fall and spring, when the roads are passable, the area receives about 40 general recreationalists per week. Most vehicles use the first 3.6 miles of the road before being stopped by "the wall" (a steep, difficult switchback). Proposed road realignment, grading, and roadbase improvement would allow increased access above the 3.6 mile mark to the peak area which contains the three cienegas, the more "primitive" conditions, the main part of the Spruce-Fir forest, and three trailheads that access the proposed wilderness area and 11 more dispersed campsites.

Trails: Five trailheads are located within the 3500 acre area. Three are trailheads into the proposed wilderness area that fit Forest Service definitions of a highly significant trail for foot use (and some horse use). There are no sanitary facilities nor other developments at the trailheads. Named trails are: High Peak, Deadman-Highline, and Gibson.

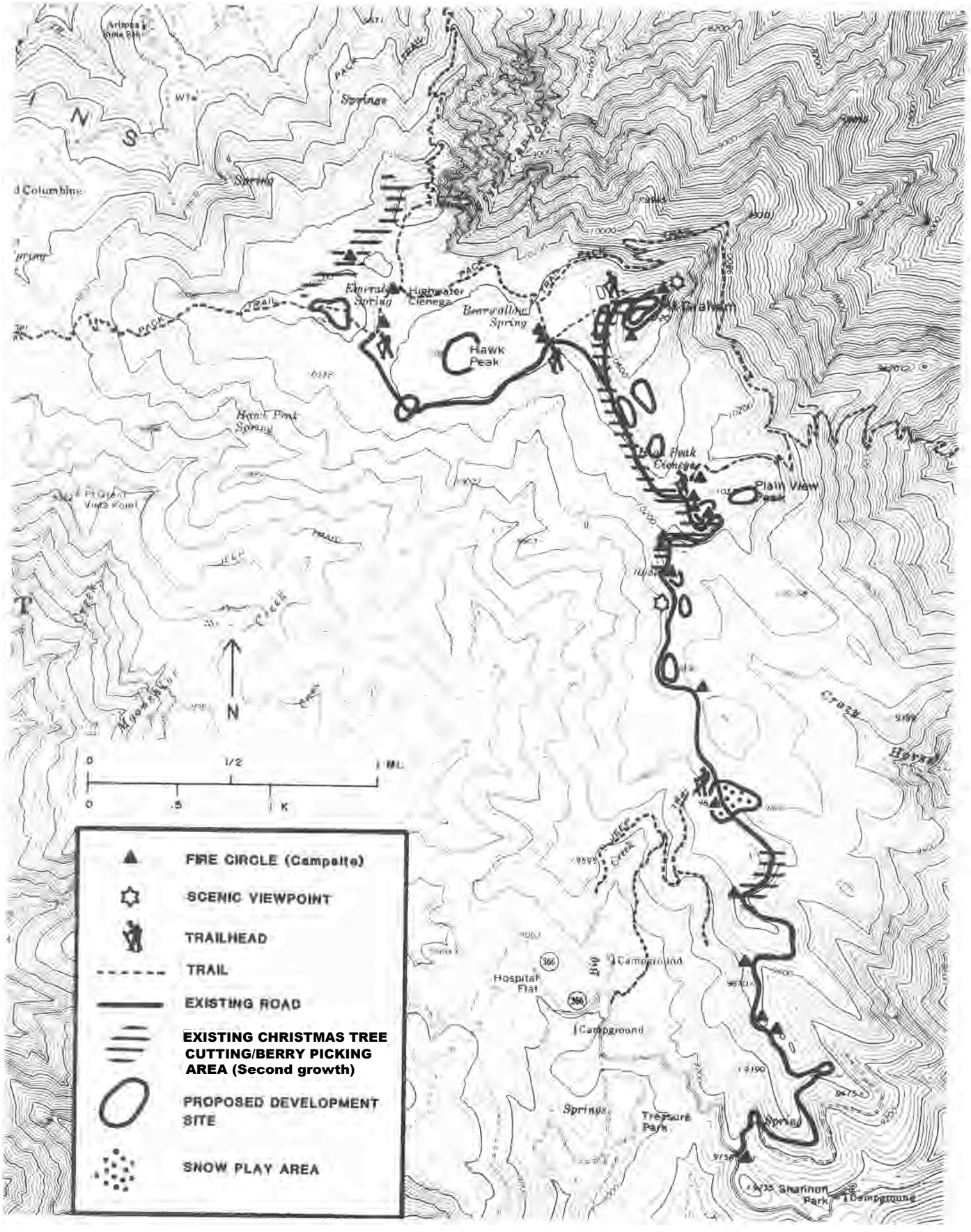

Figure 5 Existing Recreational Activities of the Proposed Mt. Graham DEIS Area.

Pinaleno Recreational Growth Outside the 3500 Acre Area

Since 1979, total recreation use accessed from State Highway 366 has increased about seven percent. Developed private use (summer homes and bible camps) has stabilized. Three of the nine monitored public developed campsites suffer from over-capacity use. Forest Service plans call for three expanded or new campsites that would alleviate some of this pressure on developed sites. Dispersed recreation has grown 2 to 5 percent per year and continues to grow. If the general recreational growth continues to increase at two percent per year, the Pinaleno Mountains would reach full capacity in 2022 (See Appendix 3).

2. Effects of Alternatives

Alternative A has no significant impact on the existing recreation opportunity spectrum (ROS) of semi-primitive motorized and roaded natural.

Alternative B would increase the quality of nonmotorized uses by the closing of unneeded roads and trails to motorized travel. The ROS would remain the same as in alternative A.

Alternative C would eliminate motorized vehicle related uses. The quality of experience would increase for nonmotorized vehicle users. The ROS would be primitive and semi-primitive nonmotorized. Access to the 5 trailheads is by hiking only (roads are closed).

Alternatives D, E, F, and PA would have effects on the recreation resources of the Mt. Graham area. Astrophysical development would bring about changes in the variety and timing of recreational use. Some changes, such as increased recreation opportunities, may be beneficial while others, such as a lowered quality of experience and reduction of area available for dispersed recreation, may be detrimental. The ROS would be semi-primitive motorized, roaded natural, and urban in alternatives D, E, F, and PA. Alternatives D, F, and PA also have an ROS of primitive (see Table 6 - Recreation Uses and Opportunities Chapter 2).

Alternative D and E prohibits public vehicular access at night to all 5 trailheads. Public vehicular access to the 5 trailheads in alternative F would be by shuttle only. In the Forest Service Preferred Alternative (PA), all trailheads are open to public vehicular access except the trail head at High Peak. In all development alternatives, walk-in access to all trail heads would be allowed. (See Figure 5 for trail head locations.)

A major astrophysical site can be expected to draw an increased number of visitors to the area not only due to interest in the telescopes, but also due to increased accessibility. Swift Trail and Forest Road 507 would be snowplowed allowing vehicles to drive into the 3500 acre management area. Increased use is likely to require visitor facilities, including visitor center(s) at the site and/or at the base of the mountain, a snowplay (tubing) area, trailhead facilities, and observation sites. The observatory facilities are also likely to draw increased numbers of visitors to more traditional developed camp and picnic sites along the Swift Trail.

During the early stages of astrophysical development (period 1), RVDs would decrease from alternative A due to construction activities. Increased RVDs in periods 2 through 5 in alternative D and PA would primarily be due to astrophysical visitation. In alternatives E and F, additional astrophysical visitation RVDs (period 3) could occur if the NNTT is constructed. Astrophysical development would be the main source of increase in visitation to the 3500 acre management area (see Table 6 - Recreation Uses and Opportunities Chapter 2).

The observatory's presence effectively shortens the time to reach full carrying capacity for the Swift Trail section of the Pinalenos. There are two basic scenarios: with the National New Technology Telescope and without the National New Technology Telescope. The number of special purpose visitors to

the observatory may be 10.000 to 15,000/year without the National New Technology Telescope and 50,000/year with the National New Technology Telescope.

With the normal increase in visitation of 2% per year and additional visitation attributed to the presence of the National New Technology Telescope, (Alternatives E and F), the carrying capacity of the Pinalenos Mountains would be reached in 2015 and 2019respectively (2022 without any astrophysical development). With astrophysical development but without the National New Technology Telescope, visitation growth in the Pinaleno Mountains would reach capacity in 2019 (see Table 6 - Recreation Uses and Opportunities, Chapter 2).

The improvement of Forest Road 507 and the presence of the proposed observatory would have two immediate effects: diversion of an increased percentage of Swift Trail traffic along Forest Road 507 and a general increase in popularity of the peak area. However, the degree of use of the peak area would be determined to a great extent by the limitations on travel through the restricted area. As the opportunities for vehicular and walk-in access decrease and/or become encumbered, many users would choose to recreate elsewhere and use of the area would be less. Conversely, as opportunities and use diminishes, the quality of the near-natural and primitive experience would increase.

Observatory development could lead to a variety of new or improved outdoor recreation opportunities. Construction of astrophysical facilities could facilitate access to public recreation opportunities, especially during winter months. Allocation of lands on Mt. Graham for astrophysical use would affect the Forest Service's ability to manage the area for all multiple uses. Table 15, Chapter 2, Recreation Use and Facility Matrix displays exclusive uses for the astrophysical areas and restricted uses for areas surrounding proposed developments by alternative. Only uses that do not conflict with astrophysical uses are allowed. The possibility exists in the future that multiple uses which produce light, smoke, or dust would either be eliminated or severely restricted throughout the entire 3500 acre area.

Possible Mitigation Measures

There are two general types of mitigation measures: control of visitor use and treating the effects of overuse. Controlling or directing use is analogous to "preventative" medicine and should be used to protect the valuable resources of Mt. Graham. Treating the effects of overuse is analogous to "symptomatic" medicine and would occur when Forest Service monitoring detects early signs of environmental degradation.

Managing Visitor Use

The best means of mitigating the impacts of an increase of visitor use on the environment of Mt. Graham is to provide facilities and management direction to accommodate that use. Table 15, Chapter 2 summarizes the direction and facilities required to best mitigate the impacts of anticipated levels of visitor use, while providing for the recreational needs of the Forest Visitors.

Under alternatives A and B dispersed use would be emphasized and no special restrictions, new facilities or mitigation would be required. Alternative C, with its emphasis on perpetuation of existing natural values, requires increased protection of the flora, fauna, and unique habitats of the study area through special area designations and closure of Forest Roads 507 and 669. Land allocations for 680 acres of ZBA, and 1.000 acres of Wilderness would be made while prohibiting astrophysical development.

Astrophysical development alternatives (D. E, F, and PA) would require different levels of restrictions on visitor use to protect astrophysical use and sensitive habitat. New recreational facilities to accommodate new or increased demands and specific mitigation to lessen adverse impacts to the existing environment of Mt. Graham would be constructed.

Table 15 (Chapter 2) identifies the new recreational facilities Steward Observatory should be expected to provide to accommodate some of the visitor use to be generated by astrophysical development.

Alternatives D, E, and PA would have a snowplay (tubing) area along Forest Road 507. The proposed snowplay area indentified on Figure 5 is the only suitable area along the road.

The aspect (northeast facing slope) for tubing runs, a flat runout, space for parking overlooking the slopes, high elevation (9,800+) relatively short, steep (but not too steep) slopes with large trees to shade them all combine to make the area by far the most desirable possible for snowplay. Where snowplowed routes to high elevation areas exist, snowplay would occur. If a safe, accessible area is not provided, the public would use any area they can reach, often injuring themselves and causing traffic and rescue problems. Parking for snowplay would be plowed overlooking the snowplay area.

Alternatives D, E, F, and PA include a small public picnic area within the astrophysical development area to accommodate astro-visitors. Observatory visits would require more than one-half day, and it is likely that most visitors would bring lunches with them. The picnic site would reduce added impacts to existing developed sites and also cut down on littering along Forest Road 507.

A two lane paved road along the current alignment of Forest Road 507 would be required prior to astrophysical site construction for Alternatives E and F. Such a road is necessary to reasonably accommodate forest visitors, astro-visitors, observatory and construction traffic. It would also cut down greatly on dust and noise as well as facilitate snow removal which would be extremely difficult without a paved surface.

Under Alternatives E and F, a motorized shuttle would transport visitors from a visitor center off-Forest up the Swift Trail to the Astrophysical Area. There would be intermediate shuttle stops at each of the existing developed recreation sites from the Forest boundary to Forest Road 507. This shuttle would, to some degree, offset the increase in visitor vehicular traffic.

Astrophysical and Forest Service information could be presented at the visitor center.

An information booth or Visitor Center could provide information on recreation opportunities, bears, cienegas, off-road vehicle use, permits required, observatory tours, and general Forest Service management goals.

A telephone information tape describing open-hours at the observatory, visitor restrictions, and recreational opportunities can be established.

Cienegas can receive appropriate protection. Signing can be improved at cienega trailheads. Trails can be rerouted around the cienegas.

Treating Adverse Effects of Visitor Use

A monitoring program will be established by Forest Service with yearly reports. The monitoring program will address the rate of visitor growth as well as environmental impacts.

Guidelines for closing overused campsites and trails will be established.

K. WILDERNESS AND OTHER SPECIAL AREA DESIGNATIONS

1. Existing Situation

There are currently no wilderness or other special area designations within the 3500 acre area. However, it has been suggested by a number of individuals and groups that the Mt. Graham wet meadows and Spruce-Fir forest are ecosystems that merit designation as either Research Natural Areas (RNA's), Zoological-Botanical Areas (ZBA's), or wilderness as identified within the Mt. Graham Roadless Area (RARE II Area #3123). All proposals have been evaluated; RNA's were eliminated from consideration because none of the area fit the National criteria for designation.

2. Effects of Alternatives

Alternatives A and B have no wilderness or other special area designations identified.

Alternatives C, D and PA each have 1000 acres of wilderness area designation. This designation would provide primitive and semi-primitive nonmotorized recreation opportunities.

Alternative C has 680 acres of Zoological-Botanical area designation, alternative D has 400 acres, alternative E has 150 acres, and PA has 569 acres. The Zoological/Botanical area designation would provide unique fauna and flora related education and recreation opportunities.

FACILITIES:

L. POWERLINE AND CORRIDOR

1. Existing Situation

There is currently no electric power service on Mt. Graham. Special use permittees and the Forest Service depend upon individual generators for electric power. Both groups have expressed a need and desire power service, but the cost has been prohibitive. The operation of generators is costly and difficult, especially during the winter months. Fuel spills and potential for fire are a threat to the environment.

2. Effects of Alternatives

In Alternatives D, E, F and PA a powerline would eventually be needed to bring electricity to astrophysical sites. The U.S. Congress (The Arizona Wilderness Bill) has reserved a 500 foot wide powerline corridor through the Mt. Graham Wilderness Study Area (WSA). The route description follows.

From highway route 266 at Stockton Pass (elevation 5660 feet), the powerline will run north east approximately .35 mile parallel and approximately 300 feet west of the existing jeep road to elevation 5800': then generally east north east approximately .30 mile to elevation 6000' on the south west ridge; then generally north east approximately .70 miles along the same south west ridge to elevation 6800' where the ridge route turns north approximately .22 miles to elevation 7100'; then north east approximately .25 miles to elevation 7400' and generally north approximately .90 miles along a weak ridge to elevation 8600', just below the existing roadway. From elevation 8600', north north east approximately .10 miles to join highway route 366 near mile post 132 (see Figures 6 and 7).

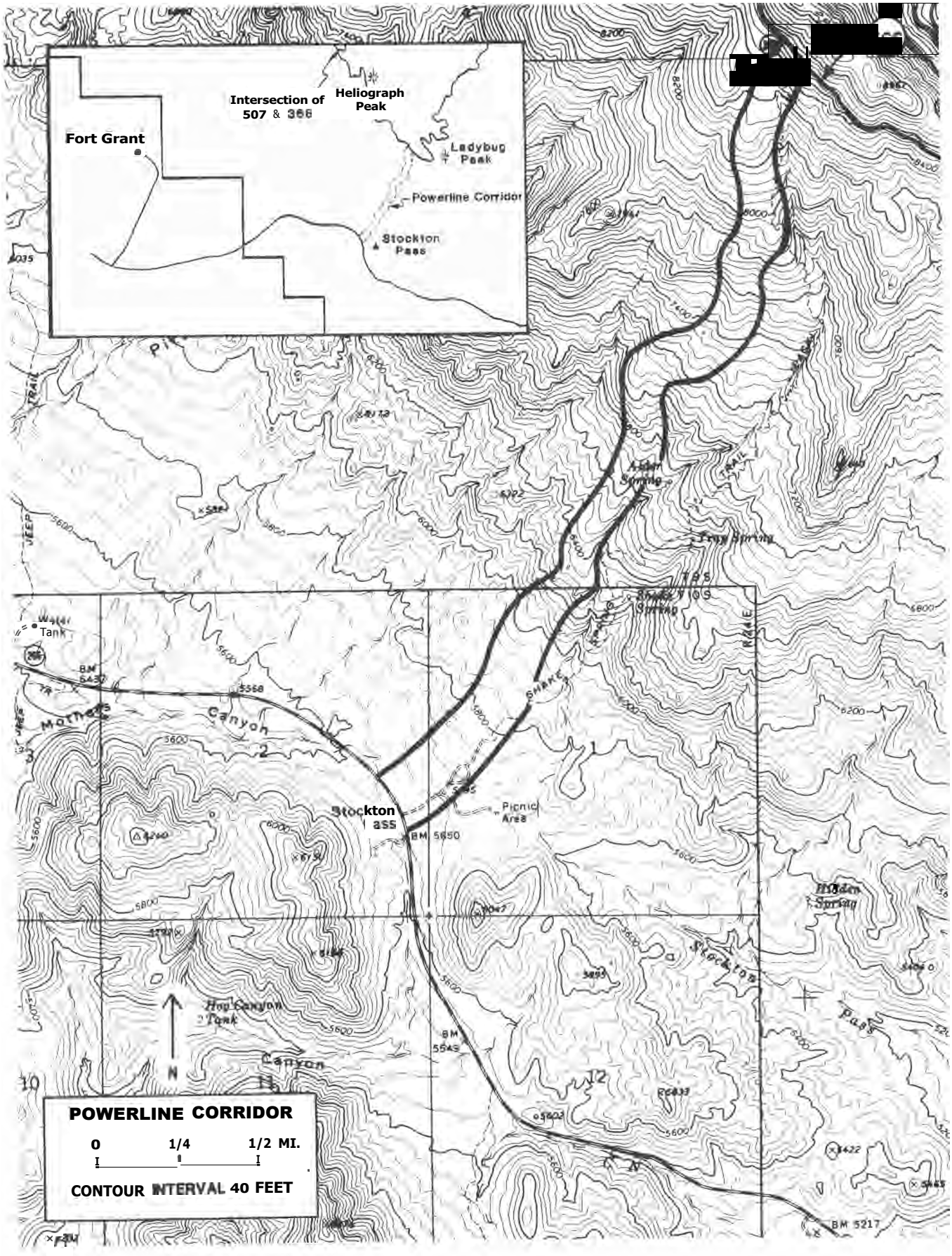

Figure 6 Powerline Corridor.

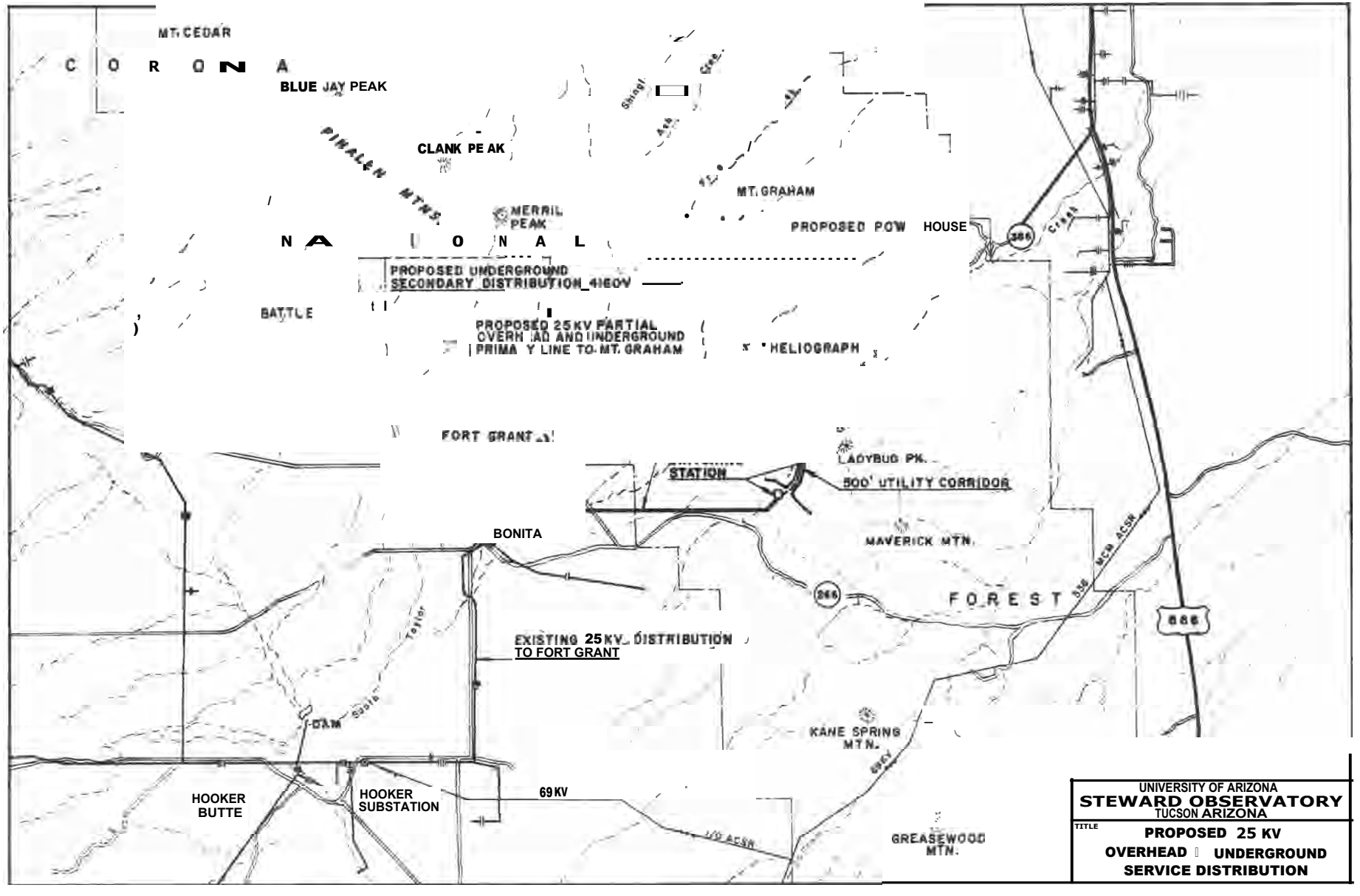

Figure 7 Proposed 25 KV Power Service Distribution.

The actual buried line would need no more than a 20 foot corridor, and would wind among rocks and larger trees. Although the actual route within the 500 foot reserved corridor has not been determined at this time, the impacts of the powerline can be assessed and are as follows:

The powerline would be strung on powerpoles until it reaches the Forest boundary, at which point it would be buried. It would go underground through the 500 foot wide utility corridor that passes through the WSA, and would then be buried in the roadways to the powerhouse and sub-station. All secondary distribution lines would be buried in the roadways. Where the powerline crosses unroaded Forest land, the line would be plowed in to a depth of three feet. This could entail using a bulldozer equipped with a center ripper, working downhill to pre-rip (no trench) along the defined route. A second bulldozer with a hollow ripper tooth and reels of cable, also plows downhill placing the cables 3 feet deep. This technique leaves a 2 to 4 foot wide plow path on the surface, with bulldozer tracks approximately 13 feet wide. The impact of the powerline would be minimized by steering the cable route around trees, rocks, and other surface features. In some sections of the utility corridor, the power cable would go in on slopes as steep as 35%.

Erosion, sedimentation, and runoff impacts would occur on the three miles of plow-in buried line from the lower end of the designated utility corridor (see Figure 6) to the connection with Swift Trail. The buried section along Swift Trail to Forest Road 507 turnoff would have no significant impact. Temporary traffic control would be necessary during portions of the powerline installation.

During construction of the powerline, there would be noise impacts that could temporarily frighten wildlife, but during operations, no significant impacts have been identified.

Mitigation Measures

Alteration of the powerline route to minimize impacts on plants and animals.

Steering the powerline route around major trees or surface features that are particularly important to reptile habitat.

Installation of water bars (herringbone-type) to prevent erosion and subsurface waterflow concentrating around buried cable.

Revegetation and restoration of all disturbed areas including the water bars with local seeds and plants from the appropriate life-zone.

Painting of all switching boxes or other surface equipment to blend with the immediate background.

Limiting construction to dry season to prevent unnecessary soil damage.

Keeping construction time to a minimum to avoid noise and human-interference with wildlife.

Steering powerline away from drainage ways and active creeks to reduce erosion potential, destruction of riparian, and interference with natural runoff and channel waterflow.

M. COMMUNICATIONS

1. Existing Situation

Table 25 and Figure 8 summarize the present state of radio frequency emmision levels and paths within the Pinaleno Mountains. Currently there is no significant electronic interference.

Table 25
MICROWAVE PATH IDENTIFICATION-HELIOGRAPH PEAK

ID Number	Description Antenna Type/Power (Watts)	Compass Bearing (Degrees)	Frequency (MHz) Receive/Transmit
1	Parabolic/4.0	32.6	958.0/954.4
2	Parabolic/1.25	38.2	6625/6745
2B	Parabolic/1.0	46.8	
3	Parabolic/4.0	50.8	957.6/954.0
4	Parabolic/1.2	62.1	T-6160.2-6367.7
5	Parabolic/0.3	62.5	6665/6785
6A	Parabolic/5.0	109.5	4010.0/3910.0
6B	Parabolic/1.5	109.5	6685/6845
7	Parabolic/3.5	133.6	
8	Parabolic/1.5	136.1	1855/1935
9	Corner reflector/40.0	144.0	414.975/419.775
10	Parabolic/1.75	168.9	T-6219.5-6338.1
11	Parabolic/1.5	169.1	1865/1945
12	Parabolic/1.4	175.0	6585/6705
13	Parabolic/1.5	177.8	1905/1985
14	Parabolic/5.0	187.0	1849/1753
15	Parabolic/1.75	199.9	T-6219.5-6397.3
16A	Parabolic/5.0	255.5	6152.8/6256.5
16B	Parabolic/1.5	255.5	6725/6865
16C	Parabolic/5.0	260.0	1831/1735
17A	YAGI/--	290.7	R-TV Channel 15
17B	Log periodic/--	290.7	R-TV Channel 2-6
17C	Log periodic/--	290.7	R-TV Channel 7-13
18	Parabolic/--	127.0	R-5952.6-6130.5
19	Parabolic/1.0	252.0	169.600/170.525
20A	Parabolic/1.0	46.0	415.375/411.275

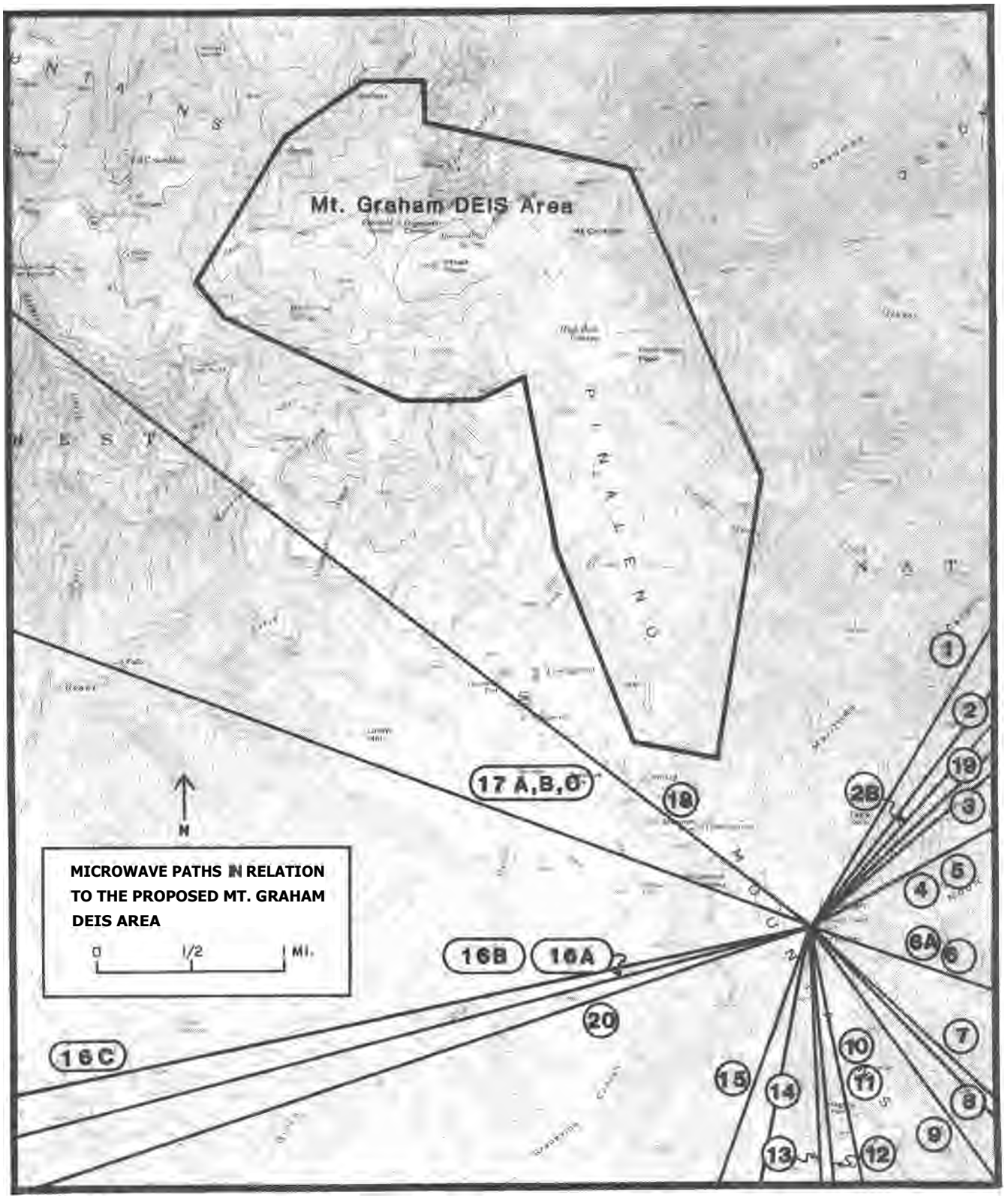

Figure 8 Microwave Paths in Relation to the Proposed Mt. Graham DEIS Area.

2. Effects of Alternatives

There would be no significant effects on communications in alternatives A, B, or C.

Current frequencies, at present field strengths, would not interfere with proposed project frequencies in Alternatives D, E, F or PA. The radio telescopes proposed in alternatives D, E, F, and PA would observe in the frequency range 70-10000 GHz (4mm-0.3 mm wavelength). Any radio emission in this range could adversely affect the radio astronomy efforts on Mt. Graham. The radio telescope receivers are also sensitive to interference from strong microwave sources at the intermediate frequency range of the radio receiver. L-band (1-2 GHz) and S-band (3-5 Ghz) are typically used; and the intermediate frequency bandwith is very broad, approximately 1 GHz. Radio interference is to radio astronomy like light pollution is to optical astronomy. It would be necessary to maintain the current low level of background radio noise to avoid conflicts between astrophysical work and other uses.

Standard procedures would be followed to notify those on the Forest electronic site mailing list of proposed additions or changes to electronic sites. Those notified would have 30 days to respond to a proposal.

N. TRANSPORTATION

1. Existing Situation

Access to the summit area by road starts with Swift Trail at the National Forest boundary and continues for 16.6 miles to the Forest Road 507 (High Peak) turnoff. Forest Road 507 continues another 5.0 miles to High Peak. Forest Road 669 starts approximately 1/3 mile from the end of Forest Road 507, and continues 1.8 miles to the Hawk Peak and Emerald Spring area. Limits to transportation are winter snow, road width, turn radius, roadbase strength, and traction.

Road Capacity and Use

Swift Trail has a maximum design capacity of 1,740 vehicles per hour for 20 mph design speed. Theoretically, the road maximal use (1,740 vehicles per hour; 24 hours per day) is 41,760 vehicles per day (Swift Trail, 1976). The actual peak daily use is much lower. Mt. Lemmon Highway experiences traffic congestion on a roughly equivalent road at 2,060 vehicles per day (Gillette, 1985).

Swift Trail is, at present, far below a traffic flow that creates safety hazards or traffic congestion. Actual traffic counts were heaviest during late June and early July with a peak of 1,874 vehicles per week during the seven days surrounding July 4. This is approximately 13 percent of the peak week traffic on the Mt. Lemmon Highway (Hitchcock Highway). Similarly, Swift Trail has only about 24 percent of the average weekly summer traffic on Mt. Lemmon.

Table 26 - Comparison of Traffic on Three Recreational Roads

	Swift Trail Pinaleno Mts.		Kitt Peak. Baboquivaris	Mt. Lemmon Highway Santa Catalina Mts.
Peak week: vehicles/week	1,874		1,000 to 1,200	14,420
"Regular" week: vehicles/week	Summer: 1000		NA	4,249
	Winter: 187			

Road 507 receives much less traffic than Swift Trail because of the condition of the road and because of attractive recreation destinations at other points along Swift Trail. From mid-May to mid-July (1984-1985), recreation traffic on Forest Road 507 averaged about 20 vehicles per week. Many vehicles

with low clearance and two wheel drive do not go past the "wall" (milepost 3.6). Forest Road 507 probably receives about five percent of all the Swift Trail traffic during the late spring, and early summer period (Traffic Counts. 1985).

Road Safety

Currently, Swift Trail is considered well within design capacity. The Forest Service maintains Forest Road 507 at Level 2 (not maintained for passenger cars) and is open to the public but closed seasonally by snow. Forest Road 507 is a rough, winding mountain road with poor visibility on many corners and steep grades in some stretches. Steep drop-offs occur along sections of the road. A total of 13 turnouts, to allow for passing oncoming vehicles, occur at intervals of approximately 0.4 miles.

Forest Road 507 averages approximately 10-12 feet in width. Forest Road 669 is narrower, about 8 to 10 feet in width and is maintained at Level 2.

Road Closure

Forest Service policy is to leave both Swift Trail and Forest Roads 507 and 669 open all year long with weather permitting. During winter months. Swift Trail is closed at the snowline with vehicle access limited to four-wheel drive vehicles and snowmobiles above the snowline. Nevertheless, about 190 vehicles per week use Swift Trail during the winter months.

Forest Road 507 is generally unreachable during the winter months. During the spring snowmelt. Forest Road 507 may be closed temporarily to prevent excessive damage to the road while it is muddy.

2. Effects of Alternatives

Under alternative A there are no changes in the existing transportation system. In alternative B. trails would be closed to motorized vehicle use and unneeded roads would be closed. Forest Roads 507 and 669 would remain open.

Under Alternative C. Forest Road 507 and 669 would be closed and revegetated. This would eliminate vehicular access to the 3500 acre area.

During construction under Alternatives D, E, F and PA. there is a need to transport at least 15 people daily to High Peak throughout the year and up to 30 construction workers per day during the summer. In addition, large equipment and large telescope parts need to reach the summit. The transport of equipment on Swift Trail would not require additional widening or realignments to accommodate telescope part transport. During operation, there would be a need to transport approximately 45 observatory personnel to the summit area nightly.

Construction workers may number as many as 50 per day. There is also a need to accommodate tourists and other summit area users. There may be as many as 10,000 astro-tourists in alternative D and PA and as many as 50,000 astro-tourists in alternatives E and F. Use on Forest Road 507 (including astro-tourists and general recreationists) is estimated at 165 vehicles per week in alternative D and PA. Steward Observatory would make available a shuttle service under alternative E and F that could transport as many as 7000 people per year to the astrophysical sites. Public use on Forest Road 507 is estimated to be a maximum of 440 vehicles per week in alternatives E and F with the NNTT.[1] Without the NNTT alternatives E and F public vehicle use would be similar to alternative D.

[1] Uses a planning value of 3.25 people per vehicle and a 30 week long high visitation season.

Approximately 1/5 acre of parking area would be required to accomodate visitors in alternative D, PA, E, or F if the NNTT is not developed. With the development of the NNTT, parking requires approximately 1/3 acre.

Initially, Forest Road 507 may need to be gravel surfaced to support heavy contruction loads, and to be useable in all seasons. Some form of dust abatement would also be necessary within the restricted area to maintain the air quality required for observations. Eventually, the transport of equipment on Forest Road 507 would require widening to 16 feet on straight sections, and 22 feet on the curves. Road widening averaging 7 feet along 4.8 miles of Forest Road 507 would result in approximately 4 additional acres of disturbance. For Alternatives E and F, Forest Road 507 would be paved. Contruction traffic would cause some congestion. Both private and commercial vehicles would be required to use pullouts to allow oncoming traffic to pass. Because large construction trucks cannot easily back up, private vehicles occasionally would have to back up to find a turnout. Vehicular traffic to the Hawk Peak area would be restricted to daylight hours only.

Transport of the mirrors to the mirror coating facility would not require any additional widening.

Snowplowing of the roads from snowline to all sites on the summit would be necessary for year round access.

During construction, the Forest Service will monitor safety and congestion problems, and require Steward Observatory to accomplish necessary mitigation. These measures may include scheduling of construction vehicles during non-peak recreation periods, traffic control during some construction periods, special escorts and traffic control for oversized vehicles, temporary suspension of visitor service, and winter roadblocks to require chains or four wheel drive. All culvert and grade dip locations would have a leadout ditch thru the snow bank to allow snowmelt to leave the roadway.

O. ASTROPHYSICAL

1. Existing Situation

Astronomy is among the oldest of sciences. Man has always observed the skies and sought to know about the universe in which he lives. This study continues today, and has *been* enhanced by the reality of space exploration.

Astronomy, being a basic science, provides research information that is part of our scientific and cultural knowledge pool. Technological and economic developments, engineering applications, new products, and industrial growth also occur because of astronomy research. In turn, the capability and productivity of astronomy research is increasing due to technological advances of instrumentation.

Most astronomical research is conducted with ground-based instruments. Space-based telescopes promise significant advances for future research, but are today economically inefficient. In addition to their high initial and maintenance costs, these instruments must be small in comparison with ground-based telescopes. Because of these and other limitations, ground-based observatories will continue to provide the best facilities for astronomical research in the near future.

One of the significant limiting factors for astronomers today is available observation time at both traditional and technologically advanced facilities. Major observatories around the world receive requests for viewing each year that exceed available time by up to four times. New telescopes, such as the MMT on Mt. Hopkins, turn away many more potential observers than traditional facilities. Even planned space-based telescopes are "over-subscribed" (the demand for observing time exceeds the time available) today by a factor of ten.

Critical to the value of observatories are the astrophysical or viewing characteristics of the site. Since modern astronomy deals with the entire light spectrum (visible and non-visible), sites may have several limiting factors. Light pollution from expanding metropolitan areas has reduced the effectiveness of some existing telescopes by up to 78%. Locating new telescopes at these sites would be an inefficient use of national resources. Light pollution is but one of several factors -- such as water vapor, air pollution, and radio wave interference -- that are critical to identifying quality sites for future observatories. These factors are especially significant for the NNTT.

Mt. Graham has been identified as a quality site for placing new telescopes, both planned and projected. Elevation, latitude, air pollution, light pollution, radio interference, and air flow -- among other factors -- were considered. Mt. Graham, however, is not the only U.S. site which offers these benefits. Mauna Kea in Hawaii and a variety of peaks in the Southwest are also recognized by the astronomical community as quality sites.

In addition to environmental factors, logistics is a consideration for any observatory. The ease and efficiency with which observers can visit the facility is important. Mt. Graham offers advantages in this regard by being located about three hours from a concentration of existing observatories and scientists around Tucson. This advantage, again, is not unique to Mt. Graham, but can be found in some degree at existing sites such as Mauna Kea.

Steward Observatory and the University of Arizona, located in Tucson, are recognized leaders in the field of astronomy. Paricularly in the fields of infrared astronomy, quasar spectroscopy, high resolution imaging, studies of star formation, and astronomical optics is this true. Scientists from around the world come to conduct research at the observatories nearby (Kitt Peak, Mt. Hopkins, Mt. Lemmon, and Mt. Bigelow) and consult with scientists in Tucson. Conversely, Steward Observatory scientists are active at telescopes the world over. Tucson is home for a number of other astronomical agencies, such as the National Optical Astronomy Observatories (see Table 67 in Appendix 4).

Of the telescopes proposed for location on Mt. Graham by Steward Observatory, one is built and operating in Texas (Texas 5-meter telescope); one is being built in Germany (10-meter SMT); one is funded but manufacturing has not begun (VATT 1.8-meter), and the remainder are projected but funding has not been secured. The 10-meter SMT will be the world's most sensitive telescope in the submillimeter wavelength region, and combined with the Texas 5-meter will permit image sharpness five times better than with either telescope alone. The VATT 1.8 meter will be used primarily for studying magnetic fields in stars and the interstellar medium, and variable extragalactic objects such as Quasars. Among the projected, but unfunded telescopes, will be the Ohio/Arizona 11.3-meter -- for study of galaxy formation and planetary systems, the NNTT -- the world's most powerful optical and infrared telescope, and the SAO Interferometer -- for mapping interstellar clouds and star formation regions, which no other existing or planned telescope can accomplish.

2. Effects of Alternatives

Alternatives A, B, and C would not permit any observatory development on Mt. Graham. The 13 telescopes with support facilities would have to be foregone or located at other sites. There is information to suggest other sites may exist within and without the State of Arizona although they may not be suitable to Steward Observatory.

If other sites are available and suitable, any potential technological and scientific impacts of not developing an observatory on Mt. Graham would probably be insignificant to the overall astronomical community. There could be adverse economic or technological impacts to specific scientific groups such as Steward Observatory by not having the Mt. Graham Observatory. The determination of availibility or suitability of these sites is outside the scope of this analysis and EIS as are the determination of the ultimate technological and scientific impacts to Steward Observatory and the astronomical community in general.

Forest Service Preferred Alternative and Alternative D

The Forest Service Preferred Alternative and alternative D would permit the number of telescopes and support facilities identified by Steward Observatory as meeting their minimum needs. Alternative D would allow for positioning of scopes on 3 separate sites as identified by Steward Observatory. The Forest Service Preferred Alternative would confine the same scopes to one location on High Peak. This might result in reductions in the quality of astronomical observations, but would result in less environmental impacts.

The NNTT and other proposed scopes, such as the Interferometer, would not be permitted on Mt. Graham. There is information to suggest other sites may exist either in or outside the State of Arizona. The NNTT would probably not be located in Arizona or the continental United States.

Alternatives E and F

Alternatives E and F permit the full range of telescopes (11 and 13 telescopes respectively) and support facilities as proposed by Steward Observatory to be placed on Mt. Graham. Alternative E would confine the telescopes and support facilities to the High Peak-Hawk Peak-Emerald Peak areas. These sites have been identified as the most environmentally sensitive and appear to be the most desirable for astrophysical observations. Alternative F would permit the final site selection to be made after completion of astronomical site testing data gathering. Alternatives E and F, as presented, have essentially the same impacts and environmental effects on the astronomical community.

P. SOCIO-ECONOMIC

1. Existing Situation

Graham County/Willcox

The local area of influence for activities on Mt. Graham is primarily Graham County and the town of Willcox in Cochise County. Graham County is located northeast of Tucson. Safford, the principal community of the area and county seat, is slightly more than a two-hour drive from Tucson and three-hour drive from Phoenix. Safford sits at the intersection of U.S. Highways 70 and 666. Following U.S. 70 to the northwest is Thatcher, home of Eastern Arizona College, and Pima. These and smaller communities of Graham County lie along the Gila River, which flows out of New Mexico toward San Carlos Lake and ultimately the Colorado River.

Willcox is located in northern Cochise County, 80 miles east of Tucson on 1-40 and 50 miles south of Safford on U.S. 666. Most of Cochise County is not influenced by activities on Mt. Graham, but rather is dominated by the copper industry in the southern part of the county and visitors to Tombstone and the Chiricahua Mountains. Willcox's elevation is 4,200 feet, compared with the 2,900-foot elevation of the Gila Valley and 2,400-foot elevation of Tucson.

Willcox was settled about 1880 as a railroad town, and has since depended upon travelers and shipping for its livelihood. Cochise County, also established in 1881, was named after the famed Chiricahua Apache leader who raided American and Mexican territories until his surrender in 1872.

Graham County is home to 23,200 residents. Safford is the largest community in the county with 7,700, followed by Thatcher with 3,600 and Pima with 1,800. Native Americans constitutes the largest minority (12%). Graham County is typical of rural Arizona in many respects, including a median age that has risen in the past few years to its current 28. Willcox has a population of nearly 3,700. Population growth has been slow in these areas during the past five years, averaging a 1.3% growth rate. This compares with over a 3% rate for both Tucson and Arizona statewide.

Graham County is one of the poorer areas of the state with a 1984 per capita personal income of $7,455. Only Apache County, at $6,312, is lower. Cochise County ranks ninth of fifteen Arizona counties with an income of $9,051. Despite this lower income, the residents of Graham County have managed their public services so that the public-debt-per-capita rates ($787) and public-debt-to-income ratios (10.6%) are among the lowest in Arizona. Neighboring Greenlee County, in comparison, has the highest public-debt-to-income ratio (102.2%) in the state.

Normal occupancy rates in Graham County indicate that housing is generally available, but not in excess. Housing prices and rent are comparable with area personal income.

Irrigation water from the Gila River made early Graham County settlement possible, and today agriculture continues as the predominant economic activity in the area. Cotton, sorghum, alfalfa, fruit, vegetables, and nuts are the crops found throughout the valley. Dairy farms and cattle ranches also contribute to the dominance of agriculture. Safford developed as a central trade center for farmers and ranchers, and thus trade and services constitute the next most important source of employment. Government employment is high in the county, primarily because of Eastern Arizona College in Thatcher. The copper mine near Morenci is commuting distance from Safford, and has typically provided another important source of employment for the area. Combined employment in the Graham County/Willcox area in 1985 was about 6,250 jobs (including full-time and part-time). Recent hard times in agriculture and copper mining, plus reduced government spending locally, has resulted in an unemployment rate (15%) which is above historic levels. Faced with these setbacks, members of the business community are searching for ways to diversify and bolster the Gila Valley economy. Development of Mt. Graham is viewed by some as the business catalyst they are seeking, while others expect little or no benefit.

Willcox, early established as a cattle shipping point, continues today in that tradition with the largest livestock auction in the state. Other agricultural activities, such as orchards, cotton, and small grains, have also sprung up in the Willcox area over the last few years. Tourism, however is probably the most significant industry in Willcox. Gas stations, restaurants, and motels benefit from 1-40 travelers crossing the county and from visitors exploring the historic and natural attractions of Cochise County.

The dominant culture of Graham County is that of its large Mormon (Church of Jesus Christ of Latter Day Saints) population. It is typified by self-reliance, traditional values, a conservative outlook, and some social reluctance toward outsiders, all of which are not uncommon to rural America as a whole. These traits are typically reflected within school systems, businesses, and politics.

The recreation business is already an integral part of the Gila Valley economy. Visitors come to the Pinalenos for hiking, camping, sight-seeing, hunting, berry picking, fishing, nature study, fuelwood gathering, Christmas tree harvests, picnicking, and winter snowplay. Tourism provides substantial income to the Upper Gila Valley towns and Willcox, Arizona. A summary of tourist-related features for these areas are found in Appendix 4.

It is common in the West for rural communities to view nearby public land with a sense of local ownership. This is derived from the land's location, local resident's ease of access, their visible and frequent use of the land, and a long history of that tradition. This is likely the case for Graham County since Mt. Graham is an important part of life for many Gila Valley residents. A recent survey of 930 vehicles traveling Swift Trail near the National Forest boundary showed that 60% of these parties were local area residents using the Forest for recreation. In addition to this use, there is one small sawmill in Graham County which has historically depended upon timber from Mt. Graham. Also there are ranchers who run livestock on parts of the Pinaleno mountains each year.

Arizona/Tucson

Arizona's economy is principally based on four industries: manufacturing, tourism, agriculture, and copper mining. Of these, manufacturing -- and most dominantly high tech manufacturing -- provides the highest employment in the state. Tucson follows a similar pattern with a doubling of manufacturing employment -- mostly in high tech firms -- in the last ten years, and a highly significant tourism industry. Tucson, however, differs from the state-wide pattern in that government is the largest employer in Pima County. The University of Arizona and Davis-Monthan Air Force Base each employ about 10,000 people.

Astronomy research and related industries is a unique feature of the Tucson and Arizona economy. In 1982-83 almost $34 million was spent by astronomy research facilities in Arizona, directly employing 860 people. About 90% of the funding for astronomical activities comes from Federal sources.

Sources: *Arizona Place Names, Byrd H. Granger, University of Arizona Press, Tucson, 1960.
*Arizona Statistical Review, 41st Annual Edition, September 1985. Valley National Bank.
*Gila Valley Directory -- 1986-87, Safford-Graham County Chamber of Commerce.
*Discover Safford and Graham County, Safford-Graham County Chamber of Commerce.
*Personal communication with Hank Geitz, Director, Gila Valley Economic Development Foundation, 1986.
*Probable Economic and Social Effects of the Proposed Mt. Graham Observatory Facility, The Roy P. Drachman Institute for Land & Regional Studies, University of Arizona, April 1986.
*Regional and Community Profiles, Community Development Program, Arizona Department of Commerce.
*Sales & Marketing Management, "Metro area, County, and City data listed by states," July 22, 1986.

2. Effects of Alternatives

In general, the proposed astrophysical project may stimulate three areas of local socio-economic activity: (1) the travel and tourist business; (2) the Forest Service management budget needs; (3) local tax base, service demands and employment. Two secondary impacts cannot be quantified but may be potentially significant. They are (1) spin-off, high technology companies that market products originally based on astronomical research in Arizona; and (2) the cultural value of an expanding astronomical program within the state.

Construction contractors can hire from the local, regional or even national labor pools. Materials and labor can come from a regional pool (Tucson, Phoenix) or local (Upper Gila Valley, Willcox).

Currently, Safford/Thatcher generally has rental vacancies and moderately priced homes that are readily available on the real estate market. There is adequate housing for workers in all 4 development alternatives. If workers are from local communities, the lodging market would not change. There would be no difficulty for workers from other areas to find places to live.

The Forest Service enforces Federal laws; the Graham County Sheriff's Department enforces state laws and Arizona Game and Fish Department (AGFD) enforces hunting and wildlife laws. By cooperative agreement, the Graham County Sheriff's department patrols Swift Trail on weekends and high use days.

With increased access in alternatives D, E, F, or PA to both Swift Trail (during the winter) and Forest Road 507 (throught out the year), law enforcement problems could increase. Forest Road 507 would be open in alternatives D, E, and PA; security of expensive equipment on the mountain top would be a major concern of Steward Observatory. Increased access would also place an increased burden on the County Sheriff's department for search and rescue operations in an area that had previously seen low use levels. Steward Observatory could hire private security officers to protect astrophysical equipment and patrol Forest Road 507 all year long and Swift Trail during the winter months. This would put financial and law enforcement responsibility on Steward Observatory.

a. Social

Alternatives A, B, and C will likely have a negligible effect upon the lifestyle and culture of the Gila Valley. Alternatives A and B would allow nearly all of the traditional activities engaged in by Graham County/Willcox residents. Alternative C, by the closure of roads atop Mt. Graham, would modify some of the patterns of local users, but this cannot be considered to significantly affect the Gila Valley lifestyle as a whole. Because of increased wilderness and dispersed recreation uses due to management for wilderness and zoological/botantical area (ZBA) designation, a local sense of area ownership may be diminished.

Alternatives D and PA would likely have some effect upon the culture of the Gila Valley, but the effect would be small. Local users of Mt. Graham may experience some minor change in their activities, especially during construction of observatory facilities. Restrictions during observatory operation would not have a significant effect. The presence of construction workers, and later observatory operation personnel new to the area, would not modify the Gila Valley lifestyle as a whole. This may be true for two reasons: 1) new residents, whether temporary or permanent, would be small in number and not directly involved in the lives of the majority of the local population, and 2) such rural populations are typically predisposed to resist outside influences on their ways of life. Because of management for wilderness and zoological/botanical area (ZBA) designation, increased wilderness and dispersed recreation users may diminish a local sense of area ownership.

Alternatives E and F would likely have some effect upon the culture of the Gila Valley, yet the local lifestyle would still remain intact. If future development leads to increased usage by non-locals, then conflicts between local and non-local users may result. Local users, who have become accustomed to sparse use, may object to increased numbers of non-locals. Local reactions would likely be negated somewhat if increased use results in increases in expenditures by non-local users. Local users of Mt. Graham would experience some change in their activities during both construction and operation of the observatory due to road activity and use restrictions. The longer presence of construction workers and the higher number of observatory operation personnel new to the area under alternatives E and F -- as compared with alternatives D and PA -- increase the opportunities for direct involvement in the lives of the local population. The number of new families, however, would be far less than the existing population.

b. Economic

Recreation/tourism - Recreation increases are expected under all alternatives, and are estimated for fifty years into the future. Economic effects accompany these increases which vary with each alternative. These effects are expressed in terms of the average annual difference from 1985 over the 50-year period.

Employment resulting from alternative A is expected to yield 276 additional jobs in the Graham County/Willcox area when compared to 1985 Figures. The same impact is expected under alternative B, and 290 additional jobs under alternative C. The development alternatives of D, PA, E, and F would generate 329, 329, 397, and 397 additional jobs, respectively. Thus, on the average Graham County/Willcox could expect from 53 to 121 more jobs due to observatory tourism than would be anticipated under the current

management (alternative A) of Mt. Graham. Current (1985) employment in the area is 6,250 -- this includes all full-time and part-time jobs. Consequently, these additional jobs mean anywhere from a 4.4% increase (alternative A) to a 6.4% increase (alternatives E and F) in employment. (Note: These increases are NOT annual growth rates but merely average increases in existing employment over the 50-year period.)

Virtually all of the tourism-related employment attributable to alternatives considered in this document within the state of Arizona will occur in the Graham County/Willcox area. Additional statewide employment is negligible.

Personal income as a result of recreation/tourism-generated employment is expected to be approximately $18,000 per employee on the average. This average includes all sectors, not just retail trade and services.

There are some minor population effects of the additional jobs generated by future recreation/tourism activity. Under alternatives A, B, C, D, and PA, about 300 people would be drawn to the area. Under alternatives E and F, about 400 people would be drawn. These population effects would materialize as in-migration if the Graham County/Willcox population were to stay constant, but would be part of local population growth otherwise.

Construction of observatory - The construction of observatory facilities was assumed to proceed at a constant annual rate regardless of the alternative (D, PA, E, or F). Thus, the annual increase in employment is the same for all development alternatives and only the length of time that increase is experienced varies by alternative. Construction is assumed to require about 11 years under alternatives D and PA, about 27 years under alternative E, and about 30 years under alternative F.

On the average, 100 new jobs in Graham County/Willcox can be attributed to construction of the observatory. Forty of these new jobs would occur in the construction industry, with the remainder predominantly in retail trade and services. Some of the new construction jobs would be filled by workers drawn into the area, and some by currently underemployed and unemployed residents. The population effect is estimated at 100. This would indicate that from 40 to 60 of the new jobs would be filled by current residents.

This new employment would generate an average personal income per employee of about $30,000 per year. All industries are included in this average.

Besides additional employment in Graham County/Willcox, Pima County would pick up an additional 120 jobs. These would be generated primarily by the materials needed for observatory facilities atop Mt. Graham. The major part of the increase is found in the "Scientific Instruments" sector, showing work on such things as specialized mirrors for the telescopes.

It should be noted here that direct employment by Steward Observatory and related agencies was considered as employment in the "Scientific Instruments" sector rather than State or Federal government. This is because both the interactions between sectors and the compensation to employees in the "Scientific Instruments" sector better reflected the situation than average government relationships. Consequently, all employment shown in the "Scientific Instruments" sector is that directly associated with Steward Observatory and related agencies. This is particularly evident when examining the operations effects in Graham County/Willcox.

Operation of observatory - The economic effects of observatory operations reflect completely constructed facilities, as specified in each alternative, under full operation. There would be some lesser effect of observatory operations as various facilities are completed while construction of other facilities were in progress.

In the Graham County/Willcox area, operation of the facilities will yield a larger annual impact than construction under alternatives E and F, and nearly as large under alternatives D and PA. About 175 new jobs could be expected with extensive development, and about 90 with limited development. One third of the new jobs are direct employees of the observatory, and the remainder result from interactions with and consumer spending in other sectors.

A population effect of about 200 people can be expected under alternatives E and F, and 100 under alternatives D and PA. Given that full operation of the facilities are at least 11 years in the future, it can be assumed that residents of Graham County/Willcox will fill most of the new positions for which they qualify.

The operations impact in Pima County is significantly larger than that in Graham County/Willcox. Alternatives E and F would result in 700 more jobs in Tucson -- about 200 directly as a result of observatory employment, 300 in retail trade and services, and 200 in other economic sectors. Alternatives D and PA would result in 200 more in Tucson -- about 60 directly with the observatory, 90 in retail trade and services, and 50 in other economic sectors. The operations impacts in Graham County/Willcox and Pima County constitute 90-95% of those statewide.

Personal income per employee for all jobs resulting from observatory operations are approximately $28,000 per year.

Combined effect of recreation/tourism and observatory operations - Once the observatory is constructed both recreation/tourism (alternatives A, B, C, D, E, F and PA) and observatory operations (alternatives D, E, F, and PA only) would combine for a total effect in Graham County/Willcox. Using the estimates discussed above, alternatives A (current management) and B show a combined employment increase of about 280 jobs, alternative C shows 290 jobs, alternatives D and PA show about 420 jobs, and alternatives E and F show about 570 jobs. The percent increases over 1985 employment are: 4.4% (alternatives A and B), 4.6% (alternative C), 6.7% (alternative D and PA), and 9.1% (alternative E and F). It is important to notice that these increases would most likely occur about 25 to 30 years in the future and would be predominantly in retail trade and services. Immediate significant increases in employment is not likely.

Because the effect on Pima County from recreation/tourism activities on Mt. Graham are negligible, the combined effect in Pima County is the same as observatory operations. As noted above, these range from no additional jobs (alternatives A, B, and C) to 200 additional jobs (alternatives D and PA) and finally to 700 additional jobs (alternatives E and F). This is compared with total 1985 employment of 225,700 in Tucson.

In summary, alternative E and F would produce the greatest increase in jobs. In the Graham County/Willcox area a maximum of about 300 jobs (over and above what would happen without astrophysical development) would develop over the next 25 to 30 years. Twenty five to 30 years in the future, this would result in a maximum increase in employment of about 5% above 1985 employment levels. In the immediate future, the affect on employment is much less. Alternative D and PA would contribute about 140 jobs. This would result in an increase in employment of about 2.5% above 1985 employment levels over the next 25 to 30 years. In Pima County, the increase in employment above 1985 levels over the next 25 to 30 years would be less than one half percent. These increases are not considered a significant contribution to employment.

Tables showing details of the economic impact for each alternative on Graham County/Willcox, Pima County, and Arizona as a whole can be found in Appendix 4.

9. FOREST SERVICE ADMINISTRATION AND FUNDING

1. Existing Situation

Currently it costs a total of about $115,000 per decade ($11,500 per year) to administer (recreation operation and maintenance, fire, wildlife operation and maintenance, and special uses administration, etc.) the 3500 acre management area. (See Table 14. Cost by Alternative. Chapter 2).

2. Effects of Alternatives

Forest Service administration costs in alternative B are the same as in alternative A through the first 5 periods (50 years). Forest Service administration costs increase from alternative C to D and PA to E to F for the first 5 periods (50 years).

Increased astro-tourism in alternatives D, E, F, and PA would result in an increase in administrative costs for the Safford Ranger District. Administrative costs for recreation, fire prevention, wildlife management, and special uses are increased. (See Table 14. Cost by Alternative. Chapter 2).

In alternatives D, E, F, and PA the Forest Service plans one new employee for fire supression and the stationing of fire equipment at Cluff Dairy.

Like many basic industries, astronomical observatories have not been held financially responsible for secondary impacts (e.g., costs of increased visitor use and consequent environmental degradation or burdens). Given the tighter funding for all public agencies, the proposed project is entering a marketplace where the Forest Service must require a substantial contribution from Steward Observatory towards mitigating these secondary impacts. The proposed Mt. Graham astrophysical development occurs within a relatively new socio-economic context: strong competition for land; additional expenses to off set the environmental consequences of site development; more rigorous Forest Service management guidelines; a declining Forest Service budget compared to costs; and a declining overall Federal budget. Those conditions mandate that the Forest Service look to Steward Observatory to satisfy the need for additional operation funds as well as the new need to share the costs of mitigating environmental consequences of ground based observatories.

R. SUMMARY OF EFFECTS

The Relationship Between Short-term Uses of Man's Environment and Enhancement of Long-term Productivity

The proposed astrophysical development would be a long term (10-years plus) use or committment of the land and resources. Many of the impacts of the astrophysical facilities (roads, buildings, etc.) would be short term (10 years or less) for the actual period of construction. These impacts can be mitigated through appropriate conservation measures. The short term impacts include increased runoff. sedimentation, dust, disturbance of wildlife and inconvenience to Forest users.

Effects created by long term occupancy of the proposed astrophysical area include human-wildlife conflicts and changes in types and patterns of recreation use. These can be positive or negative changes depending on the personal values of the interested and affected publics. Changes can be managed through application of appropriate conservation/control measures and monitoring of the long term uses which are anticipated to have significant effects.

Long term resource productivity would be adversely affected on those sites where facilities are actually constructed. This is due to direct changes to soil and vegetation structure. The acreage involved is small and relatively insignificant in any alternative.

Chances for survival of the Mt. Graham red squirrel decrease as the level of activity and facility development increases. Long term effects on other wildlife species would be insignificant or can be mitigated through conservation measures appropriate to each alternative.

Alternative PA mitigates or eliminates the most serious adverse significant effects of alternative D. PA is more clustered and eliminates man's development activities from environmentally sensitive sites 6 and 7; reduces exclusive use acres from 15 to 7; increases public access; eliminates possible development impacts on High Peak Cienega watershed; reduces development impacts on Bearwallow Cienega watershed; reduces restricted use acres from 284 to 123; reduces risk of extinction of the Mt. Graham red squirrel from 45% to 35%; increases zoological/botanical area acres from 400 to 569.

Irreversible and Irretrievable Commitment of Resources

"Irreversible" commitment is a consignment of a resource that cannot be changed in time or can be changed only over an extended period or with a large commitment of funds that are usually unavailable. "Irretrievable" commitment of resources is a commitment that is lost and cannot be recovered for a specified period of time. Theoretically, construction of facilities (roads, buildings, etc.) for the proposed observatory is a "reversible" commitment of land and water. In practice it is an "irretrievable" commitment of land use. No observatory of any major size in the United States has ever been removed and the land restored.

The loss of soil types and productivity would be irreversible where permanent facilities are actually constructed.

The withdrawal from mineral entry of 3500 acres in alternatives D, E, F, and PA would be an "Irretrievable" loss of possible mineral resource.

Use of water that results in a reduction of available water to a level below that needed by the Apache trout or any aquatic or riparian species of plant or animal would result in loss of habitat for the period of time the water is used and that is an irretrievable commitment. This potential impact can be mitigated through conservation measures and monitoring.

Long term consequences of changing the hydrology of the watershed and trampling are irreversible and irretrievable. The overall effect of this is minimal in any alternative.

Cultural resources are nonrenewable. Disturbance of a site is an irretrievable impact to that resource. Preservation in place of at least one archaeological site would not be possible under the development alternatives.

Should astrophysical development occur, the developed area would be essentially lost to forest users in pursuit of current outdoor recreation experiences; however, these experiences would be replaced with other experiences such as interpretation of natural and physical sciences.

The direct losses of vegetation due to clearing and construction are irretrievable, as are the losses due to windthrow associated with the opening of stands of spruce. The overall loss would be minimal in any alternative through application of conservation measures.

The greatest potential irretrievable committment in any alternative is the loss of the Mt. Graham red squirrel due to habitat loss or other factors. The risk of this loss increases as the level of man-induced activity increases for each alternative.

Adverse Effects that Cannot be Avoided

During the construction phase of the astrophysical development alternatives, increasing from alternative PA to D to E to F, local erosion levels would increase above natural levels and soil would be redeposited downslope. This process continues after construction, with decreasing intensity until a stable condition is again reached and drainages have adjusted to new hydrologic gradients. Vegetative clearing, roads, parking areas, buildings, power lines, and water supply lines could all add to the runoff potential and erosion. As areas are hardened (roofs, paved roads, parking etc.) overall erosion rates would be lowered, and localized erosion could occur caused by concentrated runoff. By dispersing runoff, use of culverts, use of water bars on unpaved roads, rock structures to relieve runoff velocity, eave troughs to points of collection for subsequent use or dispersal to watercourses, and revegetation, all erosional problems can be mitigated.

The burying of soil types and loss of soil productivity cannot be avoided in alternatives where facility construction is required. The acres actually impacted are relatively small for any alternative.

With construction of buildings, roads, and parking lots, it would be impossible to avoid increased water yield. The point of delivery of that water can be manipulated to mitigate the problems of localized increased yield.

Possible impacts to cienegas can be avoided by locating construction and operational activities outside cienega watersheds except those caused by increased visitation. Strict enforcement of existing regulations would reduce those effects.

Vehicle emissions cannot be avoided in alternatives that continue to allow motor vehicle access. This impact can be mitigated through the use of shuttle bus transport in the higher development alternatives.

Implementation of astrophysical development alternatives could result in destruction of one or more archaeological sites. Mitigative measures designed to offset impacts to the sites through the recovery of archaeological information would be conducted if determined appropriate in consultation with the Zuni Tribe, and state and federal agencies.

Even with all portions of the project built and operated according to State and federal fire codes, fire probability in the project area would increase. No guidelines exist for estimating the exact increase in probability of fire.

Hunting would be eliminated within the exclusive/restricted use areas. Bears and deer would become more adapted to human presence, reducing the sport aspects of hunting.

Human-bear encounters would increase with increased numbers of "garbage" bears. The semi-primitive feeling of the mountain-top and dispersed camping would change to a more developed management class. Conflicts among users and between users and resources would be greater with increasing levels of astrophysical development.

Law enforcement and search-and-rescue needs would increase relative to increases in access to the area and human use of the area.

Traffic and safety problems on the Swift Trail could result at an earlier date than otherwise anticipated, especially if the National New Technology Telescope is constructed here.

Direct and indirect losses of vegetation due to construction are unavoidable.

Under any development alternative, habitat capabilities for red squirrels and black bear would be reduced. The amount of this reduction is proportionate to the amount of development and duration would be at least twenty years.

Cumulative Impacts

The cumulative impacts of past man-induced activities such as: tree cutting, road building, introduction of the Abert squirrel, and fuelbreak maintenance have reduced the quality and extent of the critical habitat for the Mt. Graham red squirrel. Any additional like activities would further reduce the quality and extent of their habitat.

A decrease in infiltration cannot be avoided in alternatives D, E, F, and PA. This would intensify to the highest level in alternative F. If all mitigation measures are met, no significant impacts are anticipated.

The cumulative impacts for water yield are: insignificantly increased water yield to Ash, Frye, Marijilda, and Grant Creeks; and decreased flow in Deadman Creek immediately downstream from the water diversion during periods of adequate flow (during low flow periods, no water would be diverted from Deadman Creek).

Even with mitigation, increased visitation would still result in impacts on vegetation because of trampling and plant collecting.

The cumulative impacts of this project on air quality are the short term effects during construction. No significant impacts are anticipated. Assuming less than one hour per day of stable air conditions, it is anticipated that concentrations of all pollutants would be well within the air quality standards established by the State of Arizona, which are identical with those established by the Federal government. Anticipated reduction in air quality resulting from construction and operation of the Mt. Graham Observatory would not exceed established Arizona air quality standards for any of the alternatives.

Implementation of a development alternative would result in adverse effects to one or more of the known cultural resource sites. If impacts to these sites occur, appropriate mitigation or evaluation measures must take place.

Mountain tops in Arizona, and especially the southeastern part of the state, are becoming more and more in demand to satisfy demands which can be met at no other places. Among those demands are: high altitude recreation (including climatic relief and winter sports); electronic sites; and astronomical observatories. Those uses often conflict with one another and almost inevitably reduce the extent and quality of the unique habitats on those mountain tops.

Name	Discipline	Education and Experience
Larry S. Allen	Forest Range-Wildlife Staff 1978 to present	B.S. - Forestry Stephen F. Austin State University - 1960 USDA - FS - 27 years
John M. Borens, Jr.	Forest Lands Specialist 1980 to present	B.S. - Forestry University of Illinois - 1968 M.S. - Multiple-Use Forest Resource Management Southern Illinois University USDA - FS - 11 years
Gerald W. Conner	Forest Soil Scientist 1981 to present	B.S. - Soil and Water Science Univertsity of Arizona - 1977 USDA - FS - 7 years
Sarah L. Davis	Forest Landscape Architect 1980 to present	B.A. - Psychology University of Maryland - 1972 B.L.A. - Landscape Architecture University of Arizona - 1980 USDA - FS - 7 years
Peter James	District Recreation, Lands & Timber Staff 1978 to present	B.S. - Recreation Management Northern Arizona University - 1972 USDA - FS - 15 years
Howard Jones	Assistant Fire Management Officer 1970 to present	B.A. - History University of Colorado - 1966 USDA - FS - 16 years
Marc G. Kaplan	Forest Soil Scientist 1978 to 1981 Operations Analyst - LMP 1981 to present	B.S. - Watershed Management M.S. - Watershed Management University of Arizona - 1973 USDA - FS 11 years
Charles E. Kennedy	Forest Wildlife Biologist 1980 to present	B.S. - Education Northern Arizona University - 1951 B.S. - Wildlife Management University of Arizona - 1956 USDA - FS and USDI - Fish and Wildlife Service - 28 years
Robert Lefevre	Forest Hydrologist 1978 to present	B.S. - Forestry Michigan Tech. University - 1972 M.S. - Watershed Management University of Arizona - 1974 USDA - FS - 12 years

LIST OF PREPARERS U.S. FOREST SERVICE (DEIS) (Continued)

Name	Discipline	Education and Experience
Michael Noland	Civil Engineer- Transportation Planner 1978 to present	B.S. - Civil Engineer University of New Mexico - 1977 M.S. - Transporation Engineering Univ. of California Berkeley-1984
Lee Poague	Forest Recreation, Lands, Timber, Minerals & Cultural Resources Staff 1979 to present	B.S. - Forestry Oklahoma State University - 1957 USDA - FS - 25 years
John E. Roberts	Forest Fire-Timber Staff 1984 to present	B.S. - Forestry Oklahoma State University - 1973 USDA - FS - 11 years
Cecil Sims	District Ranger	B.S. - Forest - Range Management Colorado State University - 1960 USDA - FS - 24 years
William Speight	Forest Public Affairs Specialist	B.A. - Social Psychology Pask College - 1977 USDA - FS - 7 1/2 years
Patricia M. Spoerl	Forest Archaeologist 1984 to present	B.A. - Anthropology Lawrence University - 1971 Ph.D.- Anthropology Southern Illinois University, 1979 USDA - FS - 8 years
John Turner	Forest Land Management Planner 1978 to present	B.S. - Forest Management North Carolina State University - 1962 USDA - FS - 22 years

LIST OF PREPARERS OFFICE OF ARID LAND STUDIES ENVIRONMENTAL DATA REPORT

Name	Contribution	Education
Richard Brittain	Research and writer: Visual quality. Graphics: Project Features and Visual Quality.	B.S. (Architectural Studies) University of Illinois, Urbana, Illinois - 1973 B.A. Univ. of Arizona - 1979 M.A. Univ. of Arizona - 1979
K. James DeCook	Research and writer: Hydrology; Erosion. Sedimentation and Runoff.	B.S. (Geology) Univ. of Arizona - 1951 M.A. (Geology) Univ. of Texas - 1957 Ph.D. (Water Resources Admin) University of Arizona - 1970
Christian E. Downum	Research: Cultural Resources	B.A. Southwestern College - 1979 M.A. (Anthropology) University of Arizona - 1981
Robert Frye	Research: Fauna (Mammals)	B.S. (Biology) University of Arizona - 1973 Ph.D. (Ecology) University of Arizona - 1982
Martin M. Karpiscak	Executive Director: Editor; Research and Writer: Noise. Writer: Communications. Cultural Resources	B.S. (Biology) City College New York - 1968 M.S. (Biology) University of Arizona - 1973 Ph.D. (Biology) University of Arizona - 1980
Elizabeth Jennings	Graphics	B.F.A. (Art History) Northern Arizona University - 1981 Scientific Illustration - University of Arizona - 1984
Billie Jo Lobley	Graphics	
Carl A. Olson	Fauna (Insects)	B.S. (Zoology) Miami University - 1969 M.S. (Biology) Marshall University - 1972
Karen Reichhardt	Research and Writer: Flora, Fire	B.A. (Biology and Geology) Prescott College Prescott, Arizona - 1974 M.A. (Botany) University of Northern Colorado, Greeley, Colorado - 1977

LIST OF PREPARERS OFFICE OF ARID LAND STUDIES ENVIRONMENTAL DATA REPORT (Continued)

Name	Contribution	Education
Robert B. Scarborough	Research and Writer: Geology	B.S. (Geology) San Diego State Univ. - 1967 M. S. (Geochronology) University of Arizona - 1976
Earl W. Sires, Jr.	Research Cultural Resources	B.A. (Anthropology) University of Arizona - 1978
Peter Warren	Research and Writer: Air Quality, Access (part); Visitation (part); Fauna (part)	B.S. (Environmental Biology) UCSB Santa Barbara, CA M.S. (Ecology) University of Arizona - 1979
Peter Warshall	Principal Writer (Sections 1, 3. 4. 6 and 7); Research and Writing: Soils, Waste-water, Solid Waste, Powerline, Transportation and Access, Visitation, Socio-economic. Content Review and Rewrite: All Sections	B.A. (Biology) Harvard University - 1955 3 Degree Sorbonne (Anthropology) - 1967 Ph.D. (Biological Anthropology) Harvard University - 1971
Lauray Yule	Socio-economic Research	B.A. (Journalism) University of Wisconsin Eau Claire - 1974

MAILING LIST

Copies of the Mt. Graham Draft Environmental Impact Statement were distributed to the following agencies, governments, Indian Tribes, libraries, individuals, organizations, associations, and businesses.

Recipients of the DEIS

Federal Agencies:

U.S.D.A. Forest Service
- Southwest Regional Office
- Washington Office

U.S.D.A. Soil Conservation Service
U.S.D.C. Federal Aviation Administration
U.S.D.I. Bureau of Indian Affairs
- Phoenix
- San Carlos
- Zuni

U.S.D.I. Bureau of Land Management
- Arizona State Office
- Phoenix District
- Safford District

U.S.D.I. Bureau of Mines
U.S.D.I. Fish and Wildlife Service
- Albuquerque
- Phoenix

U.S.D.I. National Park Service
- Saguaro National Monument
- Western Archaeological Center

U.S. Department of the Interior
- Pacific Southwest Region
- Washington Office

U.S. Department of the Army, Los Angeles
U.S. Department of the Army, Fort Huachuca
U.S. Environmental Protection Agency
- San Francisco
- Washington

U.S.D.J. Border Patrol

State Agencies, Arizona:

Agriculture and Horticulture Commission*
Arizona Office of Tourism
Arizona State Land Department
- Phoenix Office*
- Tucson Office

Arizona Department of Transportation
- Phoenix Office
- Safford Office

Arizona Department of Water Resources
Arizona Bureau of Air Quality*
Arizona Game and Fish Department
- Phoenix Office*
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- Pima, AZ Office

State Agencies, Arizona: (continued)

Arizona Department of Mineral Resources
Arizona State Parks*
    Natural Areas Advisory Council
    State Historic Preservation Officer
Arizona Office of Economic Planning and Development
Arizona Division of Natural Resource Conservation
Arizona Natural Heritage Program*

* To receive documents through the Arizona State Clearinghouse, Office of Economic Planning and Development

County Governments, Arizona:

County Boards of Supervisors of following Counties:
    Cochise
    Graham
    Greenlee
County Cooperative Extension Service Office in:
    Cochise
    Graham
    Pima
Cochise County Planning Department

Local Governments in the Following Arizona Communities:

Benson
Bisbee
Douglas
Pima
Prescott
Safford
San Carlos
Sierra Vista
Thatcher
Tombstone
Tucson
Willcox

Native Americans:

Yavapai-Apache Community Council
Tonto Apache Tribe
San Carlos Apache Tribe
Salt River Pima-Maricopa Tribal Council
Pascua Yaqui Tribal Council
Papago Tribal Council
Navajo Tribal Council
Ak-Chin Indian Community
White Mountain Apache Tribe
Colorado River Indian Tribes
Cocopah Tribal Council
Gila River Indian Community

Native Americans: (continued)

Havasupai Tribal Council
Hopi Tribe
Hualapai Tribal Council
Kaibab Band of Paiutes
Ft. McDowell Mohave-Apache Community Council
Yavapai-Prescott Tribe
Pueblo of Zuni

Libraries, Public:

Benson, AZ
Bisbee. AZ
Douglas, AZ
Phoenix (Main), AZ
Safford, AZ
Sierra Vista, AZ
Tombstone, AZ
Tucson, AZ (All)
Willcox, AZ

Libraries, Other:

Arizona State University
Eastern Arizona College
Governor's Reference Library
Northern Arizona University
Pima College
University of Arizona

Congressional and State Delegations:
(Local and Washington Offices)

U.S. Senate and House of Representatives:

Hon. Barry Goldwater
Hon. Dennis DeConcini
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Hon. Morris K. Udall
Hon. John McCain
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Arizona State Senate:

Senator Burton Barr
Senator William Delong
Senator Greg Lunn
Senator John Mawhinney
Senator Ed Sawyer
Senator Robert Usdane

Congressional and State Delegations: (continued)
(Local and Washington Offices)

Arizona House of Representatives:

Minority Staff, Mike Fronske
Representative Gus Arzberger
Representative David C. Bartlett
Representative William English
Representative Larry Hawke
Representative Jack B. Jewett
Representative Joe Lane

Arizona State Governor

Honorable Bruce Babbitt

Individuals, Organizations, Associations, and Businesses

John Alcock
American Fisheries Society,
Arizona-New Mexico Chapter
American Museum of Natural History,
Southwestern Research Station
Arizona Nature Conservancy
Aarizona Outdoor Coalition
Geoffrey and Yvonne Babb
Charles M. Bagley, Jr., M.D.
Roy J. Barker
Arthur Bashor
Brent Bassford
Bells Vista Ranches Inc. of Arizona
Elliott Bernshaw
John J. Brady
Margaret S. Brady
Peter R. Brady
Phil Briggs
Jeanne Broome
P. W. Burbutis
James Cain
William A. Calder. III
Michael E. Cease
Douglas Christie
Eleanor Christman
Margaret G. Christman
Confidential Communications Company
Laurel M. Cooper
Coronado National Forest
Grazing Advisory Board
Mr. & Mrs. William R. Cowan
Pete Cowgill
Rudolph J. Dalpra
G. H. Daniel
Rudolf Dankwort

John Davis
Defenders of Wildlife
Kitty Deiss
Clark H. Derdeyn
Gabriel A. Desmare
Clyde W. Doran
Raleigh M. Drake
Earth First!
Mark Egger
Dan Fischer
Tim Flood, M. D.
Catherine Forsythe
Steve Forsythe
L. Fuentes-Williams
GEOCON, INC.
Clayton R. Gibson
Kenneth Goldsmith
Richard J. Gordon
(The) Great Bear Foundation
Deb Hall
Walton Hawk
H. E. Hawkes
Helen P. Hiemstra
Sidney M. Hirsh
Samuel Hodesson, D.V.M.
Donn Hopkins
Vaunetter J. & Harold W. Howell
Huachuca Hiking Club
Scott Hudson
Intermountain Forestry Services
Michael A. Johns
Bill Kendall
Art Keyes
Douglas Koppinger
Tex Liddle
Robert Locke
James R. Malusa
Maricopa Audubon Society
Mrs. Charles H. Martin
A. J. Matthews
Lester A. Mauk
Matt McWenie
Mexican Wolf Recovery Team
Audrey M. Miller
Ted R. Miller
Walter R. Mills
Marc Mittleman
Kenneth Moeller
Gale Monson
Mt. Graham Conservation Project
Doyle Mullican
Mary Mullican

Individuals, Organizations, Associations, and Businesses
(continued)

National Audubon Society -
Appleton - Whittell
Research Ranch Sanctuary
National Audubon Society -
Rocky Mountain Region
National Parks & Conservation Association -
Southwest & California Region
New Mexico State University-
Department of Fishery & Wildlife
New Mexico Wild Turkey Federation,
Las Cruces Chapter
Albert C. Noland
Martin E. Noland
Cecilia Noon
Muriel B. Noon
Jim Notestine
John F. Pamperin
Gene Anne Parker
Dorthy Hines Pelech
Walter Pelech
Neil Petersen
Cynthia Pierce
Paul C. Pierce
D. L. Pierson
Richard F. Plage
James E. Posedly
Jeff Price
Wm. J. Priest
William E. Pritchard
Frank W. Puncer
D. L. Purinton
R. & J. Associates
Thomas Val Rauh
Lonnie E. Rawdon
Joe R. Robinson D.V.M.
Dolt Rogers
Kerri Rogers
Sheila Rogers
Barbara & Vincent Roth and
Vera M. Walters
Santa Nino Ranch
George Scheffel
Paul R. Scheier
Judy Scott
Teresa E. Scott
Doris Seibold
Margaret Shannon
Steve Shiflet, et. al.
Sierra Club
Grand Canyon Chapter

Individuals, Organizations, Associations, and Businesses
(continued)

Sierra Club Legal Defense Fund,
San Francisco
Sierra Club,
Southwest Office
Elwin N. Sire
Ben L. Smith
Hermon Snootch
P. Sonneborn
Sparks & Siler, P.C.

Sally H. Spofford
Walter R. Spofford
Steward Observatory,
University of Arizona
J. R. Stringham
John S. Sumner
Peter Sundt
John R. Swanson
Bruce K. Thompson
Ethel W. Thorniley
Tucson Rod and Gun Club
Tucson Rough Riders, Inc.
Jake Turin
United Four Wheel Drive Associations
University of Chicago,
Astronomy & Astrophysics Center
Marguerite Vensel
Arthur E. Wainwright
William Waller
Gene I. Wendt
Westar Development Corporation
Wildlife Management Institute
(The) Wildlife Society,
Arizona Chapter
Jeanne Williams
Harriett D. Wilson
Woodward Clyde Consultants
Yuma Audubon Society
William Zaffer
Gabriel Zinsli

The following is a list of individuals, associations, businesses, and organizations commenting on the proposed Mt. Graham Astrophysical Area. In addition to these specific comments, numerous petitions were received for and against the proposal. The names on those petitions do not appear in this listing, however, they did receive notice of availability of the DEIS. The petitions are available for viewing at the Coronado National Forest Supervisor's Office, Tucson, Arizona.

Those requesting the Mt. Graham DEIS were sent the document. As a minimum, all persons commenting on the Mt. Graham proposal were notified upon release of the Draft EIS.

Edward Abbey
Scott Adams
Warren Adams
Beverly Alberding
John Alcock
Larry Allred
Juanita Alvarado
American Museum of
Natural History
American West Realty
Howard & Helen Ames
D. Renee Anderson
Dennis L. Anderson
Kathy Anderson
James M. Andres
Floyd & Irene Andrews
Eldon & Avalon Angle
Animal Defense Council
Arizona Conservation Council
Arizona Daily Star
Arizona Daily Wildcat
Arizona Outdoor Coalition
Arizona Public Service Co.
Arizona State Parks
Tanna Baldwin
Arizona State School
Arizona Wilderness Coalition
Arizona Wildlife Federation
Scottsdale
Tempe
Tucson
Audubon
Huachuca
Maricopa
Tucson
Mr. & Mrs. Clarence Bach
David & Diane Balanoff
Keith Bancroft
Jeffrey S. Barker
C. Barner
Joseph R. Bate
Charles Bates, Ph.D.
Helene & Abe Beaupeut
Elliot Bernshaw
Steve Bingham
Beverly Ann Black
Jennefer Bond
R. L. Bonham
John & Florence Boyd
Diane Boyer
P.R. & Margaret Brady
Jeffrey Brendecke
Brinkerhoff Realty, &
Construction
Ms. Bonnie Briscoe
Sidney Brooks
James R. Brown
Martin H. Brown
Michelle Brown
Dennis R. Brownridge
Simean Brubaker
David Bruce
Mr. & Mrs. J. R. Brugman
Debbie & Bob Buecher
Larry Buhlk
Anthony Ray Buida
Glen Burgess
Jane & Clifford Burrows
Marina Busby
W. A. Calder
Canyon State Communications
V. Carpenter
Catalina Council
Boy Scouts of America
Center for Astrophysics
Chamber of Commerce
Safford
Willcox
Larry J. Chapman
Helene Charbonneau

Individuals, associations, businesses, & organizations (continued)

Brent Bassford
Blaine C. Batcheld
Eleanor Christman
Margaret G. Christman
Phil & Charlette Christman
Valerie Chun
Church of Christ
Alf Claridge
Eleanor Claridge
Barbara Clark
Gerald Clark
W. H. Clarke, Jr.
Susan Clarke-Cordero
John K. Clary
Farrell "Dutch" Clifford
Surcie R. Clonts
Sterling W. Clouse
Guy Cloutier
Coalition for the Preservation of Mt. Graham
Cochise Conservation Council
Charles L. Colell
Columbine Summer Home Owners
Verna Colvin
Alice Combs
Cynthia R. Combs
Richard Conley
Marilee H. Conner
Laurel Cooper
Mrs. W. J. Cooper
Jim Coryell
Dennis Coules
Noel Cousins
Mr. and Mrs. William Cowan
George J. Coyne
Crary, Buchanan, Bowdish, & Bovie, L. E. Crary
Sylvia Crisler
Emil Crockett
Martie Crone
Gary Curtis
Gayla & Dr. Kay Curtis
Charlie Curtiss
J. Hall Cushman
Vernon Dale
Rudolph J. Dalpra
Dorothal S. Daniels
L. 0. Daniels
Rudolf Dankwort
Mr. & Mrs. George Dankworth
E. D. & Martha Darrell
Bruce Chastain
Doug Christie
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Floyd Davis
John Davis
Karen De Braal
C. W. De La Haussaye
Jon Deak
James & Rebecca Deatherage
Defenders of Wildlife
Steve Johnson
Javier Delarosa
Frances Dixon
Suzy Dodd
Mildred K. Doerges
Natalie Danforth
Clyde W. Doran
James & Linda Dorrell
Thorpe Dresser
Mrs. Mary Rose Duffield
John Dunckee
Jack W. Dykinga
Christopher J. Earl
Earth First
Eastern Arizona Amateur Radio Society, Inc.
Frank R. Eaton
Mark Edwards
Mark Egger
J. H. Eikenberry
El Camino Com. College Dist.
Clifford Elkins
Sarah Elkins
Peter & Maiva Ertman
Harry Euyart
Mr. & Mrs. Walter Eyrich
Fairways Property Owners
John & Ann Edwards
Daniel E. Falla
Pam Fargo
Roberta Fargo
James E. Farris
Bernie Fellz
Ed Fenn
Nancy Ferguson
First United State Cr. Union
W. A. Kelsey
Don Fischer
James R. Fitzsimons
Joyce Flamm
Timothy J. Flood, M.D.

Jessie & Cecil Darrell
John C. David
Faye Forehand
Timothy Forker
Kay and Steve Forsythe
Fort Willcox Leisure Park
Charles R. Straud
Fort Worth Museum of Science
& History, M. P. Walk
Patricia Fox
Ellis P. Franklin
Franklin & Marshall College
Michael A. Seeds
Warren French
Barry A. Friedman, M. D.
Allen E. Frye
Lourdes Fuentes-Williams
Frank Funk
David T. Gaffney
Susie F. Gale
Joanne Gallaher
The Galloways
Lucy Gander
Arlene & M. A. Garcia
Ben Gawlik
Mr. & Mrs. Ed Geare
Deborah Gearing
Roxane George
Clayton R. Gibson
Gila Communications
Gila Valley Economic
Development Foundation
Wolfgang Golser
Betsy & Gene Gomez
Venila Graham
Graham Conservation
Graham County Electric
Jack D. Prince
Graham County Forist & China
Shop, B. Hustin
Graham County Wildlife
Carmen Oaks
Karla Graves
Bill & Mariam Groth
Alan L. Gruel
GTE Sprint Communications
National Real Estate
Karen & John Gunn
Eric C. Gustafson
H. & R. Men's Wear
Ted Haas
David Hall
Food Conspiracy
K. W. Foote
Judy Hammerschlag
A. Hancock
Shirley A. Haralson
Garland Haraway
Michael Haraway
Jim & Reggie Harding
William L. Harrison
Harvard Smithsonian Center/
Astro, David W. Latham
Paul Hathaway
Marian A. Hawk
Herbert Hawkes
Charles & Lisa Heidenreich
George H. Henry
C. J. Henson
Leslie Hickerson
Helen P. Hiemstra
Dannell Higgs
Roger H. Hildebrand
Bruce Hilpert
John B. Hiott, Jr.
Randal P. Hodge
Mr. & Mrs. Dean Hodges
William Hoffmann
Ronald & Barbara Holden
Clarice Holder
Stanley Honanie
Earl Horley
George Horn
Clydett Houser
Joseph Howell, Jr.
Huachuca Hiking Club
Huachuca Precious Metals
Jefferey J. Kurtzeman
Mr. & Mrs. E.D.D. Hubbard
Becky Hudson
Scott Hudson
Alison Hughes
David L. Hughes
Georgetta Hughes
Laura Hughes
Ed Hunter
Marvin & Leda Imel
Michelle & Randy Inch
Incotax Systems
Mike Jakubal
Jensen Insurance
T. W. Jensen, M. D.
A. A. & Evangeline Jernigan
Theresa Jimenez

Deb Hall
Blaine K. Johnson
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Jack H. Johnson
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Johnson Motors
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Kim Jordan
Martin M. Karpiscak,
Office of Arid Lands
KATO
Mike Katzorke
Desmond Kearns
Sandy Kempton
Rabbi Mathew Kent
Louise Kentzle
John Kessler
Edward Klohe
Douglas Koppinger
Alex Kory, Jr.
Karl & Deanna Kreiling
David Kuck
KXKW FM
LAB Ornithology
Mr. & Mrs. James Landon
Bob Langsenkemp
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Pat Larson
Charles T. Larue
Elizabeth Laszlo
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David Lawrence
Floyd Le Fever
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Roxanne L. Lee
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K. E. Lemon
Lawrence Lesko
Tex Liddle
Life Zones Corporation
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Richard Lines, D.D.S.
Diane Link
G. Robert Lofgren
Lone Mountain Ranch
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Longbow Shooters Digest
Edward M. Lousdale
Lowell Observatory
Arthur A. Hoag
Lucy's Saddlery
Lucky Platt
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Max-Planck-Institute
Radio Astronomy
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Barbara Merreck
Scott J. Mervin
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A. Ellinor Michel
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Steven Miller
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Sierra Club-Southwest Office
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P. Sonneborn
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Environmental Council
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Sportsman & Gun Club
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Virginia Stute
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Peter Sundt
Marguerite Vensel
Penny Vestergom

Individuals, associations, businesses, & organizations (continued)

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Gerald & Ruth Sweeney
Gary Szczepanski
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Mr. & Mrs. Don Ernest Taylor
Thella Taylor
Elizabeth Tea
Aregai Tecle
Carol Ann Telander
Tracy Tenney
Thelma Terry
Ray Thiessen
Dave & Juli Thomas
Mr. & Mrs. Donald Thomas
Bruce K. Thompson
Gary Thompson
Ray Thompson
Burl Thornton
Reed Tollef son
H. E. & W. S. Tolman
Tucson 4 Wheelers
Tucson Rod & Gun Club
Jake Turin
Turkey Flat Summer Home Assoc.
V. & S. Perry
Ivan & Eva Shif let
Mr. & Mrs. E. R. Twitty
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USDA - Deschutes Nat'l Forest
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Ralph & Barbara Westerfield
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Marlene J. Wilson
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Catherine A. Wood
Mr. & Mrs. Wayne Woods
Bailey Woods, Jr.
Jim Worthan
John Yurling
Rev. Anne L. Zapf
Ena A. Zent
Gabriel Zinsli

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A

Acre-foot - A measurement of water volume. The volume of water that would cover one acre to a depth of one foot, equal to 43,560 cubic feet or 325,851 gallons.

Activity - Actions, measures, or treatments that are undertaken which directly or indirectly produce, enhance, or maintain forest and rangeland outputs or achieve administrative or environmental objectives.

Aesthetics - Pertaining to the quality of human perception of natural beauty (including sight, sound, smell, touch, taste, and movement).

Affected environment - The natural and physical environment and the relationship of people to that environment that will or may be changed by actions proposed.

Age Class - Interval of years, commonly 20, into which trees are grouped for management. Example: 1-20 years, 21-40 years.

Air pollution - Any substance or energy from (heat, light, noise, etc.) which alters the state of the air from what would naturally occur.

Allocation - The assignment of a land area to a particular use or uses to achieve management goals and objectives.

Alternative - In Forest planning, a mix of management prescriptions applied in specific locations to achieve a desired management emphasis as expressed in goals and objectives.

Amenity - The pleasurable, educational, or aesthetic features of the land or resources.

Arterial Roads - Roads which service large land areas and usually connect with public highways or other Forest arterial roads to form an integrated network of primary travel routes. The location and standard are determined by a demand for maximum mobility and travel efficiency rather than by a specific resource management service. Usually they are developed and operated for long-term land and resource management purposes and constant service.

Atmospheric water vapor - The amount of water vapor present in the atmosphere, usually measured in "millimeters of precipitable water." A measure of water molecules along a line of sight.

Basal area - A measurement of how much of a site is occupied by trees. It is determined by measuring the square feet of the diameter of all the trees in an area at breast height (4.5 feet).

Benefit-cost analysis - An analytical approach to solving problems of choice. Benefit-cost analysis identifies for each objective that alternative which yields the greatest benefit for a given cost or that alternative which produces the required level of benefits for the lowest cost.

Benefit-cost ratio - An economic indicator of efficiency, computed by dividing benefits by cost.

Best management practice - Application of the best available demonstrated control technology, processes, measures and operating methods that are socially, economically and technically feasible for controlling soil loss or improving water quality.

Big game - Those species of larger animals normally managed as a sport hunting resource, e.g., deer. turkey, elk, bear. etc.

Biological growth-potential - The average net growth attainable in a fully stocked natural forest stand.

Board foot - The amount of wood in an unfinished board 1 inch thick. 12 inches long, and 12 inches wide.

Canopy - The more or less continuous cover of branches and foliage formed by the crown of trees and other woody growth.

Capability - The potential of an area of land to produce resources, supply goods and services, and allow resource uses under an assumed set of management practices and at a given level of management intensity. Capability depends upon site conditions such as climate, slope, landform, soils, and geology, as well as the application of management practices, such as silviculture or protection from fire, insect, and disease.

Carrying capacity - (range or wildlife) - The maximum stocking rate possible without inducing damage to vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production.

Cavity nesters - Wildlife species that utilize tree cavities. Primary cavity nesters excavate their own hole. Secondary cavity nesters use natural cavities or cavities created by primary cavity nesters.

CEQ - See Council on Environmental Quality.

Clearcut - Removal of all standing trees over a given area of land in a single cut. Clearcut areas may occur in large or small blocks, patches or strips.

Clearcut harvest - Silvicultural system used to harvest mature trees at rotation age in one cut for the purpose of regenerating a new even-aged stand.

Climax - The culminating stage in plant succession for a given site; where the vegetation has reached a highly stable condition.

Closure - An administrative order restricting either the location, timing, or type of use in a specific area.

CMAI - See culmination of mean annual increment.

Cold-water fishery - Stream and lake waters which support predominantly cold- water species of game or food fishes (e.g., trout, salmon), which have maximum, sustained water temperature tolerances of about 70 degrees Fahrenheit in the summer.

Collector roads - Roads which serve smaller land areas and are usually connected to a Forest arterial road or public highway. They collect traffic from Forest local raods or terminal facilities. The location and standard are influenced by both long-term multi-resource service needs and travel efficiency. Forest collector roads are operated for constant service.

Common variety minerals - See Minerals, common variety.

Concern - See Management concern.

Cord - A unit of volume measurement containing 78 cubic feet of solid wood. Generally a stack of round or split wood measuring 4 feet wide by 4 feet high by 8 feet long.

Coronado National Forest - The administrative title of the National Forest System lands administered by the Forest Service from Tucson, Arizona.

Corridor - A linear strip of land identified for the present or future location of transportation or utility right-of-way.

Cost efficiency - The usefulness of specified inputs (costs) to produce specified outputs (benefits). In measuring cost efficiency, some outputs, including environmental, economic, or social impacts, are not assigned monetary values but are achieved at specified levels in the least cost manner. Cost efficiency is usually measured using present net value, although use of benefit-cost ratios and rates-of-return may be appropriate.

Council on Environmental Quality - An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Cover - Plants or plant parts, living or dead, used by wildlife for protection from predators, weather, or in which to reproduce.

Criteria - Predetermined factors for comparing alternatives to facilitate and expedite the decision making process.

Critical habitat - That portion of wild animal's habitat that is critical for the continued survival of the species.

Cultural resources - The physical remains (artifacts, ruins, burial mounds, petroglyphs, etc.) which represent former human cultures.

Culture - The complex whole which includes knowledge, beliefs, art, morals, customs, and any other capabilities and habitats peculiar to a society.

Current direction - The program level currently being used to implement the 1980 RPA program.

Cutting cycle - The planned, recurring period of time between successive cuttings or harvests in a stand of trees.

Data - Any recorded measurements, facts, evidence, or observations reduced to written, graphical, tabular, or computer form.

Decision unit - The smallest component of an alternative for which relevant inputs (costs) and outputs (benefits) are analyzed. A general term that applies to analyses at any level. Decision units may be grouped for decision making into aggregates called decision variables.

Decision variable - A component of an alternative in which input costs, outputs and benefits are identified and used for analysis and decision making.

DEIS - See draft Environmental Impact Statement

Demand - The quantity of a good or service called for by society at a given price.

Developed recreation - Use of a developed recreation site.

Developed recreation site - A distinctly defined area where facilities are provided for concentrated public use, e.g., camp grounds, picnic areas, swimming area.

Discount rate - The interest rate used in plan formulation and evaluation for discounting future benefits and computing costs, or otherwise converting benefits to a common time basis.

Dispersed recreation - Recreation use which occurs outside developed sites.

District - See Ranger district.

Diversity - The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Draft Environmental Impact Statement (DEIS) - The version of the statement of environmental effects required for major Federal actions under Section 102 of the National Environmental Policy Act (NEPA) and released to the public and other agencies for review and comment. It is a formal document which must follow the requirements of NEPA, the Council on Environmental Quality (CEQ) Guidelines, and directives of the agency responsible for the project proposal.

Ecosystem - The system formed by the interaction of a group of organisms and their environment.

Ecotone - see edge

Edge - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together. It often contains organisms from both communities as well as those restricted to the interface area. The number of species present is often greater than the surrounding communities.

Effects - Results expected to be achieved from implementation of the alternatives relative to physical, biological, and social (cultural and economic) factors. Examples of effects are tons of sediment, pounds of forage, person-years of employment, income, etc. There are direct effects, indirect effects, and cumulative effects.

Electromagnetic spectrum - All light energy from gamma rays to radio waves; what we can and cannot see. Virtually all information about the Universe - other than that sampled directly - reaches us in the form of electromagnetic radiation.

Endangered species - A species which is in danger of extinction throughout all or a significant portion of its range--other than members of the class Insecta--and which have been designated under the provisions of the Endangered Species Act of 1973.

Endemic organism - A taxonomic category (e.g., genus, species, variety) whose natural occurrence is confined to a certain region and whose distribution is relatively limited.

Environment - All the conditions, circumstances and influences surrounding and affecting the development of an organism or group of organisms.

Environmental assessment - A document which displays a comparison of the effects of a proposed project and alternatives to it on the environment.

Environmental Impact Statement - See Draft environmental impact statement and Final environmental impact statement.

Environmental setting - See Management situation.

Erosion - The processes whereby earthy or rocky material is worn away, loosened, dissolved and removed from any part of the earth's surface.

Erosion, natural - Wearing away of the earth's surface by natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man.

Evapotranspiration - Process by which water moves from the soil to the atmosphere by evaporation from the soil or transpiration through plants.

Even-aged management - The application of a combination of actions that result in the creation of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes) throughout the forest area. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for regeneration and is harvested. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Faint Object Death Time (FODT) - A time in the future when the sky brightness due to light pollution will equal the brightness of faint celestial objects. The FODT is location-dependent.

Feasibility - The relative advantage of managing or improving a land unit, considering its capability and suitability for specific use under the existing or projected socioeconomic climate.

Fire Suppression Terminology -

Confine: To limit fire spread within a predetermined area principally by use of natural or preconstructed barriers or environmental conditions. Suppression action may be minimal and limited to surveillance under appropriate conditions.

Contain: To surround a fire, and any spot fires therefrom, with control line as needed, which can reasonably be expected to check the fires spread under prevailing and predicted conditions.

Control: To complete the control line around a fire, any spot fires therefrom, and any interior islands to be saved, burn out any unburned area adjacent to the fire side of the control line and cool down all hot spots that are immediate threats to the control line, until the line can reasonably be expected to hold under foreseeable conditions.

Escaped Fire: A fire which has exceeded, or is anticipated to exceed, preplanned initial action capabilities or the fire management direction.

Final Environmental Impact Statement (FEIS) - The final version of the statement of environmental effects required for major Federal actions under Section 102 of the National Environmental Policy Act (NEPA). It is a revision of the draft environmental impact statement to include public and agency responses to the draft. It is a formal document which must meet legal requirements and is the document used as a basis for judicial decisions concerning compliance with NEPA.

Fire Zone 1 - A zone where the objective is to prevent fires from reaching or damaging high value resources and/or improvements.

Firewood - Wood, either round, split or sawed, and burned primarily for heating purposes.

Fisheries habitat - Streams, lakes, and reservoirs that support fish.

Floodplain - That portion of a stream valley, adjacent to the channel which is covered with water when the stream overflows its banks at flood stages.

Forage - All browse and nonwoody plants that are available to livestock or game animals for grazing or harvesting for feeding. The weight may be expressed as either green, air dry or oven dry. The term may also be modified as to time of production such as annual, current year's or seasonal forage production.

Forest land - Land at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for non-forest use. Lands developed for non-forest use include areas for crops, improved pasture, residential or administrative areas, improved roads of any width and adjoining clearings and powerline clearings of any width.

Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) - An Act requiring the preparation of a program for the management of the National Forest's renewable resources and of land and resource management plans for units of the National Forest System. It also requires a continuing inventory of all forest and rangelands and renewable resources Nation-wide.

Forest development roads - Roads that are part of the Forest transportation system, which includes all existing and planned roads, as well as other special and terminal facilities designated as Forest development transportation facilities.

Forest Plan - See National Forest land and resource management plan.

Forest Supervisor - The official responsible for administering the National Forest System lands in a Forest Service administrative unit. Reports to the Regional Forester.

Forest standard - A performance criterion indicating acceptable norms or specifications that actions must meet to maintain the minimum conditions for a particular resource. This type of standard applies to all areas of the Forest regardless of the other management area direction applied.

Fuelbreak - Any natural or constructed barrier used to segregate, stop, and control the spread of fire or to provide a control line from which to work.

Fuels - Anything within the Forest that will burn. Usually live and dead woody vegetation, e.g., grass, shrubs, trees.

Fuel treatment - The rearrangement or disposal of fuels to reduce the fire hazard. Fuels are defined as both living and dead vegetative materials consumable by fire.

Fuelwood - See Firewood.

Galaxy - A system of billions of stars bound together by its own gravity. Our galaxy is known as the Milky Way.

Game species - Any species of wildlife or fish normally harvested by hunters, trappers, and fishermen under state or federal laws.

Geological area - A unit of land which has been designated by the Forest Service as containing outstanding formations or unique geological features, including caves and fossils. Areas of this type are identified and formally classified because of their recreational and educational values.

Ground water - Water in a saturated zone of a geologic stratum.

Growing stock level (GSL) - The stand density level, usually expressed as number of trees per acre or basal area per acre in square feet, required to maintain an optimum growth through the life of a stand. Trees per acre at 10 inch dbh and above equals the square foot basal area per acre.

Guideline - An indication or outline of policy or conduct.

Habitat - The natural environment of a plant or animal. The locality where the organism may generally be found and where all essentials for its development and existence are present. Habitats are described by their geographical boundaries, or with such terms as "shady woodlands," "banks of streams," "dry hillsides," etc.

Habitat diversity - See Wildlife habitat diversity.

Herbage - Herbs taken collectively, usually used in the same sense as forage, except that it may include material not palatable to grazing or browsing animals.

Hubble Space Telescope (HST) - A 2.4-meter reflecting telescope designed to be placed into Earth orbit by the Space Shuttle. Tentatively scheduled for launch in 1987.

Hydrologic function - The behavioral characteristics of a watershed described in terms of it's ability to sustain favorable conditions of water flow.

Image sharpness - The "crisp" or "fuzzy" appearance of an image produced by a telescope. Light from a distant point source such as a star has its parallel rays deviated somewhat differently by different air parcels in Earth's atmosphere. The resulting image produced by a telescope is a blob of light which pulsates and moves around at high speed. Averaged over a minute or so, this light forms a fairly regular pattern with a bright spot in the center and intensity falling off outward. The angular width of the bright spot at a given fraction of its central intensity (usually 1/2) is a measure of the "image sharpness."

Improvement - Manmade developments such as roads, trails, fences, stock tanks, pipelines, power and telephone lines, survey monuments, and ditches.

Indicator species - A wildlife species whose presence in a certain location or situation at a given population level indicates a particular environmental condition. Population changes are believed to indicate effects of management activities on a number of other wildlife species.

Infrared (IR) - The part of the electromagnetic spectrum that lies at wavelengths longer than red visual light, but shorter than radio wavelengths; heat energy.

Infrared telescope - A telescope designed to observe the wavelengths of light longer than our eye can see. Some infrared wavelengths are absorbed by water vapor in the air.

Interdisciplinary team - A group of individuals with different training assembled to solve a problem or perform a task.

Interferometer - Telescopes can be used individually or in combinations called "arrays" or "interferometers." An interferometer combines the signals of two dish antennas to yield image sharpness of a telescope whose diameter is equal to the separation between the antennas.

Interpretive services - Information services designed to present inspirational, educational, and recreational values to Forest visitors to provide the utmost in understanding, appreciation, and enjoyment from their Forest experience.

Inversion layer - An atmospheric condition in which a layer of warm air traps cooler air near the surface of the earth, preventing the normal rising of surface air.

Irretrievable resource commitment - Allocation decision causing loss of production or use of a renewable resource.

Irreversible resource commitment - Allocation decision affecting nonrenewable resources--soil, minerals, and cultural resources--causing permanent loss of these resources.

Issue - See Public issue.

Less than standard service management - Management of developed sites, wilderness, and dispersed areas to provide service below established standards and objectives.

Lifestyle - A characteristic way of living which may be an individual variant within the cultural mainstream or may be an individual expression of a subculture. "Lifestyles" are generally expressed through the means of economic sustenance, dwelling site and type, group associations, and social practices such as family form, religious practices, sexual mores, style of dress and type of diet.

Light pollution - Mainly caused by street lighting in urban areas, light pollution affects the ability of telescopes to observe celestial objects, particularly faint objects "drowned" by the extra light from urbanization.

Light-year - The distance traveled by light in a vacuum during one year; equivalent to 5.8786 trillion miles. Light-years are used to measure distances in space.

Local roads - Local roads are usually one-Jane roads constructed to serve a dominant use or resource. Local roads do not access large land areas since they are more site specific than arterial and collector roads.

Locatable minerals - See Minerals, locatable.

Long-term effects - Those effects which will be significant beyond the RPA planning horizon of 50 years.

M - Thousand.

MM - Million.

Management area standard and guidelines - Management practices selected and scheduled for application in a specific area to attain multiple use and other goals and objectives.

Management concern - An issue, problem, or a condition which constrains the range of management practices identified by the Forest Service in the planning process.

Management direction - A statement of multiple-use and other goals and objectives, the associated management prescriptions, and standards and guidelines for attaining them.

Management indicator species - See indicator species.

Management intensity - A management practice or combination of management practices and associated costs designed to obtain different levels of goods and services.

Management opportunity - A statement of general actions, measures, or treatments that address a public issue or management concern in a favorable way.

Management practice - A specific activity, measure, course of action, or treatment.

Management prescription - Management practices and intensity selected and scheduled for application on a specific area to attain multiple-use and other goals and objectives.

Management situation - A comprehensive statement of the planning area resources, its history, past and present uses, and a review of the public's concerns with the area.

Management standards and guidelines - See Standard and Guideline.

Mature sawtimber - Trees that have attained full development and the growth rate has leveled off.

Max Planck Institute for Radio Astronomy (MPIfR) - The leading radio astronomy research institution in the Federal Republic of Germany. Headquartered in Bonn, MPIfR has over 150 employees and operates the largest fully steerable radio telescope in the world. MPIfR is currently collaborating with Steward Observatory to build a 10-meter submillimter wavelength telescope, the Submillimeter Telescope Facility (SMT).

Midden - A place where many conifer cones have been cached and stripped by red squirrels. Such a site has usually been used by many squirrels, one at a time, for many years. A midden generally surrounds a stump, lown log, snap or living conifer tree. Occasionally one is found on the open forest floor. All middens are found within the forest, usually in well-shaded, protected areas. North facing slopes are often favorite sites. Only red squirrels make middens.

Mineral entry - Filing a mining claim on public land to obtain the right to any minerals it may contain.

Mineral exploration - The search for valuable minerals on lands open to mineral entry.

Mineral withdrawal - Public lands withdrawn from mineral entry under the General Mining Laws and the mineral leasing laws. Lands withdrawn usually have unique features which are highly valued by the public or are needed for administrative purposes.

Minerals, common variety - Deposits which--although they may have value for use in trade, manufacture, the sciences, or in the mechanical or ornamental arts--do not possess a distinct, special economic

value. May include sand, stone, gravel, pumicite, cinders, pumice (except that occurring in pieces of two inches on a side), clay, and petrified wood.

Minerals, leasable - Coal, oil, gas, phosphate, sodium, potassium, oil shale, sulphur (in Louisiana and New Mexico), and geothermal steam.

Minerals, locatable - Those hard rock minerals which are mined and processed for the recovery of metals. May include certain nonmetallic minerals and uncommon varieties of mineral materials such as valuable and distinctive deposits of limestone or silica. May include any solid, natural inorganic substance occurring in the crust of the earth, except for the common varieties of mineral materials and leasable minerals.

Mining claim - That portion of the public estate held for mining purposes in which the right of exclusive possession of locatable mineral deposits is vested in the locator of a deposit.

Mining patent - The patent is a legal document which conveys the title to the ground (i.e., ownership) to the claim's owner.

Multiple-Mirror Telescope (MMT) - A large astronomical telescope combining six 72-inch Cassegrain telescopes mounted symmetrically around a central axis. The light from the six mirrors is brough to a common focus. The combined aperture is equivalent to a 176-inch telescope, making it the third largest optical telescope and the largest designed for infrared observations. Jointly operated by the Smithsonian Institution and the University of Arizona.

Multiple use - The management of all the various renewable surface resources of the National Forest System so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some lands will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources and not necessarily the combination of uses that will give greatest dollar return or the greatest unit output.

National Environmental Policy Act (NEPA) - An act declaring a National policy to encourage productive and enjoyable harmony between man and his environment, to promote efforts which will prevent or eliminate damage to the environment and the biosphere and stimulate the health and welfare of man, to enrich the understanding of the ecological systems and natural resources important to the Nation and to establish a Council on Environmental Quality.

National Forest Land and Resource Management Plan - A plan developed to meet the requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended, that guides all resource management activities and establishes management standards and guidelines for the National Forest System lands of a given National Forest.

National Forest Management Act (NFMA) - A law passed in 1976 that amends the Forest and Rangeland Renewable Resources Planning Act and requires the preparation of Forest plans.

National Forest System land - National Forests, National Grasslands, and other related lands for which the Forest Service is assigned administrative respon-
sibility.

National New Technology Telescope (NNTT) - The proposed largest telescope in the world. Designed to combine the apertures of four 7.5-meter mirrors, it will have a light-gathering area equivalent to a single 15-meter reflector. the NNTT will be used to observe both optical and infrared wavelengths, and is currently part of the National Optical Astronomy Observatories' "Advanced Development Program." The NNTT may be placed on Mt. Graham. Arizona or Mauna Kea. Hawaii. following the results of an extensive site-testing program.

National Optical Astronomy Observatories (NOAO) - Established in 1984. NOAO comprises three major astronomical centers for use by astonomers from the U.S. and around the world. Under contract to the National Science Foundation (NSF). NOAO is operated by the Association of Universities for Research in Astronomy (AURA), comprised of 17 member universities.

National Register of Historic Places - A list (maintained by the National Park Service) of areas which have been designated as being of historical significance. The Register includes places of local and state significance as well as those of value to the Nation.

National Wilderness Preservation System - Pristine Federal lands designated by the Wilderness Act of 1964 and subsequent wilderness legislation. Generally, these lands are untouched by "works of man."

Natural prescribed fire - See Prescribed fire.

Natural sky glow - The natural brightness of the nighttime sky as seen through the earth's atmosphere.

NEPA - See National Environmental Policy Act.

Net public benefits - An expression used to signify the overall long-term value to the Nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be quantitatively valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than a single measure or index. The maximization of net public benefits to be derived from management of units of the National Forest System is consistent with the principles of multiple use and sustained yield.

NFMA - See National Forest Management Act.

No action alternative - The most likely condition expected to exist in the future if current management direction would continue unchanged.

Nongame wildlife - Species of animals which are not managed as a sport hunting or fishing resource.

Non-point source pollution - The Environmental Protection Agency defines nonpoint source pollution in terms of activities rather than specific conveyances. Non-point sources of pollution are the result of activities which are initiated or caused by natural processes. including precipitation, drainage, seepage, percolation, and runoff; or is not traceable to any discreet or identifiable facility. The term silvicultural non-point source includes activities inherent to forest management which accelerate the effects of natural processes. Such activities include nursery operations, site preparation, reforestation and subsequent culture, thinning, prescribed burning, pest and fire control, harvesting operations, and the construction and maintenance of roads and other transportation systems associated with these activities.

O

Objective - A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals.

Obliterate - The action needed to close an unneeded road and return the land to production.

Observatory - A building equipped for scientific observation, especially such a building with a large telescope for astronomical research; an institution for such research.

Observing time - The time allocated to an astronomer to use a specific telescope for astronomical observations. Time - usually awarded for a few consecutive nights is most often awarded by a telescope allocation committee. Proposals are submitted to the committee for peer review; time is granted on the basis of the scientific merit of the proposed research.

Old growth - The final successional stage of a stand of trees. Characterized by a high degree of decadence because of declining health and vigor. Tree ages are in excess of 120 years.

On site soil loss - The movement of soil from the point at which it was formed to another location.

Opportunity - See Management opportunity.

Optical telescope - A telescope designed to observe the wavelengths of light from the visible spectrum - light our eyes can detect.

Optical transparency - A term referring to the quality of Earth's atmosphere for astronomical observations. As light passes through the atmosphere, some of it is lost for astronomical use. Some light is absorbed by dust particles or molecules in air, some is scattered through large angles. In general, the light within about 10 arcseconds of the image belongs to the image, and light deviated by more than that is considered lost. The optical transparency of the atmosphere can be measured as:

$$\frac{\text{light incident - light lost}}{\text{light incident}}$$

ORV - Off-road vehicle. This includes all motorized means of transportation; passenger cars, 4-wheel drive pickups, trail bikes, snowmobiles or other motorized ground transportation vehicles that are capable of traveling overland where no roads exist.

ORV closure - An administration order closing a land area to specified types of off-road vehicle travel yearlong.

ORV restriction - An administrative order restricting a land area to specified types of off-road vehicle travel during specific seasons or conditions.

Overstory - The portion of trees in a forest which forms the upper most layer of foliage.

Overstory modification - Removal of 80 percent or more of the overstory to increase production of grass and browse for utilization by livestock and wildlife.

Oversubscription rate - The amount of time requested by astronomers for telescope observation vs the time available. Most major telescope installations receive three times as many requests for time as there is time available.

Particulates - Small particles which are suspended in the air and generally are considered pollutants.

Patented land - Public lands conveyed to private ownership most commonly by homestead, mining or land exchange laws.

People at one time (PAOT) - The number of people that can use a recreation opportunity at any one time without substantially diminishing the quality of the experience sought after.

Perennial interrupted stream - Water course containing occasional perennial surface water due to ground water interception with intervening intermittent reaches exhibiting a saturated moisture regime beneath the channel bed.

Personal use - Normally used to describe the type of permit issued for removal of wood products (firewood, posts, poles, latillas, and Christmas trees), from National Forest land when the product is for home use and not to be resold for profit.

Planning area - The area covered by a Forest Plan.

Point source pollution - Silvicultural point source pollution as defined to be those forestry related activities in which and discernible, confined and discreet conveyance related to rock crushing, gravel washing, log sorting or log storage facilities from which pollutants are discharged into the waters of the United States.

Practice - See Management practice.

Precommercial thinning - Thinning trees with diameters under 5 inches where material thinned does not have a market value. Selective cutting of trees with an objective of removing the least desirable trees and improving the spacing of remaining trees to accelerate growth.

Preferred alternative - The alternative recommended for implementation as the Forest Plan based on the evaluation completed in the planning process. (See Proposed Action).

Preparatory cut - Removal of mature trees near the rotation age in a shelterwood harvest for the purpose of opening the canopy to encourage development of cone bearing crowns for seed production on the remaining trees.

Prescribed fire - The natural or intentional application of fire to wild land fuels under such conditions as to allow the fire to be confined to a predetermined area, intensity of heat and rate of spread. Required to obtain planned resource objectives.

Prescription controls - Prescription controls were used in FORPLAN to require the model to assign specific amounts of specified prescriptions to an analysis area in order to achieve a desired management practice and/or intensity of management or a desired funding level for a particular resource area. Prescription controls limit the percentage of an analysis area that can be allocated to a specified prescription level or combination of levels.

Present net value (PNV) - The difference between the discounted value (benefits) of all outputs to which monetary values or established market prices are assigned and the total discounted costs of managing the planning area.

Present value of benefits (PVB) - Cumulative discounted benefits to 2080.

Present value of costs (PVC) - Cumulative discounted costs to 2080.

Primitive roads - Roads constructed with no regard for grade control or designed drainage, sometimes by merely repeated driving over an area. These roads are single lane, usually with native surfacing and sometimes passable with 4-wheel drive vehicles only, especially in wet weather.

Productivity - See Site productivity.

Proposed action - Specified in the National Environmental Policy Act as the project, activity, or decision that a Federal agency intends to implement or undertake which is the subject of an environmental impact statement.

Public - The people of an area, state, or nation that can be grouped together by a commonality of interests, values, beliefs, or lifestyles.

Public access - Usually refers to a road or trail route over which a public agency claims a right-of-way available for public use.

Public issue - A subject or question of widespread public interest relating to the management of National Forest System.

Put-to-bed - Action needed to place a local road in a low maintenance condition during a period of low use by surface stabilization, revegetation, and drainage structures.

Radio waves - The longest wavelength energy of the electromagnetic spectrum.

Ranger District - Administrative subdivisions of the Forest supervised by a District Ranger who reports to the Forest Supervisor.

RARE II - See Roadless Area Review and Evaluation II.

Real dollar value - A monetary value which compensates for the effects of inflation.

Reconstruction - Road or trail construction activities which take place on an existing road or trail and raise the standard of the road or trail. This can include relocation of the facility in a completely new location.

Record of Decision - A document, separate from but associated with an environmental impact statement, that publicly and officially discloses the responsible official's decision on which alternative assessed in the EIS will be implemented.

Recreation Opportunity Spectrum (ROS) - A method of delineating types of recreation settings. There are six ROS settings. Only the first four are evident on the Coronado National Forest. These settings are: Primitive - Essentially unmodified natural environments; Semi-Primitive Non-Motorized - Predominantly natural or natural appearing environments without motorized use; Semi-Primitive Motorized - Predominantly natural or natural appearing environments where motorized use occurs; Roaded Natural - Predominantly natural appearing environments with moderate evidence of the sights and sounds of man; Rural - Modified natural environment with facilities for special activities; Urban - substantially urbanized environment.

Recreation Visitor Day (RVD) — A unit of measuring recreation activities which aggregate 12 visitor hours. May consist of one person for 12 hours, 12 persons for one hour or any equivalent combination of continuous or intermittent recreation use by individuals or groups.

Reforestation - The natural or artificial restocking of an area usually to produce timber and other wood products, but also to protect watersheds, prevent soil erosion, and improve wildlife, recreation and other natural resources. Natural reforestation includes site preparation to reduce competing vegetation and provide a mineral seed bed for seed provided by seed trees. Artificial reforestation is the planting of seedlings, cuttings or seeds by hand or mechanical means and may include site preparation.

Regeneration - The term is used two ways: 1) The actual seedlings or saplings existing in a young tree stand; or 2) The act of reforesting an area.

Regeneration cutting - The removal of trees intended for the purpose of assisting regeneration already present or to make regeneration of the stand possible.

Region - For planning purposes, the standard administrative unit of the Forest Service administered by a Regional Forester.

Region 3 - The Southwest Region. A Forest Service organizational unit consisting of all National Forests in New Mexico and Arizona plus four National Grasslands in Texas, Oklahoma, and New Mexico.

Regional Forester - The official responsible for administering a single Region and preparing a Regional Guide.

Removal cut - Removal of remaining mature trees near rotation age in a shelterwood harvest to provide full sunlight to the regenerated crop.

Research Natural Area - An area set aside by the Forest Service to preserve a representative sample of an ecological community; primarily for scientific and educational purposes. Commercial exploitation is not allowed and general public use is discouraged.

Resource - An aspect of human environment which renders possible or facilitates the satisfaction of human wants and the attainment of social objectives.

Resource element - A major Forest Service mission-oriented endeavor which fulfills statutory or executive requirements and indicates a collection of activities from the various operating programs required to accomplish the mission. The eight resource elements are recreation, wilderness, wildlife and fish, range, timber, water, minerals, and human and community development.

Responsible line officer - The Forest Service employee who has the authority to select and/or carry out a specific planning action.

Revegetation - The reestablishment and development of a plant cover. This may take place naturally through the reproductive processes of the existing flora or artificially through the direct action of man--reforestation or range reseeding.

Right-of-Way - The right to pass through another person's land as obtained by condemnation or purchase.

Riparian ecosystem - A transition between the aquatic ecosystem and the adjacent terrestrial ecosystem identified by soil characteristics and distinctive vegetation communities that require free or unbound water.

Roadless Area Review and Evaluation - The assessment of unroaded areas within the National Forests as potential wilderness areas. This refers to the second review which was begun in 1977 and documented in a final environmental impact statement, January 1979.

Road density - The number of miles of road per square mile in a land area.

Road maintenance - Level 1 - This level is assigned to intermittent service roads during the time management direction requires that the road be closed or otherwise blocked to traffic. Basic custodial maintenance is performed to protect the road investment and to keep damage to adjacent resources to an acceptable level. Drainage facilities and runoff patterns are maintained.

Roads receiving Level 1 maintenance may be of any type, class, or construction standard and may be managed at any other maintenance level during the time management direction requires that they be open for traffic. However, while being maintained at Level 1, they are closed or blocked to traffic.

Level 2 - This level is assigned where management direction requires that the road be open for limited passage of traffic. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level.

Roads in this maintenance level are normally characterized as single lane, primitive type facilities intended for use by high clearance vehicles. Passenger car traffic is not a consideration.

Level 3 - This level is assigned where management direction requires the road to be open and maintained for safe travel by a prudent driver in a passenger car. Traffic volumes are minor to moderate; however, user comfort and convenience is not considered a priority.

Roads at this maintenance level are normally characterized as low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. The functional classification of these roads is normally local or minor collector.

Level 4 - This level is assigned where management direction requires the road to provide a moderate degree of user comfort and convenience at moderate travel speeds. Traffic volumes are normally sufficient to require a double lane aggregate surfaced road. Some roads may be single lane and some may be paved and/or dust abated. The functional classification of these roads is normally collector or minor arterial.

Level 5 - This level is assigned where management direction requires the road to provide a high degree of user comfort and convenience. These roads are normally double lane, paved facilities. Some may be aggregate surfaced and dust abated. Functional classification of these roads is normally arterial.

Rotation age - The period of years between initial establishment of a stand of timber and the time when it is regenerated.

RVD - See Recreation Visitor Day.

Salvage harvest - Removal of dead or dying trees resulting from insect and disease epidemics or wildfire.

Sanitation harvest - Removal of dead or dying trees to prevent spread of insects or disease.

Sawtimber - Trees suitable in size and quality for producing logs that can be processed into lumber. For planning purposes on the Forest, trees with a nine-inch diameter were classified as sawtimber.

Scoping - Determination of the significant issues to be addressed in an EIS.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Sedimentation - The deposition of detached soil and rock material transported by or suspended by water.

Seed cut - Removal of mature trees near rotation age in a shelterwood harvest to permanently open the stand and prepare the site for regeneration from the seed trees left for that purpose.

Seedling/sapling - A forest successional stage in which trees less than five inches in diameter are the predominant vegetation.

Seeing - The quality or steadiness of an image when viewed through a telescope. Changes in air temperature produce turbulence in the atmosphere, causing celestial objects to "twinkle."

Selection cutting - The annual or periodic removal of trees, individually or in small groups from an uneven-aged forest in order to realize the yield and establish a new crop of irregular constitution.

Seral - A plant and animal community which is transitional in stage of succession, being either short- or long-term. If left alone, the seral stage will pass, and nother plant and aninmal community will replace it. Aspen represents a seral stage that would eventually be replaced by conifers such as spruce.

Shelterwood cutting - The removal of a stand of trees through a series of cuttings designed to establish a new crop with seed and protection provided by a portion of the stand.

Shelterwood harvest - Silvicultural system used to harvest mature trees at rotation age in a series of preparatory, seed and removal cuts designed to regenerate a new even-aged crop under the shelter of the old crop.

Short-term effects - Those effects which will not be significant beyond the RPA planning horizon fo 50 years.

Silviculture - The science and art of growing and tending crops of forest trees.

Site productivity - Production capability of specific area of land.

Size class - For the purposes of Forest planning, size class refers to the intervals of tree stem diameter used for cassification of timber in the Forest Plan data base: less than five-inch diameter = seedling/sapling; five to nine-inch diameter = pole timber; and greater than nine-inch diameter = sawtimber.

Slash - Debris left after logging, pruning, thinning, or brush cutting, and large accumulations of debris resulting from windstorms. It includes logs, bark, branches, and stumps.

Small game - Birds and small mammals normally hunted or trapped.

Smithsonian Astrophysical Observatory (SAO) - An astrophysical observatory located on Mt. Hopkins, Arizona. operated by the Smithsonian Institution. Facilities for optical, infrared and gamma-ray detection are in use.

Snag - A standing dead tree from which the leaves and most of the branches have fallen.

Snag recruitment - Reservation of suitable live trees near death for replacement of snags in the future or killing trees to create new snags.

Social analysis - An analysis of the social (as distinct from the economic and environmental) effects of a given plan or proposal for action. Social analysis includes identification and evaluation of all pertinent desirable and undesirable consequences to all segments of society, stated in some comparable quantitative terms. It also includes a subjective analysis of social factors not expressible in quantitative terms.

Soil erosion - The detachment and movement of soil from the land surface by wind, water, or gravity.

Soil productivity - The capacity of a soil to produce a specific plant or sequence of plants under a specific system of management.

Southwestern Region - See Region 3.

Special use permits - Permits and granting of easements (excluding road permits and highway easements) authorizing the occupancy and use of land.

Special uses - Special use permits.

Stand - A group of trees on a minimum of 1 acre of forest land that is at least 10 percent stocked by forest trees of any size.

Standard - Performance criteria indicating acceptable norms or specifications that actions must meet. A principle requiring a specific level of attainment, a rule to measure against.

Standard service management - Management of developed sites, wilderness, and dispersed areas to provide optimum service.

Steward Observatory (SO) - An astronomical observatory operated by the University of Arizona, serving as the research arm for the Department of Astronomy.

Submillimeter - Very short radio waves, similar to microwaves, near the infrared portion of the electromagnetic spectrum. Submillimeter waves are emitted in areas where stars are forming, but most are absorbed by water vapor in Earth's atmosphere. Submillimeter waves can be observed from high mountains under dry conditions.

Submillimeter Telescope Facility (SMIT) - A joint project of the Max Planck Institute for Radio Astronomy, West Germany, and the University of Arizona, the SMT consists of a 10-meter dish designed to detect submillimeter wavelengths - very short radio waves. The SMT is one of the first telescopes proposed for Mt. Graham, Arizona.

Suitability - Tlhe appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses foregone. A unit of land may be suitable for a variety of individual or combined management practices.

Suitable lands - Lands which are appropriate for the application of certain resource management practices as determined by an analysis of the economic and environmental consequences and the alternative uses foregone.

Sustained yield of products and services - The achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the National Forest System without impairment of the productivity of the land.

Temporary roads - Temporary roads are low-level roads constructed for a single purpose and short-term use. Once use of the road has been completed, it is obliterated, and the land it occupied is returned to production.

Thinning - Cutting made in an immature stand to accelerate diameter growth and improve form of remaining trees.

Threatened and endangered species - See Threatened species and Endangered species.

Threatened species - Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and which has been designated in the Federal Register by the Secretary of the Interior as a threatened species.

Tiering - Refers to the coverage of general matters in broad environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basin wide program statements or ultimately site-specified statements), incorporating by reference the general discussions and concentrating solely on the issues specific to the statement in question.

Timber - A general term for the major woody growth of vegetation in a forest area.

Timber production - The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. The term "timber production" does not include production of fuelwood.

Timber stand improvement (TSI) - Cuttings made in an immature stand to accelerate diameter growth and improve the form of the trees that remain.

Topography - The configuration of a land surface including its relief, elevation and the position of its natural and man-made features.

Trailhead - The parking, signing, and other facilities available at the terminus of a trail.

Trail Maintenance - Level 1: Trails maintained for primitive experience level. Custodial care only. No tread maintenance. Drainage functional and not likely to fail. Trail sides not bushed but tread is kept passable. Small slides may remain except for those with erosion potential. Structures maintained as needed. Signing may be deferred. Level 2: Trails maintained for near-primitive experience level. Tread maintained for public safety. Logs or similiar rustic structures may be provided at stream crossings. Drainage same as level 1. Signing at a minimum level commensurate with level of trail use. Level 3: Trails maintained for intermediate experience level. Tread maintained for public safety and user convenience. Drainage same as level 1. Trailsides brushed out to handbook standards. Structures maintained to original design standards. Signing same as level 2. Level 4: Trails maintained at relatively high standards to provide for public safety and convenience. Tread relatively smooth, firm and may require stabilization. Signing at high level. All other elements same as level 3. These trails are generally maintained for family or senior citizen use. Level 5: Trails maintained for high use and experienced levels, including special purposes such as interpretive trails, bicycle trails, trails to major vista points, trails for the handicapped. etc. Basic care is the same as level 4 but patching of paved tread may be needed annually. Trail sides maintained to meet high visual quality standards by brushing and clean-up of debris beyond the trail limits. Vistas are maintained. Criteria for determining appropriate trail maintenance level are type of use (e.g., foot, horses, vehicles or mix), amount of use, and significance of the trail (e.g., major access route, leads to dead end. etc.)

Transportation system - All existing and planned roads and trails needed to access the Forest.

Trick tank - A water development constructed by laying an inmpervious surface on a collection area and funneling water to a storage use point. The key consideration for trick tanks is they are not placed in defined channels, and therefore are not making use of appropriable water. Commonly constructed of tin, concrete, butyl or treatment soil and sometimes use natural collection from rock outcrops.

TSI - See Timber Stand Improvement.

Uneven-aged management - The application of a combination of actions needed to simultaneously maintain continuous high-forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products. Cutting is usually regulated by specifying the number or proportion of trees of particular sizes to retain within each area, thereby maintaining a planned distribution of size classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Use season - That period of time developed recreation sites are open for public use, with routine maintenance, cleanup, and operation on a scheduled basis.

USF&WLS - U.S. Fish and Wildlife Service, Department of Interior.

V

Visual Condition - The degree of visual alteration of the landscape. Six condition classes, ranging from pristine to drastic disturbance, define the degree of deviation from a natural appearing landscape.

Visual Quality Objective (VQO) - Measurable standards for the management of visual resources of the landscape. Refers to the degree of acceptable alterations of the characteristic landscape based on the importance of aesthetics. Objectives use in the Proposed Plan are:

Preservation - provides for ecological change only.

Retention - Man's activities are generally not evident to the casual visitor.

Partial Retention - In general man's activities may be evident but must be subordinate to the characteristic landscape.

Modification - Man's activity may dominate the characteristic landscape but must, at the same time, utilize naturally established form, line, color and texture. Man's activities should appear as natural occurrences when viewed from foreground or middle ground.

Maximum modification - Man's activity may dominate the characteristic landscape but should appear as a natural occurrence when viewed as background.

Visual resource - The composite of basic terrain, geological features, water features, vegetative patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for visitors.

Visual variety class - A classification system for establishing visual landscape categories according to the relative importance of the visual features.

Watershed - The area that contributes water to a drainage or stream.

Watershed condition - A description of the health of a watershed, or portion thereof in terms of the factors which affect hydrologic function and soil productivity.

Water right - A legal ownership of a right to use a quantity of water for a given use, in a given time, and in a specific location. In Arizona, water rights are required for all appropriable water which includes groundwater used by commercial agriculture, industry and municipalities, and all surface water.

Water yield - That portion of the annual precipitation which contributes to stream flow and recharge of the ground water table.

Wavelength - The distance between wave crests in any types of wave. The distance between points in light oscillation with the same phase; each type of light has a specific wavelength range.

Wetlands - Any area that is more or less regularly wet or flooded. Where the water table stands at or above the land surface for at least part of the year.

Wilderness - All National Forest lands included in the National Wilderness Preservation System; an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.

Wilderness Recreation Opportunity (WOS) - The WOS concept is essentially a system for subdividing the wilderness into distinct management units, each of which can be perceived by both land managers and recreational users as possessing homogeneous landscape and social setting characteristics. This allows the manager to conceptralize his/her wilderness into more understandable and manageable smaller units. It also allows the option of developing more area specific direction which is supportive of the diversity of settings within wilderness. The four settings developed for the WOS concept are derivatives of the national ROS system and can be aggregated back to the ROS setting of either Primitive or Semi-primitive Nonmotorized. The four settings are:

1. Pristine (trailless)
2. Primitive
3. Semi-primitive
4. Transition

All four settings have objectives and standards which are within the legal mandates of the 1964 Wilderness Act and all subsequent additional statewide national legislation.

Wilderness Act - Establishes a National Wilderness Preservation System to be composed of Federally-owned areas designated by Congress, administered for use and enjoyment as Wilderness, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as Wilderness.

Wildfire - Any fire on wild lands other than one intentionally set for management purposes and confined to a predetermined area.

Wildlife - All nondomesticated mammals, birds, reptiles, and amphibians living in a natural environment, including both game species and nongame species. Animals, or their progeny, which once were domesticated but escaped captivity and are running wild (i.e., feral animals), such as horses, burros, and hogs, are not considered wildlife.

Wildlife habitat diversity - The distribution and abundance of different plant and animal communities and species within a specific area.

Withdrawal - An order removing specific land areas from availability for certain uses.

Woodland - Pinyon, juniper, and oak forests usually growing on drier sites in the low elevations (less than 8,000 feet).

Zoological-Botanical Area - A unit of land which has been designated by the Forest Service as containing outstanding or unique examples of fauna and/or flora. Areas of this type are identified and formally classified because of their recreational and educational values.

APPENDIX 1 ASTROPHYSICAL

Different types of telescopes have different environmental impacts. These can be summarized by size, required line-of-site cutting, visitor interest and the mobile interferometer.

Size

Of the thirteen telescopes proposed, seven are considered "large." They will contain mirrors or dishes 7.5 meter (24.6 feet) or larger in diameter. These telescopes range from 65 to 100 feet in height. With clearance for opening the telescope enclosure and protection from falling trees, they require a minimum diameter of cleared land approximately 160 to 250 feet wide. (Figures 10 and 11). The "small" telescopes will have mirrors or dishes of up to 4.0 meters (13 feet) wide (Figure 12). They range from 40 to 50 feet in height and require a minimum cleared diameter of approximately 130 feet to 200 feet.

Line-of-site Cutting

The multi-piece submillimeter telescopes require a point of alignment that has been chosen as Heliograph Peak. To align on Heliograph Peak some line-of-site cutting of forest is required. In Phases 2 or 3, some submillimeter telescopes will have greater cutting needs than the optical/infrared telescopes.

Visitor Interest: The NEW NATIONAL TECHNOLOGY TELESCOPE (NNTT)

If the National New Technology Telescope (NNTT) is funded and Mt. Graham chosen as the building site, the observatory will have the world's largest telescope and one of the newest types of telescopes. The Mt. Graham observatory would then be of international interest and might draw up to 50,000 visitors/year. Without the NNTT, visitor interest is estimated to be 10,000/year. The effPct of large visitor interest will be discussed in Chapter 3 (Recreation Use and Opportunities).

Interferometer

This "telescope" is a series of six 6 meter (19 feet) dishes that can be arranged and re-arranged in a "Y" shaped array that allows sharp "focussing" of submillimeter radiation (Figure 13). The telescopes would be moved along the road by truck and crane to allow the six telescopes to be arranged among any of nine sites (i.e., roadside turnouts). This telescope differs from others in that it requires road widening, turnouts, and perhaps line-of-site cutting for the telescopes to see various parts of the sky. Each site of the array is 1,300 square feet. The interferometer also requires a separate control building of about 4,500 square feet.

Steward Observatory's Preferred Project

Number, Quality and Size of Needed Sites

Eleven sites have been proposed for the location of the twelve telescopes (See Figure 9). The potential of each site for small and/or large telescopes is summarized in Table 27. This estimate is based on Steward Observatory's assessment of land area easily cleared, line-of-site viewing for each telescope and astronomical character. A preliminary ranking of sites based on size and the astronomical quality (water vapor, image sharpness) is summarized in Table 28.

Figures 14 thru 22 and Table 27 gives the acreage of areas reserved for observatory development (telescopes, water tanks, other support facilities). The "reserve" areas allow final siting to be somewhat flexible. The actual area cleared for telescopes and support facilities will be less than the

reserved area. Only Site 3, High Peak (Phase 1) has alternative facility locations pinpointed (Figure 16). Figures 16, 18 and 22 give alternative locations and configurations for the "logistic" sites (dormitory, powerhouse, water supply, etc.).

The preferred alternative for SO is the choice of: 1) the five best astronomical sites from the proposed eleven; (See Table 28) 2) the most clustered sites, if astronomical characteristics (image sharpness) on various peaks are equal; 3) the least environmentally damaging cluster, if astronomical needs can be met.

TABLE 27

Site Potentials and Areas Reserved for Project Development[1]

Site Number and Name	Large Telescopes	Small Telescopes	Alternative to Large Telescopes	Reserved Area (Acres)	Spur Road (Acres)
1 Emerald Peak	3	2	-	4.8	0.5
2 Hawk Peak[2]	1	-	-	9.6	0.8
3 High Peak	3	2	-	6.8[3]	
4 Plain View Peak	1	-	(2 Small)	2.2	0.4
5 Plain View SW	1	-	(2 Small)	1.9	0.1
6 High Peak Ridge-1	1	-	(2 Small)	3.5	0.6
7 High Peak Ridge-2	1	-	(2 Small)	2.6	-
8 Hawk Peak SW		2	-	2.9	-
9 South Optical-1	1	-	(1 Small)	1.3	0.05
10 South Optical-2	1	-	(1 Small)	1.3	0.05
11 South Optical-3	1	-	(1 Small)	2.6	0.05
12 Logistics (L-12)		-	-	-	
13 Logistics (L-13)	-		-	-	
14 Logistics (L-14)	-	-	-	-	
15 Interferometer[4]	-	6	-	6.5	
Phase 1: Forest Road 507 the "Wall" (milepost 3.6)	-	-		1.0	
Phases 2+3: Forest Road 507 Widening	-	-	-	9.9	

1 Parking, turnouts and new roadside firebreaks not included.

2 Two large telescopes could replace NNTT at Hawk Peak.

3 Includes 0.35 acre for line-of-site cutting.

4 Reserved area includes width greater than 16 foot road plus turnouts and control buildings.

Table 28
Preliminary Astronomical Site Ranking

Site Number	Name	Space Available Acres	Rank	Projected Water Vapor (Ranking)	Optical Projected Seeing Rank	Seeing Measure-ments	Comments
1	Emerald Peak	4.8	A	B	A		Free air flow in prevailing winds: good air drainage.
2	Hawk Peak	9.6	A	A	A		Free air flow in prevailing winds: good air drainage from summit.
3	High Peak	6.8	A	A	B	Exten-sive	Potential for disturbed air flow along ridge and in funnel to prevailing wind. Seeing comparable to Mt. Hopkins.
4	Plain View Peak	2.2	B	B	B/C		Peak at south end of High Peak ridge, potential for disturbed air flow.
5	Plain View Southwest	1.9	B/C	B	B	1	At S. W. end of High Peak ridge, single measurement showed seeing comparable to High Peak.
6	High Peak Ridge-1	3.5	B	B	C		Higher potential for air flow disturbance.
7	High Peak Ridge-2	2.6	B	B	C		Higher potential for air flow disturbance.
8	Hawk Peak Southwest	2.9	B	B	A/B	1	Southwest projection; air flow unimpeded in prevailing winds.
9	South Optical-1	1.3	C	C	B		Raised knolls on north-south ridge.
10	South Optical-2	1.3	C	C	B		Raised knolls on north-south ridge.
11	South Optical-3	2.6	B	C	B		Raised knolls on north-south ridge.

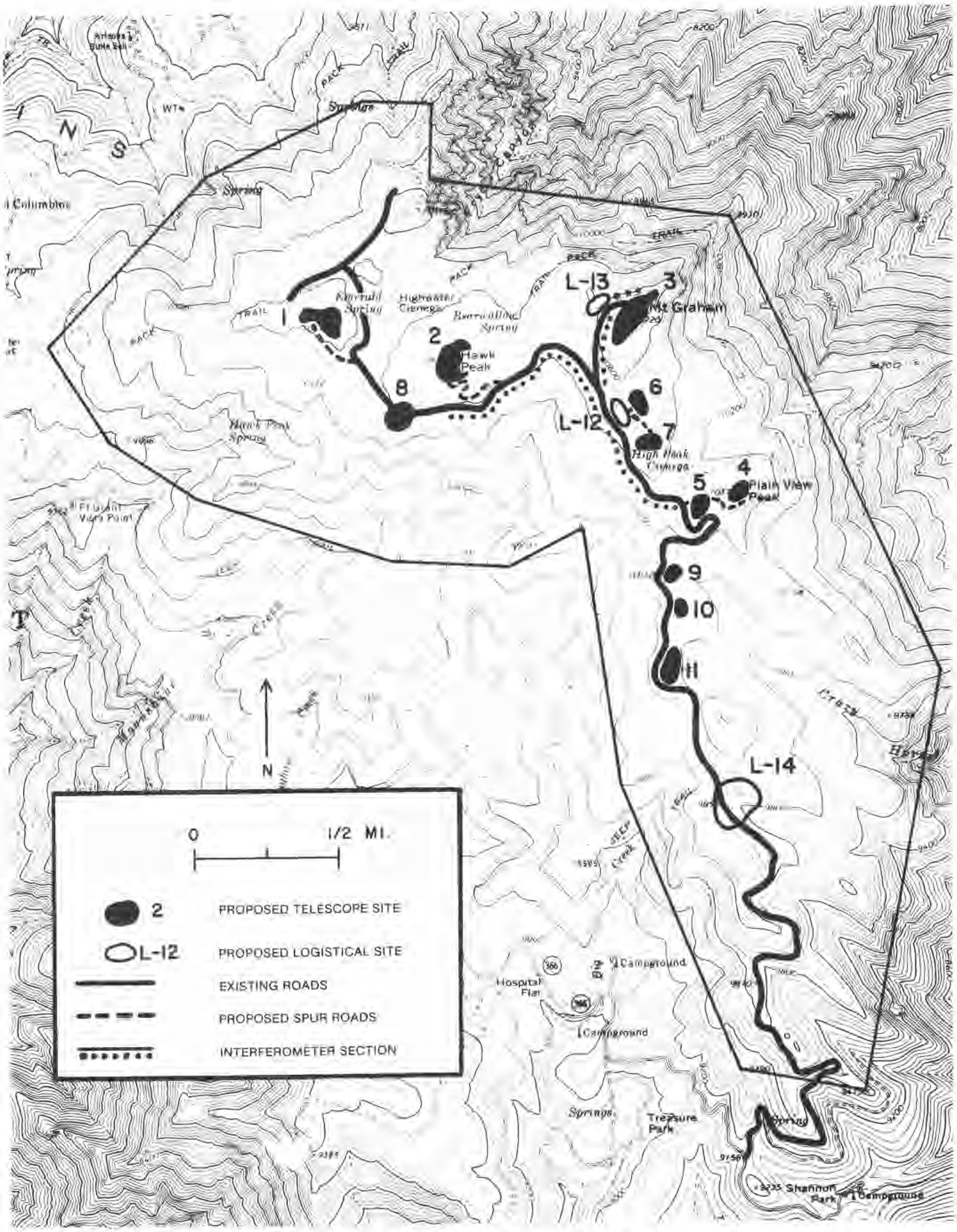


Figure 9 Possible Telescope and Logistical Sites for the Proposed Mt. Graham DEIS Area.

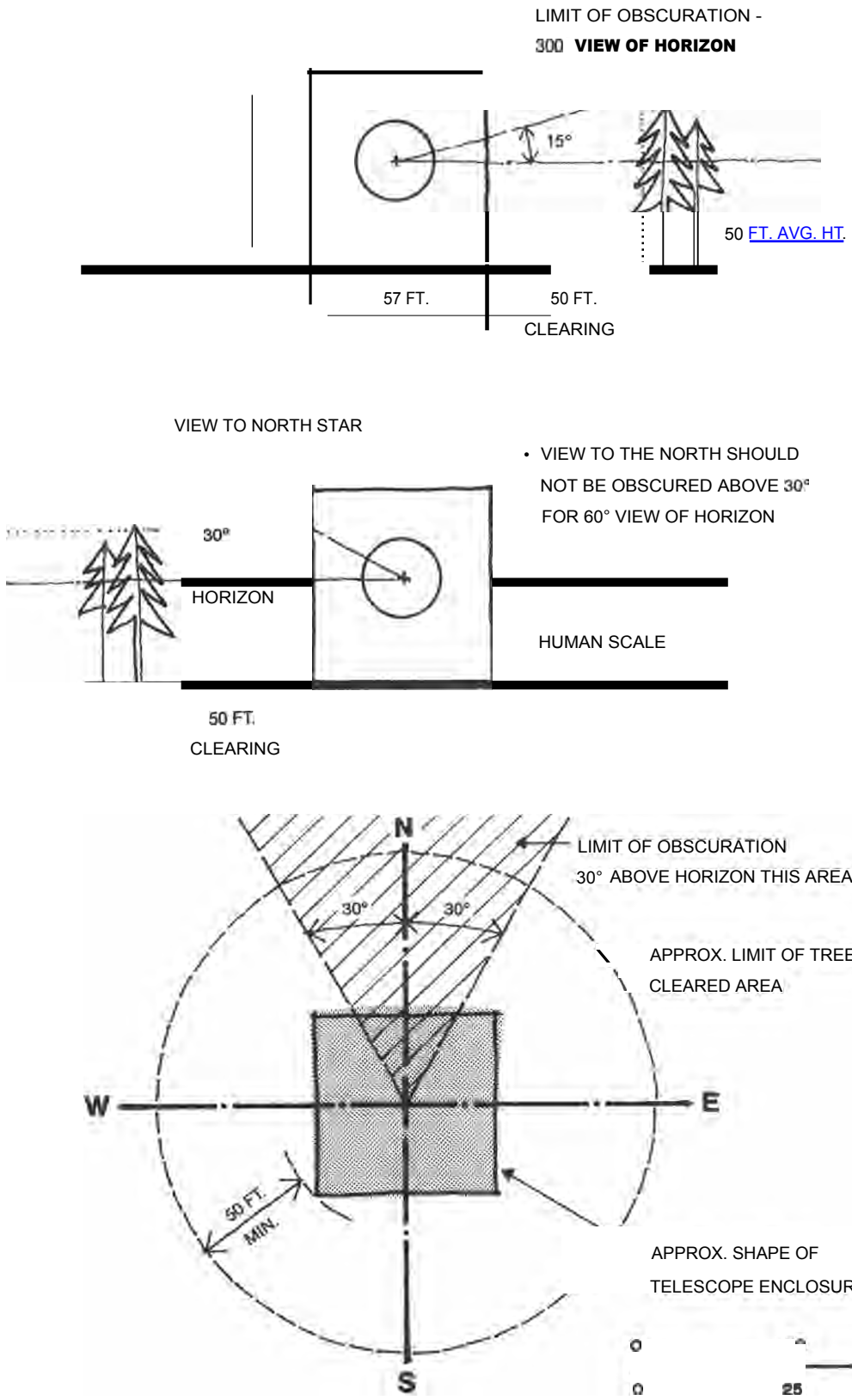
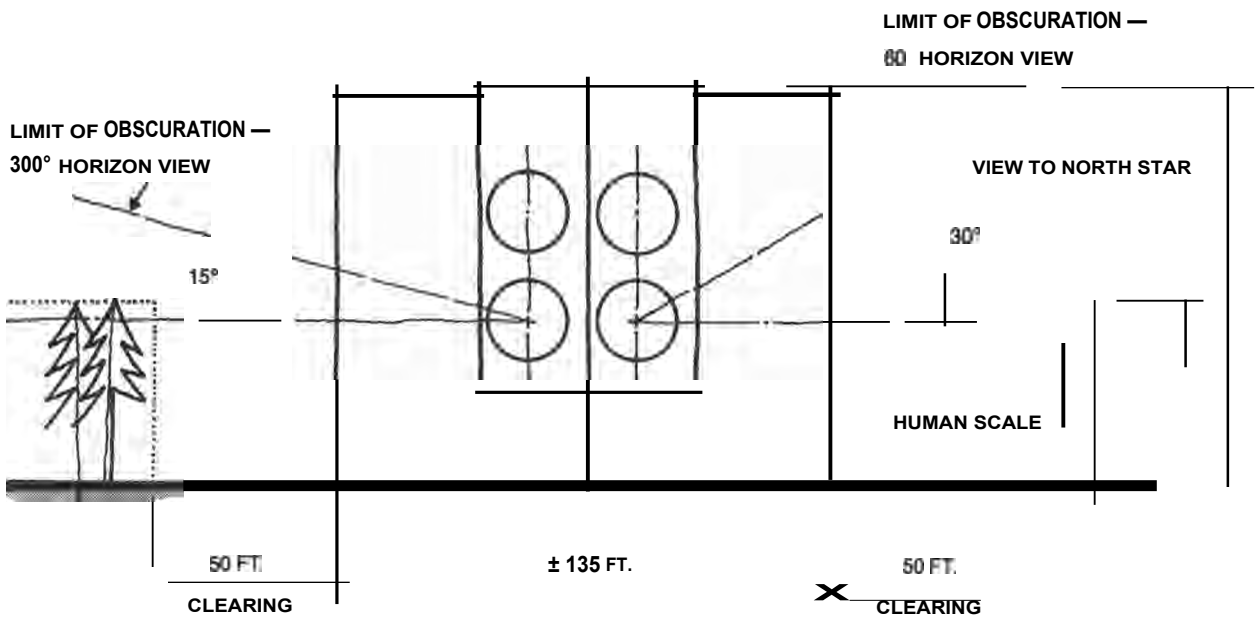


Figure 10 Arizona-Ohio State 8-Meter Telescope Concept.



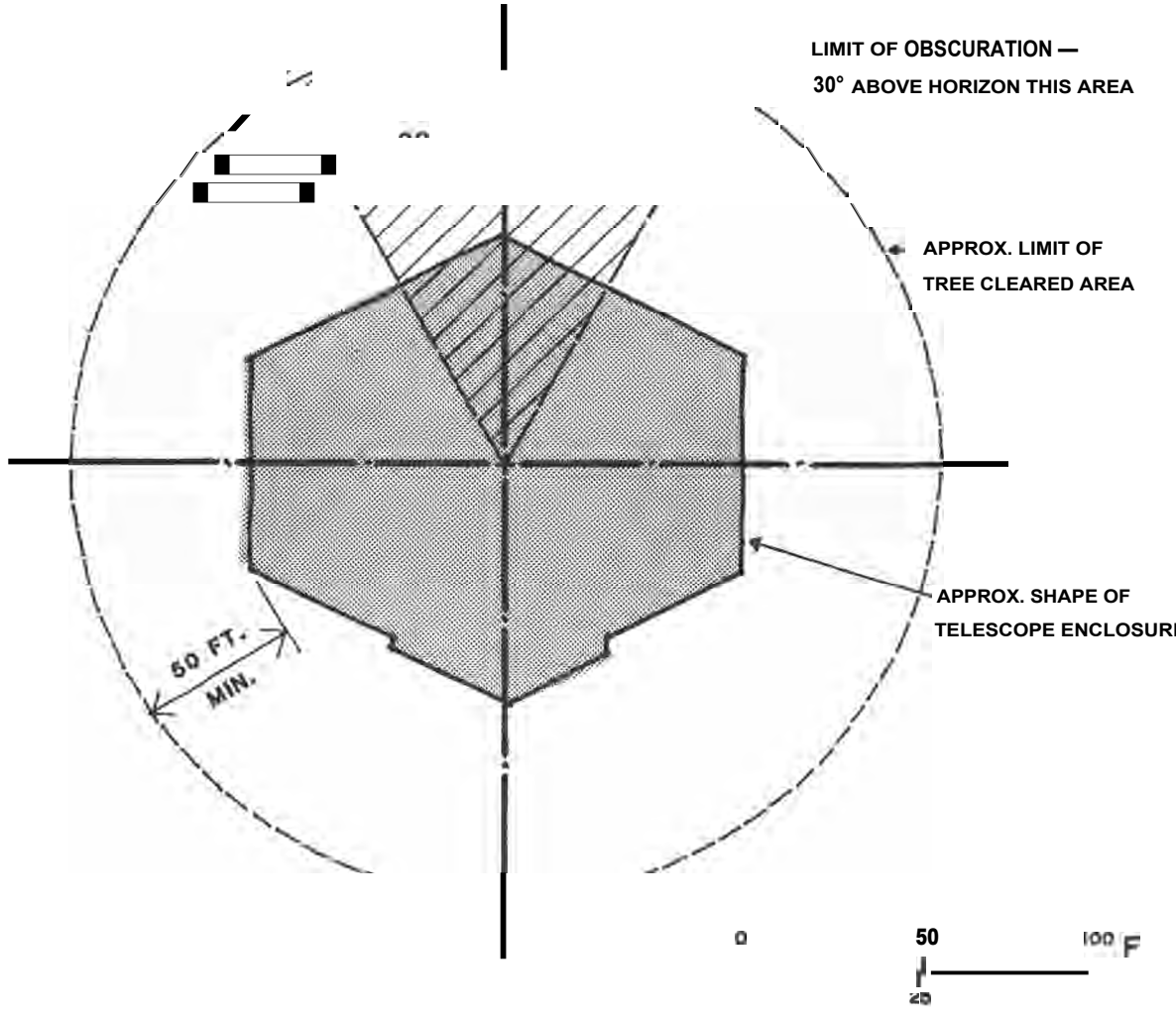
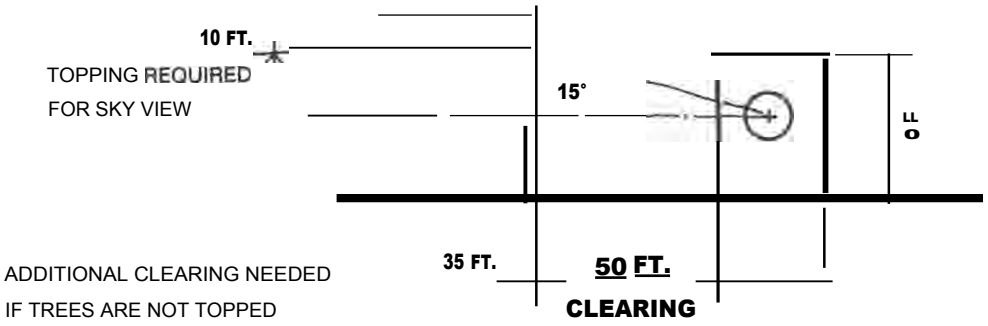
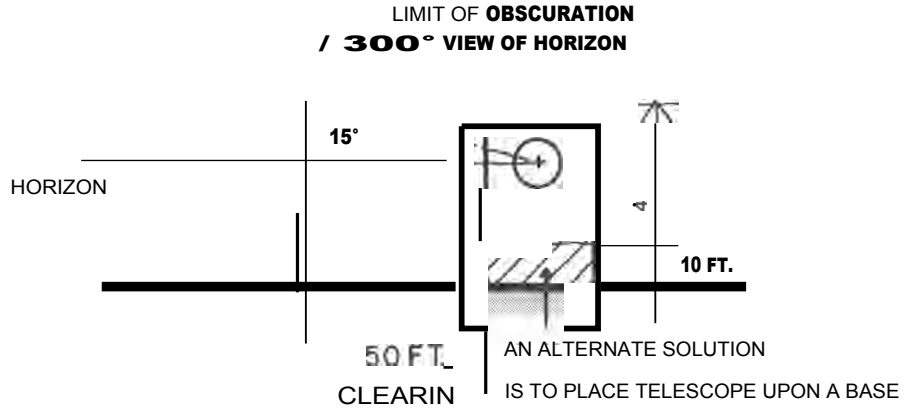
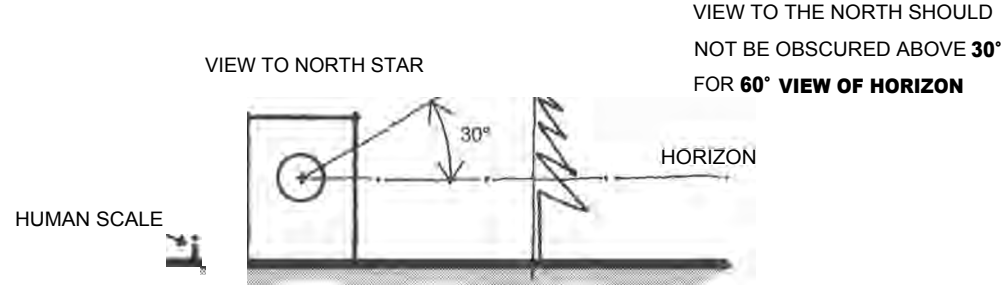


Figure 11 National new technology Telescope 15-Meter Concept.







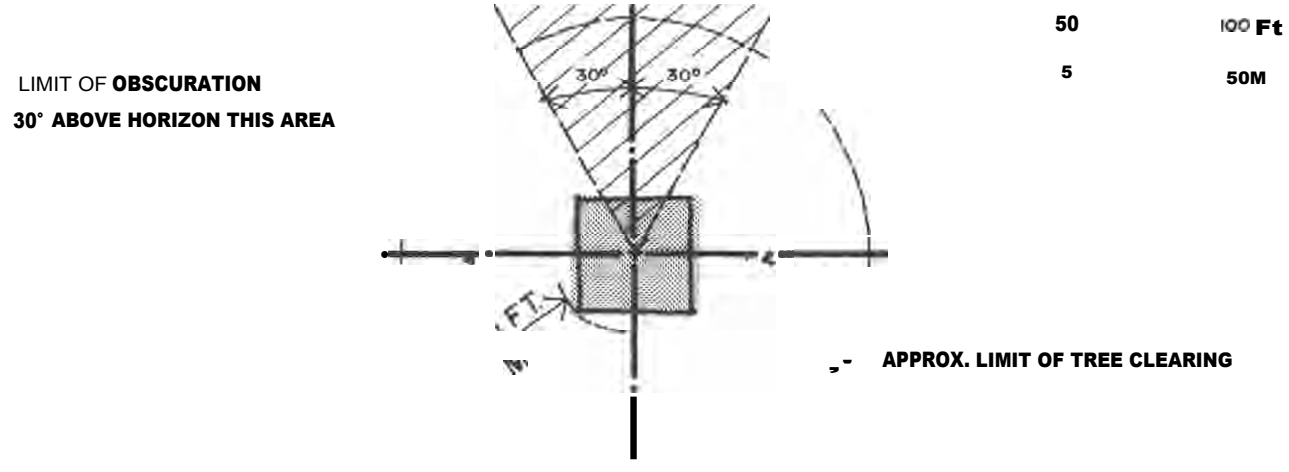


Figure 12 Four-Meter Telescope Concept.

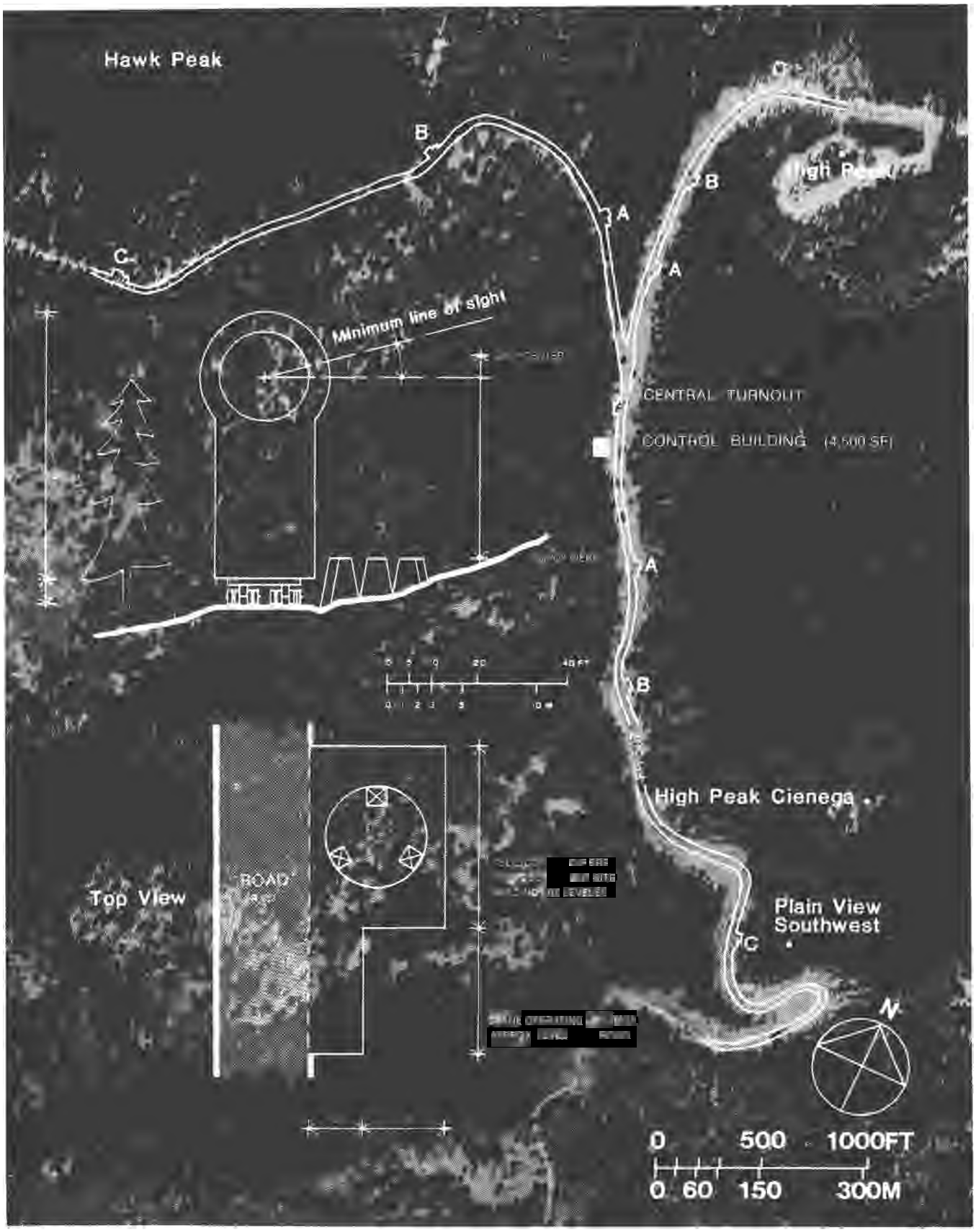


Figure 13 Proposed plan for the SAO Interferometer. The stations and the control building woul d be positioned along FR507. The insert on the left shows an e xample of the individual dishes and the layout of each station.

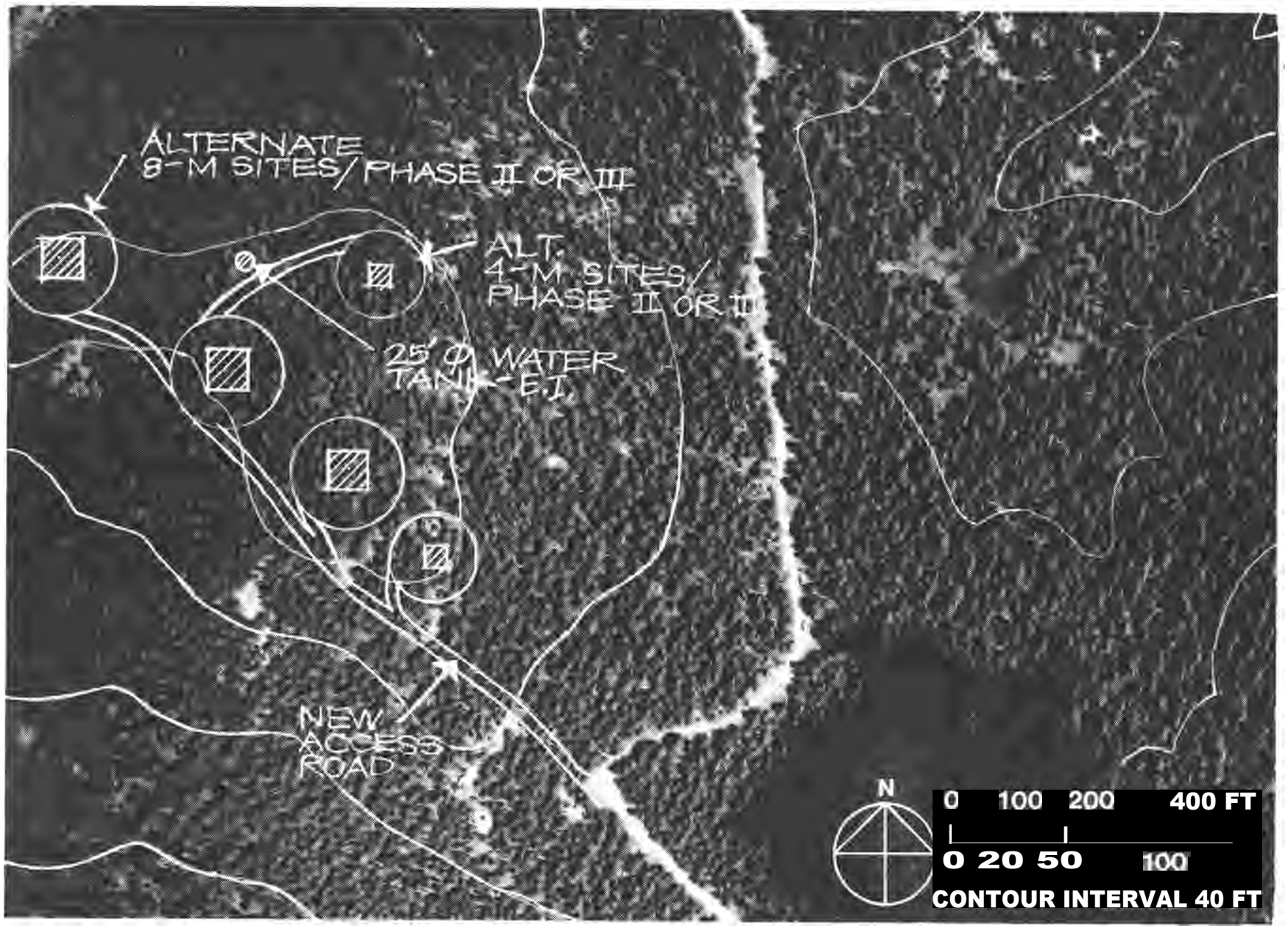


Figure 14 Proposed site plan for Site 1, Emerald Peak (el. 10,471 ft.).

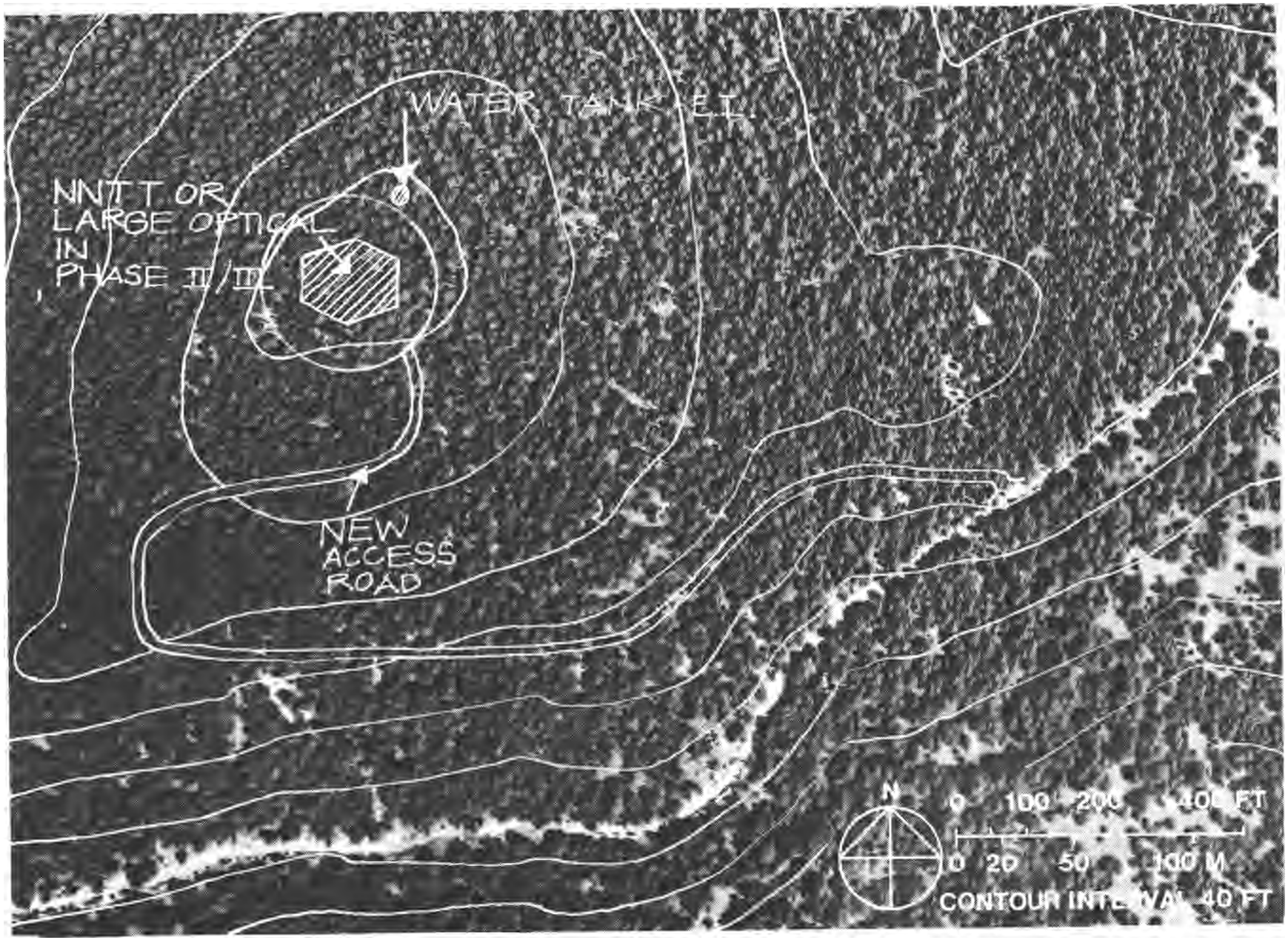


Figure 15. Proposed site layout for Site Z, Hawk Peak (el. 10,640 ft.).

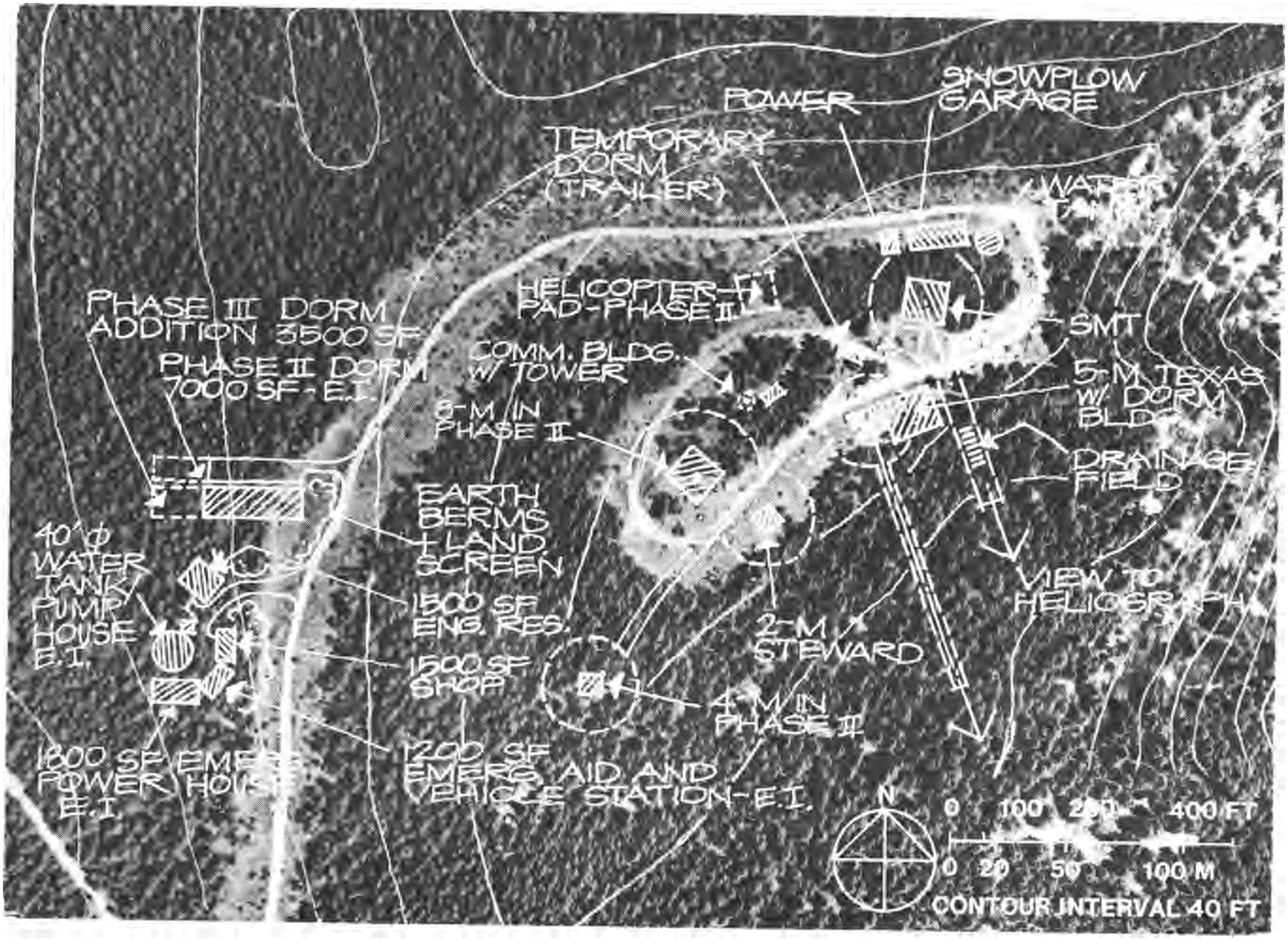


Figure 16 Proposed site plan for Phase I development of Site 3, High Peak (el. 10,720 ft.). Also shown is a conceptual plan for logistical Site 13 (el. 10,600 ft.).

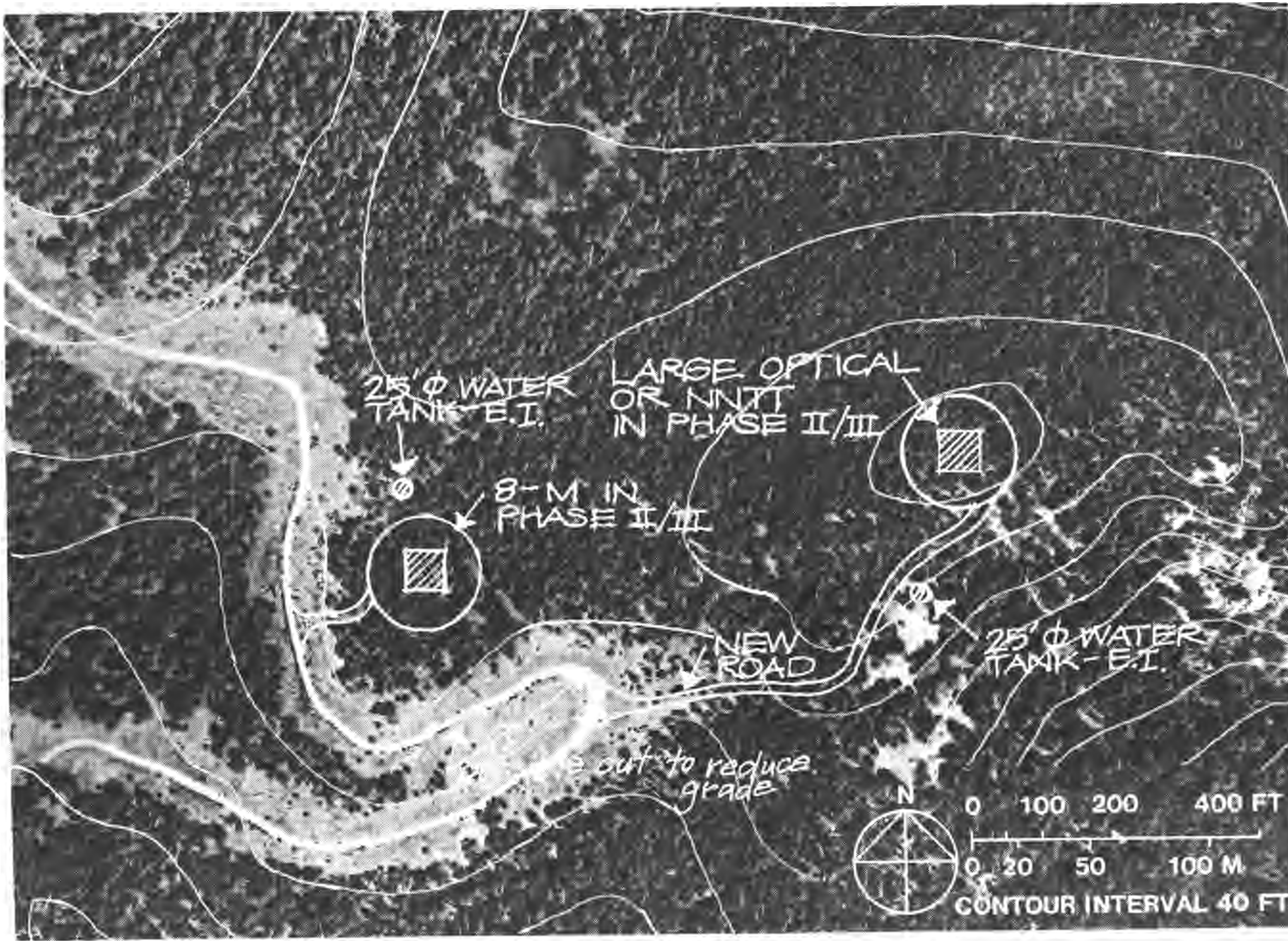


Figure 17 Proposed site plan for Sites 7 and [illegible] Southwest
(el 10,300 ft)

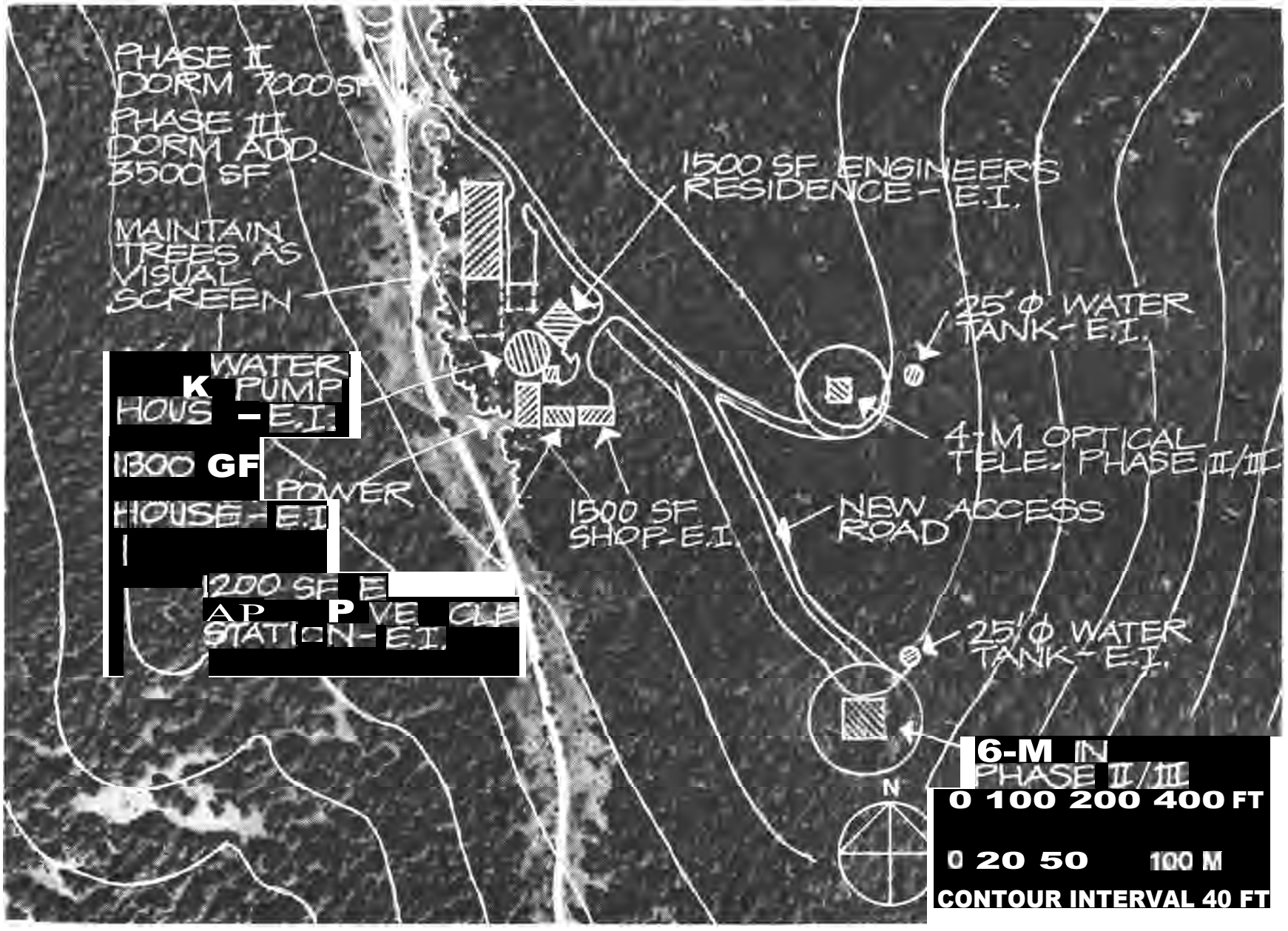
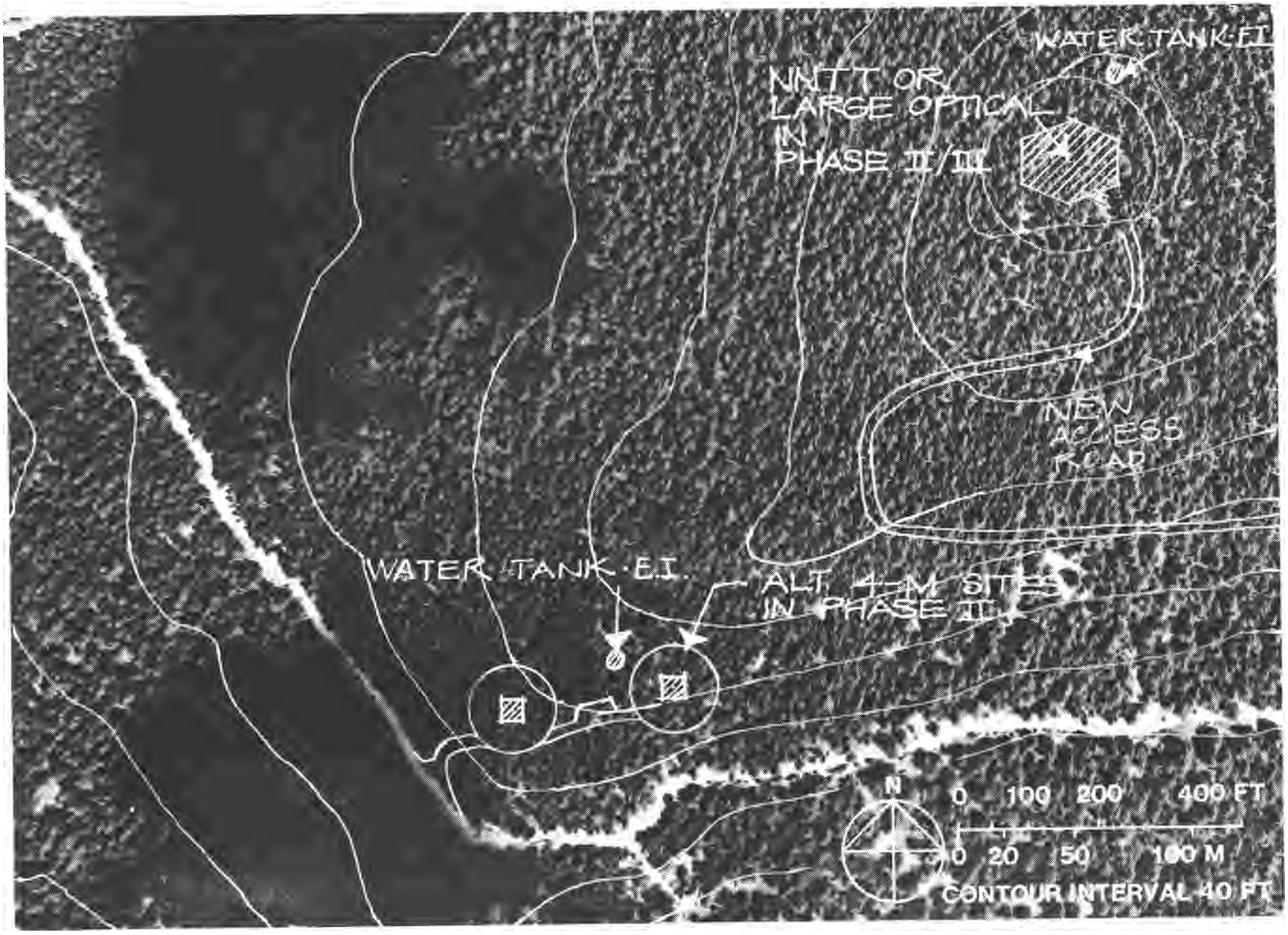


Figure 18 Proposed site plan for Sites 6, High Peak Ridge-1 (el. 10,520 ft.) and 7, High Peak Ridge-2 (el. 10,470 ft.). Also shown is a conceptual plan for logistical Site 12 (el. 10,470 ft.).



Proposed site plan for Sites . Hawk Peak (el. 10,640 ft) and . Hawk Peak Southwest (el 10,400 f.).

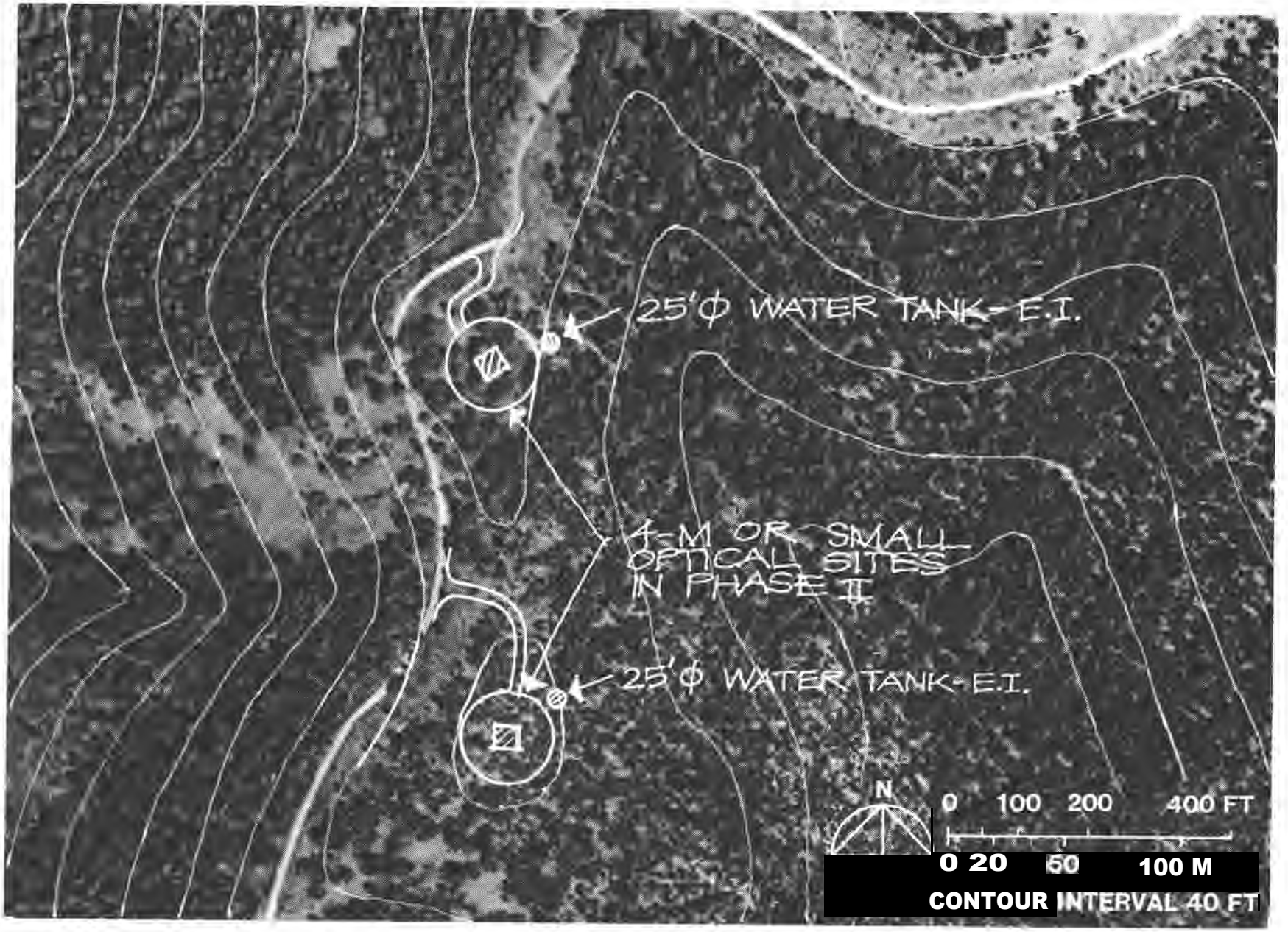


Figure 20 Proposed site plan for Sites 9, South Optical-1 (el. 10,150 ft.) and 10, South Optical-2 (el. 10,130 ft.).

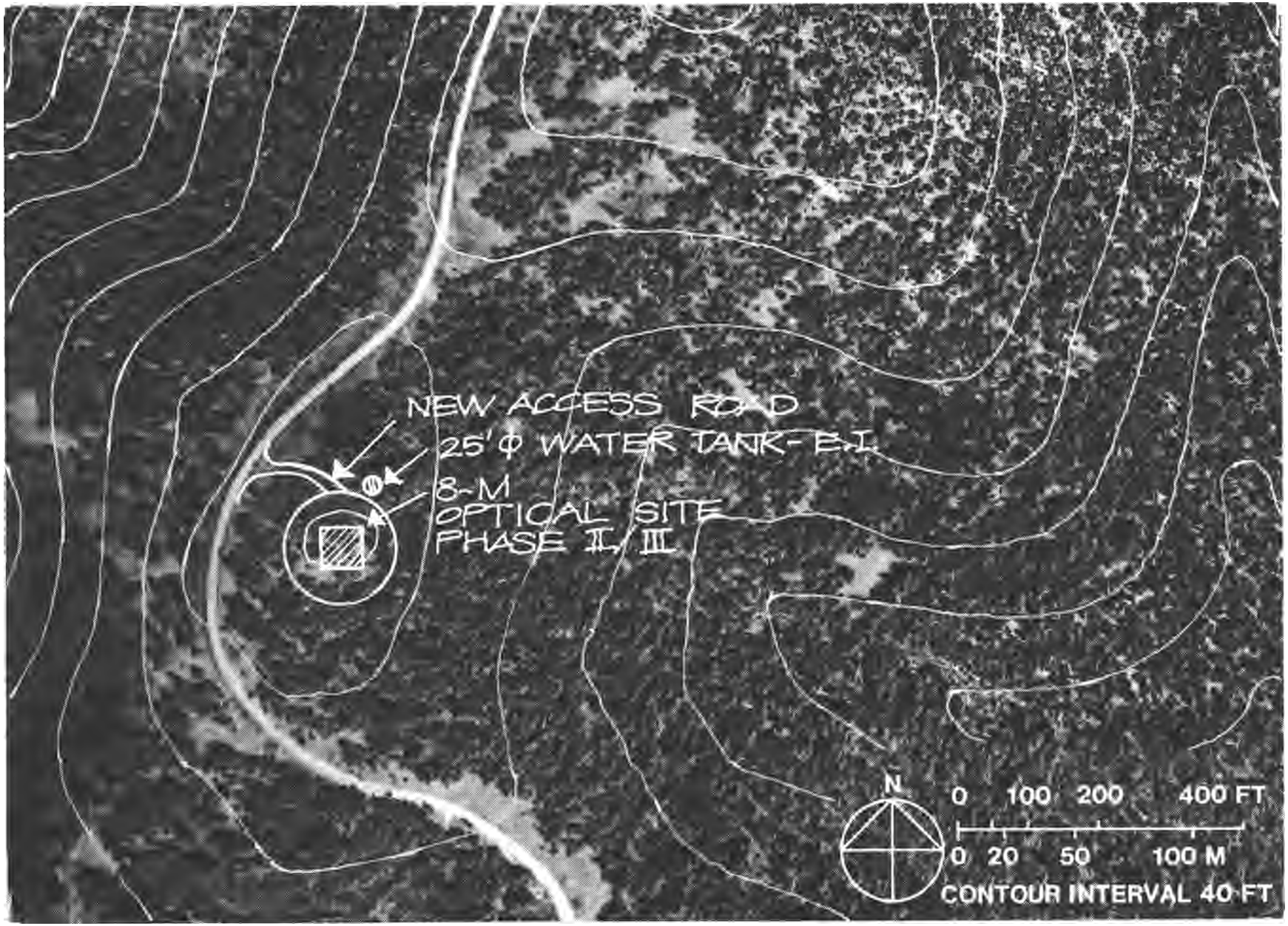


Figure 21 Proposed site plan for Site 11, South Optical-3 (el. 10,090 ft.).

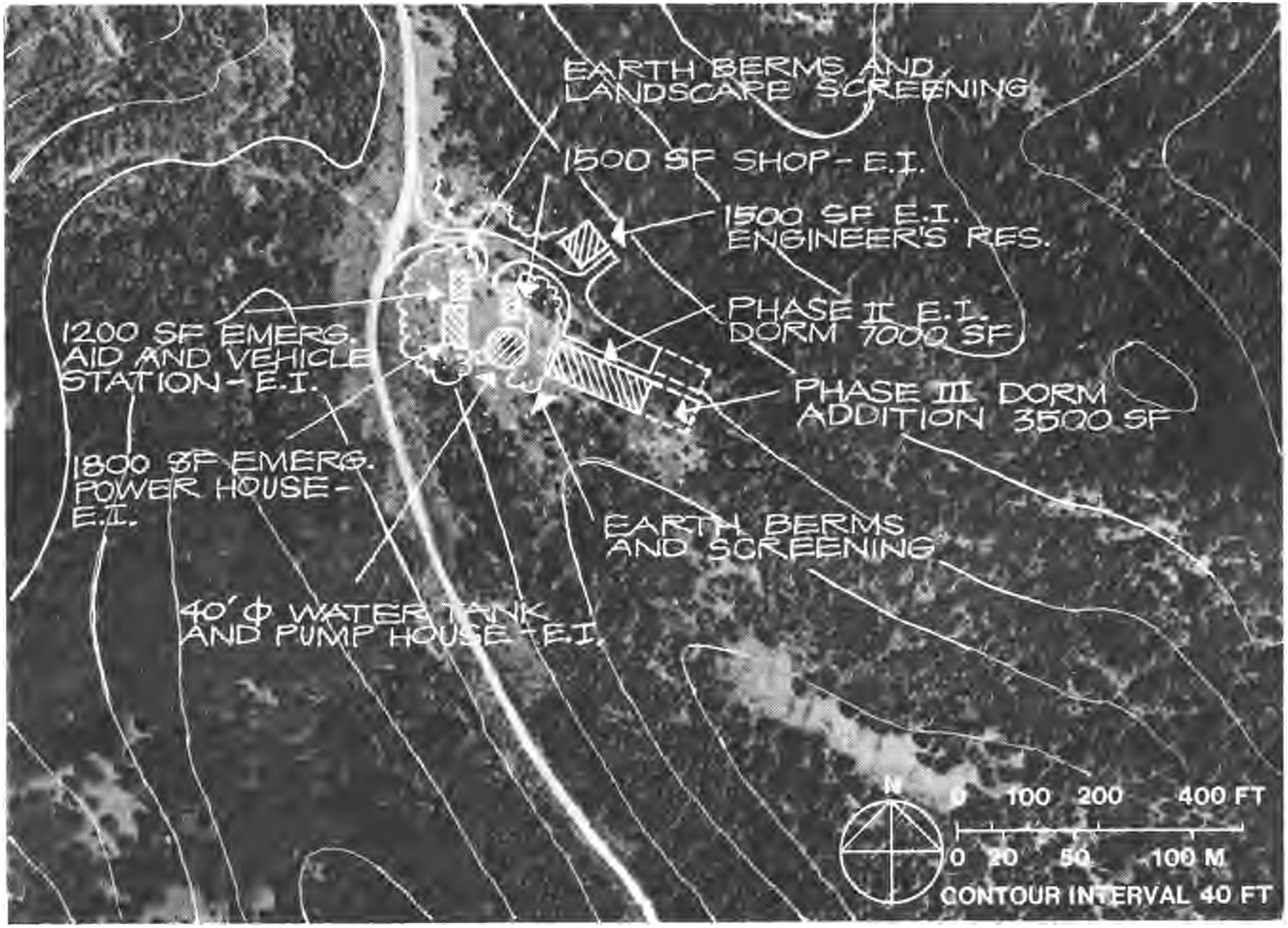


Figure 22 Proposed site plan for logistical Site 14 (el. 9,800 ft.).

APPENDIX 2 WILDLIFE

Mt. Graham Red Squirrel Census

Tamiasciurus hudsonicus grahamensis (Allen)

Status of the Mt. Graham Red Squirrel was reported by Spicer (August 1985). Spicer assessed red squirrel abundance with twenty-six belt transects at 300 to 500 individuals and noted highest densities were in the Spruce-Fir habitat. He presented a historical review of impacts on the squirrel (logging and introduction of a possible competitor, the Abert Squirrel Sciurus aberti.)

In February 1986 a Biological Evaluation Team (BET) was formed to cooperatively evaluate the impacts of a proposal by the University of Arizona, Steward Observatory, to place astrophysical structures on Mt. Graham/High Peak, etc. The team is composed of representatives from the Department of Agriculture, U.S. Forest Service, Department of Interior, U.S. Fish and Wildlife Service, the Arizona Game and Fish Department, the University of Arizona, Steward Observatory, and the University of Arizona, Office of Arid Land Studies (total of 23 individuals).

Six Core Team Members participated in a winter census March 4-5, 1986. Information from this survey indicated a low density population and suggested a complete "active primary food cache survey." The BET report of May 1, 1986 gave the objectives as follows: Map current distribution and location of red squirrel caches (middens) which reflect current and historic distribution, relative density of and total squirrel populations census. Dates were set for June 9-13.

Dates and Methods

Dates were revised and the midden census began May 27 through May 30, and continued on June 3 through June 6, 1986. Census units were set up by using roads, trails, and prominent land features, for boundaries. Teams were organized with an experienced team leader and four to seven members. Most days had four to seven teams working. People were coming and going so that team composition and team leaders changed daily. A total of sixty people participated.

Teams began at a logical point on their unit walking from 30 to 100 feet apart depending upon visibility between members. Members on each end of the line placed plastic flagging along their route as they walked and searched for caches (middens). On most units, teams started at the highest point in their unit and searched down hill. Whenever possible, teams were picked up at the bottom end of the census unit and driven back to the high point to repeat another walk through midden search. On the second pass the team shifted either to the right or left of the first walk through so that one person out on the end was putting up flagging while the person on the other end was taking down flagging put up on the first pass, (etc., etc.) In this manner entire census units were searched. At the end of each day, walk throughs were mapped on a large map for all census units and assignments could then be determined for the next day.

When a midden was located, the team took down considerable information (see example "Midden Data" sheet). Photos were taken and the midden location noted on a map. A consolidated map showing all middens located was prepared later. Approximately 2200 acres were surveyed.

Middens located were:

114 active/primary middens on Mt. Graham area.
13 active/primary middens on Heliograph Peak.
33 active/primary middens in the Webb Peak area.

160 total active middens

Additional active middens have been located by Office of Arid Land Studies as follows:

4 Grant Hill area
1 Riggs Flat
7 Ash Creek

171 total active middens to date. (August 26, 1986)

Conclusions

1. Red squirrel populations are concentrated in the higher elevations in the Spruce-Fir habitats.
(81 percent are above 10,200 ft. elevation).
2. North and east aspects are favored cache locations. Apparently this aspect provides a cooler/damper exposure which preserves the cones.
3. Other aspects are used when shading, cool air drainage, etc. meet the same micro climate needs.
4. Red squirrels prefer gentle slopes for their midden. Fifty-nine percent of the middens were found on a 0-20% slope class, 36% in a 21 to 40% slope class, 6% in the 41 to 60%, and none on slopes in the 61-80% slope class.

This effort provided acceptable initial data regarding red squirrel numbers and habitat locations. Monitoring these middens, their uses, reoccupancy of inactive middens will provide data to begin establishing trends for the red squirrel. Fall midden surveys may be used in the future to include young of the year and subsequent recruitment into the adult population.

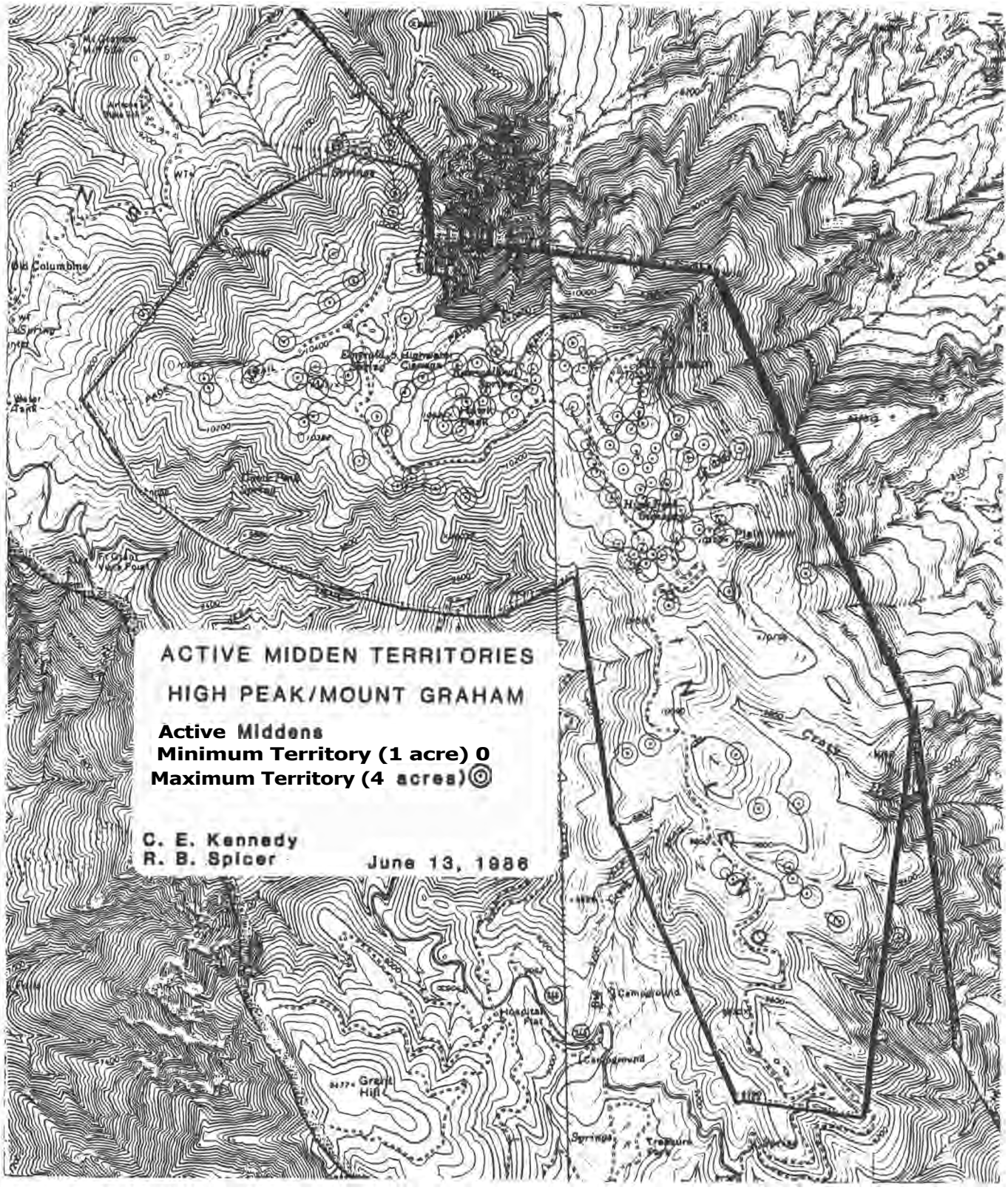
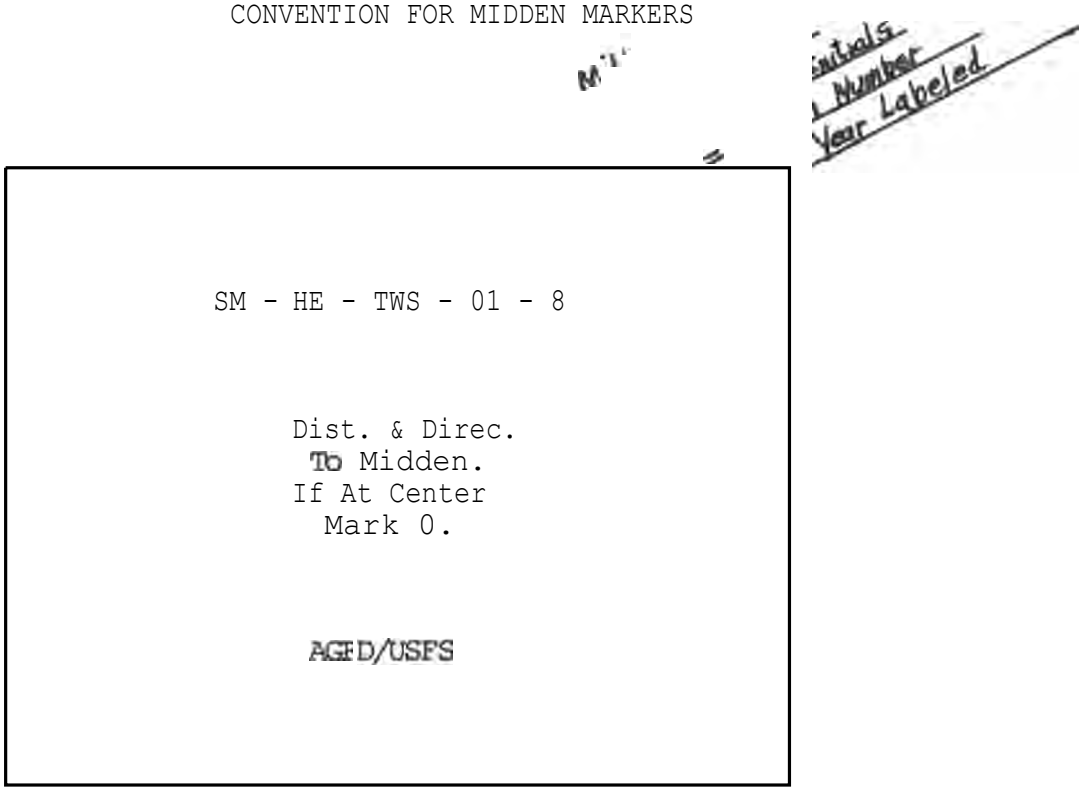


Figure 23 MIDDEN MAP

CONVENTION FOR MIDDEN MARKERS



Location Of Marker:

On the live tree (>6 in DBH) closest to the midden center.
On the upslope side of the tree (use the south side if on level ground).
6 ft from ground level.

Remember to indicate the tree and the marker location on the midden sketch map.

Figure 24 MIDDEN MARKERS

MOUNT GRAHAM RED SQUIRREL MIDDEN DATA

MT GRAHAM (AT)
SPICER (BS)

Complete with short answers or circle choices as alcircPriate.

Identification Number: SM MT-BS-06-86 Date: 8 MAY 86
Personnel:

Site

Overstory: Spr/Fir 10,520

Understory: Very little. Spr-4 Fir Scattered

Slope EN

Exposure: Open slop %: 0%

Primary Midden
Active Inactive
Diameter, Maximum: Minimum: 2 ft
Depth:
Central

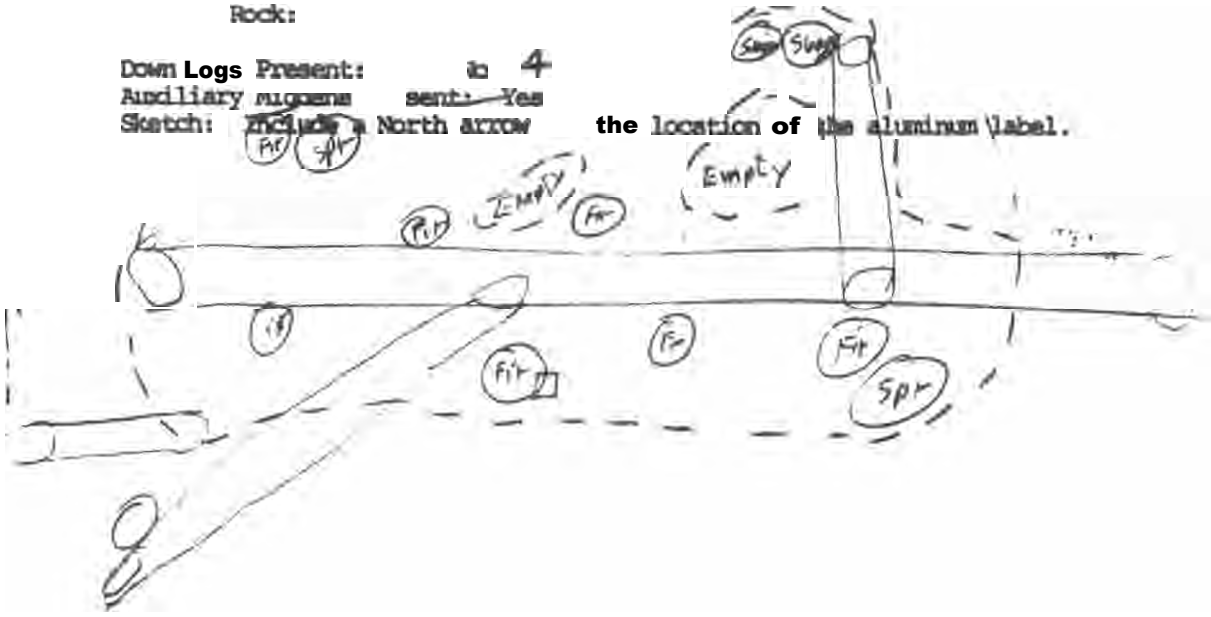
and DBH) Co

Snag (Species and DBH):

Stump (Species and DBH):

Rock:

Down Logs Present: to 4
Auxiliary Midden Present: Yes
Sketch: Include a North arrow the location of the aluminum label.



Aluminum Label Put Up: p'vls
Photos Taken: Yes No
Red Squirrel Seen at Midden: No Seen Near Midden: distance and direction)

Comments: Coverag 45 ft dia 60%
idden 90%

Please return completed data forms to: Barry Spicer, AGFD

06

Figure 25 MIDDEN DATA SHEET

MOUNT GRAHAM RED SQUIRREL OBSERVATIONS, RATIONALE, ASSUMPTIONS, AND MODELS

The following is a documentation summary of some of the decisions and assumptions that had to be made during the modeling and analysis processes involved in the biological evaluation of the Mount Graham red squirrel. The observations within the document are focused on the biological aspects only and make no inference of any other values. Even though several species are shown within the Habitat Capability Model (HCM), the primary emphasis of the entire job was on the red squirrel since the evaluation was necessary for the listing package recommendations, and the proposed projects were within the squirrel's range.

MODELS

HCM This model was primarily used to derive the habitat capability for the red squirrel, while looking at the changes within the capabilities of several other species. The outputs of this model will show the expected change in vegetative structure over time for alternatives that include "no action", and each of the three development alternatives for the proposed astrophysical sites. The basic structure of this model assumes that all vegetative types are evenly distributed, that adequate water exists for all species, that any one species has essentially no influence over the habitat capacity of another species, and all species (if present) use the area exclusively (at least seasonally) and in entirety.

In addition to the inherent premises within the model, several assumptions were used for the Mount Graham version of the program. Runs were made to simulate the current condition on Mount Graham itself (essentially alternative "b"), Heliograph Peak, and Webb Peak. All future simulations assumed no catastophic events like fires, blow-downs, or extensive timber harvests. As a result, Heliograph was not seen to have any significant change in acreage within any classification of vegetative structure or type, and thus the current mix of acres was considered as a constant. Mount Graham and Webb Peak will change over time and thus were run for current plus 20, 40, 60, 80, 100, and 200 years. The changes encountered over these periods were derived from normal growth rates for the species involved.

When analyzing the three development alternatives for the site, the entire project as outlined was put into the first year of the analysis. After the affected roads and acres were calculated, no further impacts were assumed for the life of the project (although some might be expected). There were several unknown effects of the projects including risk of increased rates of blow-down, spread of diseases or insects, and increased risk of fire. The basic process for ascribing effects was to look at the stand in which the effect would occur and then decide what precentage of the total would be impacted. On stands of less than 10 acres, if more than 1/2 the area was impacted, then the total area was considered unavailable due to disturbance. On larger than 10 acre stands, the portion affected was estimated in terms of the percentage of the total acres within the stand. The area of disturbance by alternative will not agree with the minimum disturbance areas shown within other documents, but the Figures used are reasonable for the purpose of this analysis. Road development and mangement levels were considered to be appropriate with the emphasis of each alternative.

POPDYN For a detailed explanation of this model see the user's manual. In basic terms, this model has the equations to predict the population trends and composition by sex and age-class of all or any part of a given population of animals. The model uses either deterministic (preset) or stochastic (random) variables to assist in the process of predicting the probability of a population trend being followed over a time sequence. The model also has the equations for measuring the effects of various inbreeding scenarios.

As outlined in the run documentation document, a range of variables was used when no specific data was available from the mountain itself. The items for which ranges were used and the span of the entries are shown below:

Variable	Min.	Max.	
Life Expectancy	8 years	10 years	
Sub-adult age (max)	1 year	1 1/2 years	
Adult age (max)	6 years	8 years	
Senescent Age (max)	8 years	10 years	
Survival Probabilities, Juveniles	0.4	0.6	
Survival Probabilities, Sub-adult	0.55	0.85	
Survival Probabilities, Adult	0.55	0.85	
Survival Probabilities, Senescents	0.4	0.6	
% Reproductivity, Sub-adults	0.4	0.8	(Per individual)
Reproductivity, Adults	1.2	1.6	("
Reproductivity, Senescents	0.0	0.4	("

The above numbers were based on literature searches and knowledge of the biological evaluation team. When high, moderate, or low levels are spoken of in the documentation, those terms relate to the above listing, with high being maximum values, low being minimum, and moderate being the averages.

The ranges of inbreeding used were from 0.0 to .2 for both initial and sequential rates with all mixes looked at over time. This factor (inbreeding) and any accompanying genetic depression, is perhaps our greatest unknown in this process. As a result, all project runs were done with no inbreeding being shown and then low (>= .10) level being considered. If higher inbreeding depressions are being experienced, then the model indicates that extiction is essentially inevitable within the current scenarios.

The range of runs looked at are documented elsewhere. However, some clarification may be beneficial. A few extra runs were considered and tried but either were not significantly different or were a waste of time as they showed strong increases or extictions only and were beyond the ranges already tested and documented. An attempt was made to analyze the logical extremes for the entire squirrel habitat (7505 acres) and population (279). Then the area adjacent to the proposed activities was analyzed separately (4097 acres, 177 animals). The assumption operating here is that some influx of animals is possible (and perhaps probable) thus making some of the adverse impacts somewhat less. However, if extremes are reached, they will carry over to the entire population (i.e.: if extinction occurs within the central area, the entire population will not survive, or if a strong increase occurs in the core, then those animals will cause a strong increase in the overall population). The runs of the model to analyze the projects were based entirely on moderate variable values, since these were the only ones that fit a scenario that would explain past and current conditions and populations. All alternatives were looked at both with and without inbreeding coefficients. While only the first twenty years were analyzed, some of the runs were rolled over into the next decade to test the effects of starting at lower population levels. All samples examined went to extinction within that decade.

During the analysis of the outputs of the model, the results were classified into six general categories (see documentation). The determination of whether to call a run strongly increasing or strongly decreasing, as opposed to simply increasing or decreasing, was based on the level staying beyond + 2/3 of the initial maximum population. Extinction only was shown if the population dropped to less than 5 total animals (most went to 0 but some runs dropped to 1 or two individuals that lasted to the end of the period being analyzed). When displaying some of the results of the analysis, round numbers were used so that some of the differences appear more significant than they are. However, the only real differences are the timing of extiction probabilities and not their occurance since all "strongly decreasing" runs went to extinction very quickly and most of the rounding errors occurred between the classes of "strong decrease" and "extinction".

GENERAL

Some general observations about the overall project might be beneficial to some readers. The ground surveys for various parts of the project were variable in scope and intensity. The heaviest survey was the "Midden" search (census). This survey was used to estimate the area and total existing populations of the squirrels. The data from this survey was slightly biased by the short sampling of the "poor" habitat areas. All other types were adequately surveyed. The results of the inventory were kept, however, but that is the reason that the term is used "maximum" existing population since the data for the "poor" class appears to be high and other surveys support this conclusion.

The data from the intensive surveys was not simply lumped. Instead, the Mount Graham data was analyzed and then used as a predictor for Heliograph Peak. This was then validated by the survey data and carried on to Webb Peak when the data held up, and again the survey served as a validation.

Direct observations of the squirrels on the mountain shows that both species (red and Abert) have atypical habitat use and behavioral patterns. The degree of competition between the species is uncertain, but interaction is inevitable. Much more information is needed before drawing final conclusions about the effects of the differences, especially in behavioral characteristics.

CONCLUSIONS

The main concept to keep in mind while working in any analysis and evaluation (whether of a species or a project) is that we never have "enough" knowledge or data. The use of models, both mental and computer, gives the decision makers another tool to assist them in making judgement calls. The attempts made with the two models used in this process were to give the responsible officials the probabilities that any given reaction will occur within the squirrel population in response to each level of proposed activity. The only way that anyone will be able to assess the reality of the effects of our actions will be to monitor the populations of the red squirrel in both the spring and fall for several years and then determine which trend line we are really following. This discovery could tell us much about both the squirrel and the analitical tools.

For further information about the process of this project please contact any member of the evaluation team. The core group consisted of Chuck Kennedy (Coronado National Forest), Barry Spicer (Arizona Game and Fish Department), Tice Supplee (Arizona Game and Fish Department), Bob Vahle (Apache/Sitgreaves National Forest), Peter Warshall (private contractor with the University of Arizona, Office of Arid Land Studies), and Rick Wadleigh. Great assistance was given in this process by many other contributors. These contributors include, but are not limited to, Will Moir, Reggie Fletcher, Leon Fisher, Reuben Weisz, and Bill Stephens' working group all of the Regional Office of the Forest Service, Region 3; Bruce Marcot, Richard Holthousen, and Nancy Weaver of Region 6 of the Forest Service; Peter Warren and Martin Karpiscak of the Office of Arid Land Studies; Stewart Observatory (especially John Ratje); Tom Waddell (who was invaluable), Jim DeVos, Rich Glinski, and Terry Johnson of the Arizona Game and Fish Department; Safford Ranger District personnel (especially Darryl Tersey and Pete James) Coronado National Forest; the Coronado National Forest Supervisor's Office staff and volunteers from other ranger districts; and many other volunteers who gave their time and energies to different aspects of this work.

Runs that used lower values or higher inbreeding (IB) coefficients than shown in the following table, produced 5-10 year extinctions every time and, therefore, were not displayed, nor given the quantities of runs needed for "P" (probability) calculations. The total number of runs were limited but were sufficient to establish general trends.

Table 29 Probabilities

Run#	Title	Strong Inc.	Inc.	Stdy.	Dec.	Strong Dec.	Ext.
1.	High, All, No IB	1.0	0	0	0	0	0
2.	Moderate, All, No IB	.2	.3	.3	.1	.1	0
3.	Low, All, No IB	0	0	0	0	0	1.0
4.	High, All, W/Low IB	.9	.1	0	0	0	0
5.	High, All, W/Moderate IB		Strong Increase				
6.	High, All, W/High IB		Extinction (10 years)				
7.	High, All, W/High IB		Extinction (6 years)				
8.	High, Site, No IB (4097 acres)	.9	.1				
9.	High, Site, W/Low IB	1.0					
10.	High, Site, W/Variable IB	.9	.1				
11.	High, Site, W/High IB	0				.1	.9
12.	Moderate, Site, W/No IB	.05	.25	.3	.2	.2	0
13.	Moderate, Site, W/Low IB	0	.15	.1	.3	.25	.2
14.	Alternative D, Site, W/No IB		.25	.1	.2	.35	.1
15.	Alternative D, Site, W/Low IB		.3		.3	.3	.1
16.	Alternative E, Site, W/No IB	.05	.2	.1	.15	.4	.1
17.	Alternative E, Site, W/Low IB		.1	.1	.2	.5	.1
18.	Alternative F, Site, W/No IB		.3	.1	.1	.4	.1
19.	Alternative F, Site, W/Low IB		.2	.1	.1	.3	.3

All runs were based on a twenty year span. In the above Table, all "Strong Decrease" populations go "Extinct" within the following ten years.

Table 30

CONFIRMED AND PROBABLE SPECIES OF MAMMALS OCCURRING ABOVE 9,000 FEET IN THE PINALENO MOUNTAINS

Myotis volans interior	Hairy Winged Myotis Bat
Eptisecus fuscus pallidus	Big Brown Bat
Canis lupus baileyi **	Mexican Grey Wolf
Felis rufus baileyi *	Bobcat
Felis concolor azteca *	Mountain Lion, Puma
Ursus americanus amblyceps *	Black Bear
Conepatus mesoleucus venaticus	Hog-nosed Skunk
Mephitus mephitus estor *	Striped Skunk
Castor canadensis	Beaver
Odocoileus virginianus couesi *	Coues's White-tailed Deer
Mustela frenata neomexicana **	Long-tailed Weasel
Sciurus aberti aberti *	Abert Squirrel
Tamiasciurus hudsonicus grahamensis *	Mt. Graham Red Squirrel
Spermophilus variegatus grahamensis	Rock Squirrel
Eutamias dorsalis dorsalis *	Cliff Chipmunk
Neotoma mexicana mexicana *	Mexican Wood Rat
Peromyscus maniculatus rufinus *	Deer Mouse
Microtus longicaudus leucophaeus *	Long-tailed Vole
Reithrodontomys megalotis megalotis *	Western Harvest Mouse
Sorex vagrans monticola *	Vagrant Shrew
Thomomys bottae grahamensis *	Western Pocket Gopher

* Seen by EIS team or other observers. **Extinct in Pinalenos.

Table 31

CONFIRMED AND PROBABLE SPECIES OF REPTILES FOUND ON OR NEAR PROPOSED OBSERVATORY SITES IN THE PINALENO MOUNTAINS, GRAHAM COUNTY, ARIZONA

Crotalus viridus cerberus	Arizona Black Rattlesnake
Crotalus pricei pricei	Twin-spotted Rattlesnake
Crotalus molosus molosus	Black-tailed Rattlesnake
Pituophis melanoleucus affinis	Gopher Snake
Thamnophis cyrtopsis cyrtopsis	Western Garter Snake
Lampropeltis pyrelomena pyrelomena	Sonora Mountain Kingsnake
Sceloporus jarrovi jarrovi	Yarrow's Spiny Lizard
Phrynosoma douglassi hernandesi	Mountain Short-horned Lizard

Table 32

CONFIRMED AND PROBABLE BIRDS OF THE MT. GRAHAM ASTROPHYSICAL STUDY AREA+

Species	Species	Foraging method[a]	Nest type
Cathartes aura	Turkey Vulture		
Buteo jamaicensis	Red-tailed Hawk		
Buteo albonotatus	Zone-tailed Hawk		
Falco sparverius	American Kestrel		
Accipiter gentilis	Goshawk		
Accipiter cooperii	Cooper's Hawk		
Aquila chrysaetos	Golden Eagle		
Falco peregrinus	Peregrine		
Columba fasciata	Band-tailed Pigeon	C,TFS	
Zenaida macroura	Mourning Dove		
Otus flammeolus	Flammulated Owl		
Bubo virginianus	Great Horned Owl		
Glaucidium gnoma	Pygmy Owl		
Strix occidentalis	Spotted Owl**		
Aegolius acadicus	Saw-whet Owl*		
Selasphorus platycercus	Broad-Tailed Hummingbird		
Lampornis Clemenciae	Blue-Throated Hummingbird		
Colaptes aurctus	Common Flicker	GS	
Picoides villosus	Hairy Woodpecker	TD	
Picoides pubescens	Downy Woodpecker	TD	
Empidonax difficilis	Western Flycatcher		
Contopus pertinax	Coues' Flycatcher		
Tachycineta thalassina	Violet-green Swallow	A	
Progne subis	Purple Martin*	A	
Cyanocitta stelleri	Steller's Jay	TFS	
Corvus corax	Common Raven		
Parus gambeli	Mountain Chickadee	TFS	
Sitta carolinensis	White-breasted Nuthatch	TG	
Sitta canadensis	Red-breasted Nuthatch	TG	
Sitta pygmaea	Pigmy Nuthatch	TG	
Certhia familiaris	Brown Creeper	TG	
Troglodytes aedon	House Wren	GS	

Table 32 (continued)
CONFIRMED AND PROBABLE BIRDS OF THE MT. GRAHAM ASTROPHYSICAL STUDY AREA

Species	Species	Foraging method[a]	Nest type
Turdus migratorius	American Robin	GS	
Catharus guttatus	Hermit Thrush	GS	
Sialia mexicana	Western Bluebird*		
Sialia currucoides	Mountian Bluebird		
Myadestes townsendi	Townsend's Solitaire*	GS	
Regulus satrapa	Golden-crowned Kinglet	TFS	
Regulus calendula	Ruby-crowned Kinglet	TFS	
Vireo gilvus	Warbling Vireo	FTS	
Vermivora celata	Orange-crowned Warbler	TFS	
Meleagris gallapavo merriama	Turkey	GS	
Vermivora virginiae	Virginia's Warbler	TFS	
Peucedramus taeniatus	Olive Warbler		
Dendroica coronata	Yellow-rumped Warbler	TFS	
Dendroica graciae	Grace's Warbler	TFS	
Cardellina rubrifrons	Red-faced Warbler	TFS	
Septophaga picta*	Painted Redstart	TFS	
Piranga iudoviciana	Western Tanager	TFS	
Pheucticus melanocephalus	Black-headed Grosbeak	TFS	
Carduelis pinus	Pine Siskin	TFS	
Loxia curvirostra	Red Crossbill		
Pipilo chlorurus	Green-tailed Towhee	GS	
Junco phaenotus	Yellow-eyed Junco	GS	
Spizella passerina	Chipping Sparrow	GS	

[a] Foraging method: A = Aerial forager, F = flycatcher, GS = ground or slash forager, N = nectar feeder, P = predator on vertebrates, C = cone forager, TD = timber driller, TFS = timber-foliage searcher, TG = timber gleaner.

Nest type: H = hole, C = cup (non ground), G = ground.

**Probable but no confirmed sitings.
Heard adjacent to study area. Not known to nest in study area.
+ Transients not well studied. Not included

References: field notes, 1984-1985, Peter Warshall; Phillips, et al. 1964; Monson and Phillips, A.R.. 1981.

Table 33

HUNTING SEASONS FOR THE PINALENO MOUNTAINS, 1984-1985.

Species	Season	Weapon	Limit
Antlered mule deer	Oct. 26-29 Nov. 02-12	Firearm or archery	1
Antlered white-tailed Deer	Nov. 09-18 Nov. 14-30	Firearm or archery	1
Archery only deer	Sept. 14-26	Archery only	1
Mountain lion	July 01, 1984 June 30, 1985	Firearm or archery	1
Bear	Aug. 31-Sep. 13 Apr. 12-28	Firearm or archery	1*
Bobcat, skunk, fox, etc.	Year round	Firearm, or archery	unlimited
Bobcat, skunk, fox, etc.	Nov. - March	Trapping	unlimited
Tree squirrel	Oct. 12-Nov. 18	Firearm or archery	5 per day maximum in possession 10
Tree squirrel	Sept. 14-26	Archery only	as above

In 1986, due to proposed endangered listing, the Mt. Graham red squirrel is no longer legally huntable. The Abert squirrel is still huntable.

Table 34

PINALENOS AS A TRANSITIONAL MIXTURE OF SPECIES FROM MEXICAN AND COLORADO PLATEAU[1]

Species	Mountain Ranges			Probable Origin
	Whites	Pinalenos	Chiricahuas	
Butterflies				
Nymphalis milberti (Godart)	P	p**	A	
Speyeria atlantis (Edwards	P	p**	A	
Oeneis alberta daura (Strecker)	P	p**	A	
Habrodais grunus (Boisduval)	P	p**	A	
Erynnis icelus (Scudder & Burgess)	P	p**	A	
Piruna pirus (Edwards)	P	p**	A	
Thorybes mexicana (Herrich-Schaeffer)	P	p**	A	

Table 34 (continued)

PINALENOS AS A TRANSITIONAL MIXTURE OF SPECIES FROM MEXICAN AND COLORADO PLATEAU[1]

Species	Mountain Ranges: Whites	Pinalenos	Chiricahuas	Probable Origin
Yarrow's Spiny Lizard	A	P	P	Southern
Sagebrush Lizard	P	A	A	Northern
Bunch Grass Lizard	A	A	P	Southern
Striped Plateau Lizard	A	A	P	Southern
Mountain Skink	A	A	P*	Southern
Rock Rattlesnake	A	A	P	Southern
Twin-Spotted Rattlesnake	A	P*	P	Southern
Mexican Long-Tongued Bat	A	P*	P	
Tree Squirrel	P	P**	A	Northern
Apache Squirrel	A	A	P*	Southern
Long-Tail Weasel	P	P**	A	Northern
Coati	A	P	P	Southern
Blue Grouse	P**	A	A	Northern
Whiskered Owl	A	A(?)	P	Southern
Violet-Crowned Hummingbird	A	A	P	Southern
Rivoli's Hummingbird	A+	P	P	Southern
Yellow-Bellied Sapsucker	P	A	A	Northern
Northern Three-Toed Woodpecker	P	A	A	
Earred Trogon	A	A	P*	Southern
Elegant Trogon	A	A	P	Southern
Downy Woodpecker	P**	A	A	Northern
Willamson's Sapsucker	P	A	A	Northern
Arizona Woodpecker	A	P	P	Southern (?)
Sulphur-Bellied Flycatcher	A	P*	P	Southern
Olivaceows Flycatcher	A+	P+	P	Southern (?)
Gray Flycatcher	P	A	A	Southern (?)
Dusky Flycatcher	P	A	A	Southern (?)
Clark's Nutcracker	P	A	A	Northern
Gray Jay	P	A	A	Northern
Pinyon Jay	P	A	A	Northern
Mexican Chickadee	A	A	P*	Northern
Mountain Chickadee	P	P**	A	Northern
Ouzel	P	P**	A	Northern
Mountain Bluebird	P	A	A	Northern
Eastern Bluebird	A	A	P	Northern
Townsend Solitaire	P	A(?)	A	Northern
Orange-Crowned Warbler	P	P	A	Southern (?)
Pine Grosbeak	P	A	P	Northern
Green-Tailed Towlee	P	A	A	Northern
Dark-Eyed Junco	P	A	A	Northern
Yellow-Eyed Junco	A	P	P	Northern

[1] Many races and subspecies could be added to emphasize transitional position of the Pinalenos (e.g., pygmy owl, brown creeper, evening grosbeak). The list is incomplete and is to illustrate importance to North American biogeography. Birds are for breeding species only. "P" means "breeding." "A" means "non-breeding" or "absent." * means species is at northern most point of distribution. ** means southern most point of distribution. + means fluctuating presence as breeder.

Table 35

MOLLUSKS FOUND WITHIN THE PROPOSED
MT. GRAHAM ASTROPHYSICAL STUDY AREA

1. Large mollusks (above 1 cm in diameter):
   Sonorella imitator Gregg & Miller*
   Oreohelix grahamensis Gregg & Miller*

2. Small mollusks (1 mm to 10 mm):
   Discus Cronkhitei (Newcomb)
   Punctum Californicum (Bland)
   Vallonia perspectiva Sterki
   Microphysula ingersolli (Bland)
   Gastrocopta spp.
   Pupilla spp.
   Vertigo spp.

*Endemic to the Pinaleno Mountains.

Table 36

Unique Insects Found in the Proposed Mt. Graham Astrophysical Area

Coleoptera
- Byrrhidae
  - Byrrhus sp.
- Carabidae
  - Trechus arizonae Casey
- Salpingidae
  - Priognathus sp.
- Scarabaeidae
  - Diplotaxis saylori Cazier
  - Scaphinotus petersi grahami Van Dyke

Diptera
- Rhagionidae
  - Symphonoromyia fulvipes Group

Hemiptera
- Anthocoridae
  - Tetraphleps sp.
- Miridae
  - Deraeocoris sp.
  - Dichrooseytus sp.

Orthoptera
- Eumastacidae
  - Eumorsea pinaleno Rehn and Grant

The High Peak area has 10 locations (some with more than one fire circle) that are flat enough to be used for dispersed camping (off-road parking plus tent site; see Figure 5, Chapter 3). A theoretical maximal use gives these sites a capacity of 70 persons at one time. (It is doubtful if this intense use can occur without significant environmental damages, see below). There are 47 dispersed use campsites (including High Peak) accessible from the Swift Trail above 7,000 feet elevation. Total capacity at full-use (including High Peak) is about 420 campers at one time. This does not include developed campsites at Shannon, Hospital Flat, Riggs Flat and Old Columbine.

Pinaleno Recreational Growth

In 1979, the recreation use of areas accessed from State Highway 366 was 207,000 visitor-days per year. This use included dispersed recreation, private (summer homes) and public (developed sites) areas. Recreation Visitor Days per year increased to about 223,000 in 1981 and has varied between 215,000 and 221,000 Recreation Visitor Days since then (see Table 37 which follows). The overwhelming majority of the visitors (greater than 96 percent) used the Swift Trail access.

Dispersed recreation in the Pinalenos has grown 2 to 5 percent per year (Table 37). Developed private use (summer homes and bible camps) has stabilized at about 39,000 visitor-days per year which is near capacity. Use of developed campsites (with Tables, parking spurs, water, and toilets) has averaged about 82,000 Recreation Visitor Days per year (varying recently between 80,000 and 83,000) (Table 37). Of the nine monitored campsites (public, developed) six remain within acceptable management capacities and three suffer from over-capacity use. This differs significantly from 10 years ago when two to three developed campsites were underused.[1]

According to Forest Service plans, if funded, the pressure on developed campsites would be alleviated by the development of three expanded or new campsites in the Mt. Graham area (Twilight, Riggs Lake Ridge, and Snowflat-Treasure).[2] These campsites could increase public, developed campsites by 45, to 90,000 visitor-days per year.

The overall carrying capacity for the Pinalenos (as serviced by Swift Trail is estimated at 470,000 visitor-days per year.[3] In 1985, this section of the Pinalenos was at 65 percent capacity. If the general recreational growth continues to increase at 2 percent per year (a conservative estimate), the Swift Trail area would reach full capacity in 2022.

FOOTNOTES

1. Data from RIM computer printouts, summarized in Table 38 in Appendix 3.
2. Proposed Coronado National Forest Plan, p.27. Calculations in Table 39 Appendix 3.
3. Swift Trail Environmental Statement, Coronado National Forest, USDA, 1976. Appendix G.

TABLE 37
Dispersed and Developed Recreation Use
Reported in Recreation Visitor days (RVDs)
Safford Ranger District

	Dispersed Use			Developed Sites[4] Public Sector, Swift Trail	Developed Sites[5] Public Sector Other	Developed Sites[6] Private Sector Swift Trail
	District-wide[1]	Pinaleno[2]	Pinaleno[3]			
1975[7]	99,800			92,800	5,400	24,500
1976	131,000			101,100	5,400	25,900
1977	135,600			98,300	6,000	32,700
1978[8]	145,100	---	---	88,100	8,000	33,300
1979		107,700	80,800	91,500	7,000	34,800
1980		106,200	79,700	78,500	7,100	35,900
1981		134,000	100,500	86,800	7,100	35,900
1982		121,800	91,300	83,900	11,400	40,100
1983		127,500	95,600	82,600	10,000	38,200
1984		129,100	96,800	81,300	10,000	39,100
1985		135,100	101,300	80,000	10,000	39,500

[1] District wide Dispersed Use: All mountain ranges on District lumped together in a composite. Includes Pinaleno, Santa Teresa, Galiuro, excluding Galiuro Wilderness, and Winchesters. 1975-1978
[2] Pinaleno All: Total dispersed use which occurred on mountain range - 1979 onward.
[3] Pinaleno Swift Trail: Dispersed use which occurs along Swift Trail from Forest boundary to Clark Peak
[4] Riggs Lake, Soldier Creek, Hospital Flat, Shannon, Upper Arcadia, Arcadia, Wet Canyon, and Noon Creek
[5] Stockton Pass, and beginning in 1982 Safford Ranger District Office.
[6] Southern Arizona Bible Camp, Columbine and Turkey Flat Summerhome Area, and Pima Ward until 1979.
[7] Recreation use reported on calendar year basis 1975 - 1977.
[8] Recreation use reported on fiscal year basis 1978 on.

Methods for Estimating Visitation to Mt. Graham

Estimates for repeat visitors were made from discussions with Vic Heller, Director, School of Hotel and Restaurant Management, College of Business, Northern Arizona University. It was estimated that 20 percent of the visitation would be local, repeat visits with some local visitors and others twice every three years.

The estimate of 50,000 visitors per year to see the National New Technology Telescope (NNTT) was arrived at in three ways. First, Kitt Peak receives 100,000 visitors per year and is half the distance to Tucson. Fifty thousand is half of the Kitt Peak visitation for 1985. Second, 50,000 is approximately the visitation to both the Chiricahua National Monument and Roper Lake. These are the two nearest, somewhat comparable, visitor attractions. Third, about ten percent of all visitors to the Tucson areas show an interest in astronomy or "educational" attractions (only one percent of all visitors actually went to Kitt Peak). About 400 to 500,000 out-of-county visitors pass through the Safford area by highway. Again, ten percent of that number is about 50,000. They appeared reasonable to tourist experts consulted by Office of Arid Land Studies. The estimates made without the National New

Technology Telescope are for six percent of both observatory visitors plus multi-purpose visitors to the Pinalenos (Table 40, Appendix 3).

With the National New Technology Telescope, the Proportion of visitor-days per year using Forest Road 507 might rise from 13,510 (1985) to somewhere between 72,500 and 88,000 visitor-days by 1995. This increase includes normal (no project) visitation increases plus increases due to observatory visitation. The baseline is five percent of 1984 Swift Trail visitation. This is the amount of visitation that leaves Swift Trail to visit the peak area (13,510 visitor-days per year). The road improvements and increased publicity and attention given the observatory will probably cause more side-trips to the peak area. Estimates range from a five percent annual growth rate to a fifteen percent annual growth rate of combined general recreationists plus astro-tourists. Growth rates could be drastically curtailed by enforced visitor limitations.

Visitation

The carrying capacity of a developed campsite has been determined to lie between 20 and 40 percent of its theoretical capacity (Swift Trail Environmental Statement, 1976, Appendix G). Swift Trail campsites were "underused", "within capacity", or "overused" as follows:

Table 38 Swift Trail Campsite Use

Year	Underused	Within Capacity	Overused
1975	3	3	3
1976	2	6	1
1977	NA	NA	NA
1978	0	4	5
1979	NA	NA	NA
1980	0	7	2
1981	NA	NA	NA
1982	0	6	3
1983	NA	NA	NA
1984	NA	NA	NA

Table 39 Projections for Newly Developed Campsites, Safford Ranger District (Persons at one time=PAOT)

Name	PAOT	Seasonal	Total Capacity	20-40% Capacity
Twilight	250	199 days	49,750	10,000-20,000
Snowflat Treasure	200	196 days	39,200	7,840-15,700
Riggs Ridge	200	180 days	36,000	7,200-14,400
Totals			125,000	25,000-50,000

Table 40 Estimated Visitation to High Peak Without the National New Technology Telescope

Visitor-Day Growth Rate/Year	High Peak Visitor Days per Year 1990	1995	2005
2%	14,930	16,501	20,154
5%	17,347	22,274	36,724
10%	22,274	36,724	99,826
15%	28,601	60,548	271,356

Growth rates start at 13,510 VDY (1985) for High Peak Road. This is 5 to 6% of Swift Trail visitation. Increases are for general recreationists. For astro-tourists in 1985, add 50,000 VDY with the NNTT. Calculated by $y=Yoe^{rt}$ where Y=number of VDY; Yo=13,510 (VDY in 1984); r=rate of growth, t=number of years of growth.

APPENDIX 4 SOCIO-ECONOMIC

An econometric model was used to estimate the economic impacts of the alternatives. An econometric model is a tool specifically designed to estimate complicated economic interactions through the use of mathematical expressions or equations, each of which represents a major relationship in the economy. Some of the equations express basic definitional relationships (e.g., total wage and salary employment is the sum of eight major employment categories). The remaining equations express other relationships which are estimated using statistical techniques. Equation estimation involved a mechanical statistical procedure which calculated equation coefficients that best fit historical time series data.

The model used is one of a family of econometric models developed at the University of Arizona's Division of Economic and Business Research, College of Business and Public Administration. It is an expanded version of a highly detailed annual econometric model of Arizona and its three major substate areas (the Phoenix Standard Metropoliton Statistical Area (SMSA) -- or Maricopa County, the Tucson SMSA -- or Pima County, and the nonurban balance of the State) that was built originally as part of a study funded by the National Science Foundation.[1] The model is designed primarily for impact analysis. The model estimates employment for 37 industrial categories for each substate area. Personal income is estimated as the sum of five major components: labor and proprietors' income; dividends, interest, and rent; transfer payments; personal contributions to social insurance; and residence adjustment. Labor and proprietors' income is further disaggregated into eight major industrial categories. Population estimates are derived from separate estimates of natural increases and net migration. All state and local revenue to Arizona, including federal aid, is estimated in the model.[2]

The results are displayed in Tables 41 thru 58 which follow on the next page.

1 Carol A. Taylor and Alberta H. Charney, "Development of Compatible State-SMSA Econometric Models," final report to the National Science Foundation, Grant No. DAR-7909489m 1981.

2 A description of the model and its simulative capabilities are discussed in Alberta H. Charney and Carol A. Taylor, "Integrated State-substate Econometric Modeling: Design and Utilization for Long-run Economic Analysis," in Regional Econometric Modeling, Perryman and Schmidt (eds.), Kluwer-Nijhoff Publishing, 1986.

TABLE 41 Socio-Economic Effects in Graham County/Willcox
ALTERNATIVE A

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	250	O	O	0
Mining				0
Construction	200	D	D	14
Manufacturing		E	E	5
Durable--Scientific Instruments		V	V	0
Other	--	E	E	0
Non-durable	170	L	L	5
Transport, Communication, & Utilities	340	O	O	3
Wholesale Trade	290	P	P	8
Retail Trade	1,530	M	M	114
Finance, Insurance, & Real Estate	200	E	E	9
Services	1,260	N	N	93
Government	2,010	T	T	30
Federal	190			0
State & Local	1,820			30
Total	6,250			276
Personal Income ($ millions)**	$205.6			4.9
Population (1,000)	26.9			0.3

TABLE 42 Socio-Economic Effects in Pima County (Tucson)
ALTERNATIVE A

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	2,400	O	O	0
Mining	2,300			0
Construction	21,100	D	D	0
Manufacturing	31,800	E	E	0
Durable--Scientific Instruments	1,400	V	V	0
Other	24,600	E	E	0
Non-durable	5,800	L	L	0
Transport, Communication, & Utilities	8,400	O	O	0
Wholesale Trade	7,300	P	P	0
Retail Trade	44,500	M	M	0
Finance, Insurance, & Real Estate	11,600	E	E	0
Services	51,300	N	N	0
Government	45,000	T	T	0
Federal	11,500			0
State & Local	33,500			0
Total	225,700			0
Personal Income ($ millions)**	$7,471.4			0
Population (1,000)	638.0			0

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 43 Socio-Economic Effects in Arizona
ALTERNATIVE A

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	29.400	O	O	0
Mining	12.000			0
Construction	112,100	D	D	15
Manufacturing	181.600	E	E	15
Durable--Scientific Instruments	10.800	V	V	0
Other	129.600	E	E	12
Non-durable	41,200	L	L	3
Transport, Communication. & Utilities	54.100	O	O	5
Wholesale Trade	63.400	P	P	15
Retail Trade	239,100	M	M	114
Finance, Insurance. & Real Estate	81.200	E	E	8
Services	284.700	N	N	91
Government	207.000	T	T	30
Federal	40.900			0
State & Local	166.100			30
Total	1.264.600			293
Personal Income ($ millions)**	$38,539.7			6.1
Population (1,000)	3,260			0.3

TABLE 44 Socio-Economic Effects in Graham County/Willcox
ALTERNATIVE B

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	250	O	O	0
Mining				0
Construction	200	D	D	14
Manufacturing		E	E	5
Durable--Scientific Instruments		V	V	0
Other	--	E	E	0
Non-durable	170	L	L	5
Transport, Communication. & Utilities	340	O	O	3
Wholesale Trade	290	P	P	8
Retail Trade	1.530	M	M	114
Finance, Insurance, & Real Estate	200	E	E	9
Services	1.260	N	N	93
Government	2.010	T	T	30
Federal	1190			0
State & Local	1.820			30
Total	6.250			276
Personal Income ($ millions)**	$205.6			4.9
Population (1,000)	26.9			0.3

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 45 Socio-Economic Effects in Pima County (Tucson)
ALTERNATIVE B

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	2,400	O	O	0
Mining	2,300			0
Construction	21,100	D	D	0
Manufacturing	31,800	E	E	0
Durable--Scientific Instruments	1,400	V	V	0
Other	24,600	E	E	0
Non-durable	5,800	L	L	0
Transport, Communication, & Utilities	8,400	O	O	0
Wholesale Trade	7,300	P	P	0
Retail Trade	44,500	M	M	0
Finance, Insurance, & Real Estate	11,600	E	E	0
Services	51,300	N	N	0
Government	45,000	T	T	0
Federal	11,500			0
State & Local	33,500			0
Total	225,700			0
Personal Income ($ millions)**	$7,471.4			0
Population (1,000)	638.0			0

TABLE 46 Socio-Economic Effects in Arizona
ALTERNATIVE B

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	29,400	O	O	0
Mining	12,000			0
Construction	112,100	D	D	15
Manufacturing	181,600	E	E	15
Durable--Scientific Instruments	10,800	V	V	0
Other	129,600	E	E	12
Non-durable	41,200	L	L	3
Transport, Communication, & Utilities	54,100	O	O	5
Wholesale Trade	63,400	P	P	15
Retail Trade	239,100	M	M	114
Finance, Insurance, & Real Estate	81,200	E	E	8
Services	284,700	N	N	91
Government	207,000	T	T	30
Federal	40,900			0
State & Local	166,100			30
Total	1,264,600			293
Personal Income ($ millions)**	$38,539.7			6.1
Population (1,000)	3,260			0.3

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 47 Socio-Economic Effects in Graham County/Willcox
ALTERNATIVE C

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	250	O	O	0
Mining	--			0
Construction	200	D	D	14
Manufacturing		E	E	5
Durable--Scientific Instruments		V	V	0
Other	--	E	E	0
Non-durable	170	L	L	5
Transport, Communication, & Utilities	340	O	O	3
Wholesale Trade	290	P	P	8
Retail Trade	1,530	M	M	120
Finance, Insurance, & Real Estate	200	E	E	10
Services	1,260	N	N	98
Government	2,010	T	T	32
Federal	190			0
State & Local	1,820			32
Total	6,250			290
Personal Income ($ millions)**	$205.6			5.2
Population (1,000)	26.9			0.3

TABLE 48 Socio-Economic Effects in Pima County (Tucson)
ALTERNATIVE C

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	2,400	O	O	0
Mining	2,300			0
Construction	21,100	D	D	0
Manufacturing	31,800	E	E	0
Durable--Scientific Instruments	1,400	V	V	0
Other	24,600	E	E	0
Non-durable	5,800	L	L	0
Transport, Communication, & Utilities	8,400	O	O	0
Wholesale Trade	7,300	P	P	0
Retail Trade	44,500	M	M	0
Finance, Insurance, & Real Estate	11,600	E	E	0
Services	51,300	N	N	0
Government	45,000	T	T	0
Federal	11,500			0
State & Local	33,500			0
Total	225,700			0
Personal Income ($ millions)**	$7,471.4			0
Population (1,000)	638.0			0

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 49 Socio-Economic Effects in Arizona
ALTERNATIVE C

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*		N	N	
Agriculture	29,400	O	O	0
Mining	12,000			0
Construction	112,100	D	D	16
Manufacturing	181,600	E	E	16
Durable--Scientific Instruments	10,800	V	V	0
Other	129,600	E	E	13
Non-durable	41,200	L	L	3
Transport, Communication, & Utilities	54,100	O	O	5
Wholesale Trade	63,400	P	P	16
Retail Trade	239,100	M	M	120
Finance, Insurance, & Real Estate	81,200	E	E	8
Services	284,700	N	N	96
Government	207,000	T	T	32
Federal	40,900			0
State & Local	166,100			32
Total	1,264,600			309
Personal Income ($ millions)**	$38,539.7			6.5
Population (1,000)	3,260			0.3

TABLE 50 Socio-Economic Effects in Graham County/Willcox
ALTERNATIVE D, PA

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	250	0	0	0
Mining		0	0	0
Construction	200	41	4	16
Manufacturing		6	19	5
Durable--Scientific Instruments		0	16	0
Other		4	2	0
Non-durable	170	2	1	5
Transport, Communication, & Utilities	340	6	1	4
Wholesale Trade	290	3	3	9
Retail Trade	1,530	12	37	139
Finance, Insurance, & Real Estate	200	5	3	11
Services	1,260	18	13	109
Government	2,010	12	9	36
Federal	190	0	0	0
State & Local	1,820	12	9	36
Total	6,250	103	89	329
Personal Income ($ millions)**	$205.6	3.2	2.4	5.8
Population (1,000)	26.9	0.1	0.1	0.3

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 51 Socio-Economic Effects in Pima County (Tucson)
ALTERNATIVE D, PA

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	2,400	0	0	0
Mining	2,300	0	0	0
Construction	21,100	5	3	0
Manufacturing	31,800	58	66	0
Durable--Scientific Instruments	1,400	53	59	0
Other	24,600	2	2	0
Non-durable	5,800	3	5	0
Transport, Communication, & Utilities	8,400	4	5	0
Wholesale Trade	7,300	3	6	0
Retail Trade	44,500	15	69	0
Finance, Insurance, & Real Estate	11,600	6	9	0
Services	51,300	22	20	0
Government	45,000	10	32	0
Federal	11,500	0	0	0
State & Local	33,500	10	32	0
Total	225,700	123	210	0
Personal Income ($ millions)**	$7,471.4	4.0	5.7	0
Population (1,000)	638.0	0.1	0.2	0

TABLE 52 Socio-Economic Effects in Arizona
ALTERNATIVE D, PA

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	29,400	0	0	0
Mining	12,000	0	0	0
Construction	112,100	40	10	18
Manufacturing	181,600	70	90	18
Durable--Scientific Instruments	10,800	52	76	0
Other	129,600	14	9	14
Non-durable	41,200	4	5	4
Transport, Communication, & Utilities	54,100	11	7	5
Wholesale Trade	63,400	11	19	18
Retail Trade	239,100	27	106	134
Finance, Insurance, & Real Estate	81,200	11	15	9
Services	284,700	40	45	107
Government	207,000	20	50	36
Federal	40,900	0	0	0
State & Local	166,100	20	50	36
Total	1,264,600	230	342	345
Personal Income ($ millions)**	$38,539.7	7.3	9.7	7.2
Population (1,000)	3,260	0.3	0.3	0.4

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 53 Socio-Economic Effects in Graham County/Willcox
ALTERNATIVE E

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	250	0	0	0
Mining	--	0	0	0
Construction	200	41	6	20
Manufacturing		6	64	7
Durable--Scientific Instruments		0	57	0
Other	--	4	4	0
Non-durable	170	2	3	7
Transport, Communication, & Utilities	340	6	2	4
Wholesale Trade	290	3	5	11
Retail Trade	1,530	12	46	164
Finance, Insurance, & Real Estate	200	5	7	13
Services	1,260	18	28	134
Government	2,010	12	19	44
Federal	190	0	0	0
State & Local	1,820	12	19	44
Total	6,250	103	177	397
Personal Income ($ millions)**	$205.6	3.2	4.8	7.1
Population (1,000)	26.9	0.1	0.2	0.4

TABLE 54 Socio-Economic Effects in Pima County (Tucson)
ALTERNATIVE E

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	2,400	0	0	0
Mining	2,300	0	0	0
Construction	21,100	5	21	0
Manufacturing	31,800	58	215	0
Durable--Scientific Instruments	1,400	53	190	0
Other	24,600	2	10	0
Non-durable	5,800	3	15	0
Transport, Communication, & Utilities	8,400	4	18	0
Wholesale Trade	7,300	3	20	0
Retail Trade	44,500	15	203	0
Finance, Insurance, & Real Estate	11,600	6	32	0
Services	51,300	22	88	0
Government	45,000	10	104	0
Federal	11,500	0	1	0
State & Local	33,500	10	103	0
Total	225,700	123	701	0
Personal Income ($ millions)**	$7,471.4	4.0	18.6	0
Population (1,000)	638.0	0.1	'0.6	0

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 55 Socio-Economic Effects in Arizona
ALTERNATIVE E

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	29,400	0	0	0
Mining	12,000	0	0	0
Construction	112,100	40	20	22
Manufacturing	181,600	70	280	22
Durable--Scientific Instruments	10,800	52	240	0
Other	129,600	14	17	18
Non-durable	41,200	4	16	4
Transport, Communication, & Utilities	54,100	11	21	7
Wholesale Trade	63,400	11	49	26
Retail Trade	239,100	27	249	164
Finance, Insurance, & Real Estate	81,200	11	42	11
Services	284,700	40	140	131
Government	207,000	20	130	44
Federal	40,900	0	0	0
State & Local	166,100	20	130	44
Total	1,264,600	230	931	423
Personal Income ($ millions)**	$38,539.7	7.3	26.6	8.8
Population (1,000)	3,260	0.3	0.8	0.4

TABLE 56 Socio-Economic Effects in Graham County/Willcox
ALTERNATIVE F

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	250	0	0	0
Mining		0	0	0
Construction	200	41	5	20
Manufacturing		6	65	7
Durable--Scientific Instruments		0	58	0
Other	--	4	4	0
Non-durable	170	2	3	7
Transport, Communication, & Utilities	340	6	2	4
Wholesale Trade	290	3	5	11
Retail Trade	1,530	12	42	164
Finance, Insurance, & Real Estate	200	5	7	13
Services	1,260	18	28	134
Government	2,010	12	16	44
Federal	190	0	1	0
State & Local	1,820	12	16	44
Total	6,250	103	171	397
Personal Income ($ millions)**	$205.6	3.2	4.8	7.1
Population (1,000)	26.9	0.1	0.2	0.4

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

TABLE 57 Socio-Economic Effects in Pima County (Tucson)
ALTERNATIVE F

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	2,400	0	0	0
Mining	2,300	0	0	0
Construction	21,100	5	23	0
Manufacturing	31,800	58	252	0
Durable--Scientific Instruments	1,400	53	223	0
Other	24,600	2	12	0
Non-durable	5,800	3	17	0
Transport, Communication, & Utilities	8,400	4	20	0
Wholesale Trade	7,300	3	21	0
Retail Trade	44,500	15	198	0
Finance, Insurance, & Real Estate	11,600	6	35	0
Services	51,300	22	100	0
Government	45,000	10	104	0
Federal	11,500	0	2	0
State & Local	33,500	10	102	0
Total	225,700	123	733	0
Personal Income ($ millions)**	$7,471.4	4.0	20.2	0
Population (1,000)	638.0	0.1	0.6	0

TABLE 58 Socio-Economic Effects in Arizona
ALTERNATIVE F

	Base	Projected Average Annual Change		
		Observatory		Recreation/
	1985	During construction	During operations	Tourism
Employment (Number of jobs)*				
Agriculture	29,400	0	0	0
Mining	12,000	0	0	0
Construction	112,100	40	20	22
Manufacturing	181,600	70	320	22
Durable--Scientific Instruments	10,800	52	281	0
Other	129,600	14	21	18
Non-durable	41,200	4	18	4
Transport, Communication, & Utilities	54,100	11	23	7
Wholesale Trade	63,400	11	51	26
Retail Trade	239,100	27	240	164
Finance, Insurance, & Real Estate	81,200	11	45	11
Services	284,700	40	150	131
Government	207,000	20	120	44
Federal	40,900	0	0	0
State & Local	166,100	20	120	44
Total	1,264,600	230	929	423
Personal Income ($ millions)**	$38,539.7	7.3	25.3	8.8
Population (1,000)	3,260	0.3	0.8	0.4

*Employees covered by Arizona employment security laws.
**1984 base year for personal income only.

PROPONENT'S COST

Table 59 Annual Operational Expense and Employment
(based on 10.5% of capital)
ALTERNATIVE D

Mt. Graham	
Personnel	
Operators/Technicans - 7#	260.400
Maintenance - 9	279,000
Observers - *	
Sub-total - 16	$539,400
Operations	$2,600,000
Tucson	
Personnel	
Observers - 9	406.629
Support staff/scientists	
10-meter SMT -2	89,600
Texas 5-meter - 2	89,600
Small Optical/IR - 1	44,800
AZ/OH 8-meter Optical/IR - 25	1,120.500
Large Optical/IR - 20	896.000
Sub-total - 59	$2,647,129
Operations	$1,445,996
TOTAL - 75	$7,232,525

TABLE 60 Annual Operational Expense and Employment
(based on 9.5% of capital)
ALTERNATIVE E

Mt. Graham	
Personnel	
Operators/Technicans - 17#	632.400
Maintenance - 40	1,240.000
Observers - *	
Sub-total - 57	$1,872,400
Operations	$2,600,000
Tucson	
Personnel	
Observers - 19	858.458
Support staff/scientists	
10-meter SMT - 2	89,600
Texas 5-meter - 2	89,600
Small Optical/IR - 1	44,800
AZ/OH 8-meter Optical/IR - 25	1,120,500
Large Optical/IR - 20	896.400
Large Optical/IR - 20	896,400
NNTT - 50	2,241,000
SAO Interferometer - 20	896,400
Small Optical/IR - 10	448,000
Small Optical/IR - 10	448,000
Small Optical/IR - 10	448,000
Sub-total - 189	$8,477,158
Operations	$8,839,642
TOTAL - 246	$21,789,200

*Based and included in Tucson estimates #Number of employees

TABLE 61 Annual Operational Expense and Employment
(based on 8.5% of capital)

	ALTERNATIVE F
Mt. Graham	
Personnel	
Operators/Technicans - 18#	670,000
Maintenance - 40	1,240,000
Observers - *	
Sub-total - 58	$1,910,000
Operations	$3,000,000
Tucson	
Personnel	
Observers - 22	994,000
Support staff/scientists	
10-meter SMT - 2	89,600
Texas 5-meter - 2	89,600
Small Optical/IR - 1	44,800
AZ/OH 8-meter Optical/IR -25	1,120,500
NNTT - 50	2,241,000
SAO Interferometer - 20	896,400
Large Optical/IR - 20	896,400
Large Optical/IR - 20	896,400
Large Optical/IR - 20	896,400
Small Optical/IR - 10	448,000
Small Optical/IR - 10	448,000
Small Optical/IR - 10	448,000
Small Optical/IR - 10	448,000
Sub-total - 222	$9,957,100
Operations	$7,326,450
TOTAL - 280	$22,193,550

*Based and included in Tucson estimates #Number of employees

TABLE 62 Construction Cost Detail
($1,000 1985 dollars)
ALTERNATIVES D, PA

	Telescope	Enclosures/ Buildings	Utilities. Site Prep & Misc.	Total
10-meter SMT	3,460[a]	1,040	500	5,000
Texas 5-meter	180	420[b]	-	600
1.8-meter 0/IR	480	420	100	1,000
AZ/OH 8-meter	21,900	5,100	3,000	30,000
8-meter 0/IR	21,900	5,100	3,000	30,000
Generator Building	-	30		30
Texas Support Building	-	385	-	385
Equipment Garage	-	120	-	120
Meteorological Tower/ Communication Building		35	-	35
Shop Area		295	-	295
Site Residence		160	-	160
Dormitory		500		500
TOTAL	$47,920	$13,605	$6,600	$68,125

a The SMT is being fabricated by the Max Planck Institute for Radio Astronomy in West Germany.
b Includes small dormitory as part of telescope enclosure.

TABLE 63 Construction Cost Detail
($1,000 1985 dollars)
ALTERNATIVE E

	TelescoRe	Enclosures/ Buildings	Utilities, Site Prep & Misc.	Total
10-meter SMT	3,460	1.040	500	5.000
Texas 5-meter	180	420[b]	100	600
1.8-meter O/IR	480	420	100	1.000
AZ/OH 8-meter	21.900	5.100	3.000	30.000
NNTT	73.000	17.000	10.000	100.000
SAO Interferometer	18.250	4.250	2.500	25.000
Two 8-meter O/IR	43,800	10.200	6.000	60.000
Three 4-meter O/IR	2.175	1.950	1.125	5.250
Generator Building	-	30	-	30
Texas Support Building	-	385	-	385
Equipment Garage	-	120	-	120
Meteorological Tower/ Communications Building	-	35	-	35
Site Residence	-	295	-	295
Shop Area	-	160	-	160
Dormitory	-	1,260	-	1.260
Visitor Center	-	225	-	225
TOTAL	$163,245	$42,890	$23,225	$229,360

TABLE 64 Construction Cost Detail
($1,000 1985 dollars)
ALTERNATIVE F

	TelescoRe	Enclosures/ Buildings	Utilities, Site Prep & Misc.	Total
10-meter SMT	3.460	1.040	500	5.000
Texas 5-meter	180	420[b]	-	600
1.8-meter 0/IR	480	420	100	1.000
AZ/OH 8-meter	21,900	5.100	3.000	30.000
NNTT	73.000	17.000	10.000	100.000
SAO Interferometer	18.250	4.250	2.500	25.000
Three 8-meter 0/IR	65.700	15.300	9.000	90.000
Four 4-meter 0/IR	2.900	2.600	1.500	7,000
Generator Building	-	30	-	30
Texas Support Building	-	385	-	385
Equipment Garage	-	120	-	120
Meteorological Tower/ Communications Building	-	35	-	35
Site Residence		295	-	295
Shop Area	-	160	-	160
Dormitory	-	1.260	-	1.260
Visitor Center	-	225	-	225
TOTAL	$185,870	$48,640	$26,600	$261,110

[a] The SMT is being fabricated by the Max Planck Institute for Radio Astronomy in West Germany.
[b] Includes small dormitory as part of telescope enclosure.

Table 65 Capital Expenditures and Estimated Operations Expense Summary
($1,000 1985 dollars)

	Alternative		
	D. PA		
Capital Expenditures			
Facilities:			
10-meter SMT	$5,000	$5,000	$5,000
Texas 5-meter	600	600	600
Small Optical/IR	1,000	1,000	1,000
AZ/OH Large Optical/IR	30,000	30,000	30,000
NNTT	-0-	100,000	100,000
SAO Interferometer	-0-	25,000	25,000
Large Optical/IR	30,000	30,000	30,000
Large Optical/IR	-0-	30,000	30,000
Large Optical/IR	-0-	-0-	30,000
Small Optical/IR	-0-	1,750	1,750
Small Optical/IR	-0-	1,750	1,750
Small Optical/IR	-0-	1,750	1,750
Small Optical/IR	-0-	-0-	1,750
Support Facilities	1,525	2,285	2,285
Visitor Center	-0-	225	225
TOTAL	$68,125	$229,360	$261,110
Operations Expenses			
Mt. Graham			
Personnel	$ 539.4	$1,872.4	$1,910.0
Operations	2,600.0	2,600.0	3,000.0
Tucson			
Personnel	$2,647.1	$8,477.2	$9,957.1
Operations	1,446.0	8,839.6	7,326.5
TOTAL	$ 7.232.5	$21,789.2	$22,193.6

TOURISM IN THE GILA VALLEY AND WILLCOX AREAS

In 1985, a very preliminary survey of Swift Trail traffic indicated that 54 percent of the travelers and tourists were from the Upper Gila Valley (Safford, Thatcher, Pima, etc.) and seven percent from other nearby communities (Bowie, Benson, Willcox, etc.). Twenty-two percent came from Tucson and the surrounding areas in Pima County, 12 percent were from Phoenix or the surrounding areas of Maricopa County and 6 percent were from out of state.[4] The high local use (over 60 percent) adds marginally to the tourist and traveler economy. It is generally agreed that this pattern will remain even with the observatory. In similar situations in Arizona, about 20 percent of the local tourist trade visits twice a year (taking friends, relatives, etc.) and 30 percent of the lcoal tourist trade visits once evey three years.[1]

In general, throughout Arizona, about 40 percent of all out-of-county, highway travelers stay in a motel.[2] The proportions of cash outlays, throughout Arizona, for out-of-county, highway travel parties is: Food (26 percent); lodging (11 percent) and other (9 percent).[1,2] Again, the low percentage of lodging reflects the pass-through nature of visits to Mt. Graham and the greater percentage of camping. Only 30 percent of all vehicles visiting the Mt. Graham area by way of Swift Trail reported any local cash expenditures (Table 66)[4].

In Arizona, cash outlays from out-of-county, highway traveling parties average between $40 to $50 per day. An average traveling party is 2.5 persons per vehicle. The Mt. Graham survey of out-of-county travelers averaged 3 persons per car and about $25 per vehicle.[3]

Footnotes

1. Vic Heller, School of Hotel and Restaurant Management, College of Business Administration. Northern Arizona University. Personal Communication.

2. Letter of September, 1985, with data on tourism from Northern Arizona University, College of Business Administration; "Highlights of Research on Summer Visitors to Tucson," 1985, Tucson Convention and Visitors Bureau; "Tourism and Travel in Arizona." 1981, Arizona Office of Tourism (prepared by Bureau of Business and Economic Research, Arizona State University); Highlights of Research on Spring Visitors to Tucson." 1985, Tucson Convention and Visitors Bureau.

3. The survey conducted was for vehicles going up Swift Trail. Cash expenditures after return trip are not included. Expenditures are for gasoline and some food.

4. Office of Arid Land Studies Environmental Data Report, Proposed Mt. Graham Astrophysical Area Pinaleno Mountains. Graham County, Arizona. 1985. Office of Arid Land Studies. University of Arizona.

Table 66 OUT-OF-COUNTY TRAVEL AND TOURISM EXPENDITURES FROM ROAD SURVEYS

Amount of Purchases: Safford/Willcox

	Food	Fuel	Lodging	Other	Total
Total Purchases	$953	$1,045	$285	$223	$2,506
% of Total Purchases*	38%	42%	11%	9%	100%
Average Amount Per Vehicle	$8.43	$9.25	$2.52	$1.97	$22.18

*386 vehicles were surveyed. 113 (29%) made purchases.

FUNDING OF ASTRONOMICAL ACTIVITIES IN ARIZONA

Funding for astronomical activities in the State of Arizona was about $34 million for fiscal year 1982-1983. Current funding is estimated to be about $40 million, mostly from sources outside of Arizona (see Table 67). Arizona state taxes provide about $5 million. Half of these funds go toward pure astronomical research. The total capital invested in the physcial facilities has been estimated at $291 million before depreciation and/or obsolence.

Over the past fifteen years, the public and its representatives have been sympathetic to spending public funds on ground-based astronomy and all other aspects of the exploration of outer space. National Science Foundation (NSF) funding for all astronomy activities was over $60 million in FY 1983. Ground-based astronomy research has been consistently funded by NSF, while funding for space-based astronomy has increased enormously.

TABLE 67
Selected Economic Statistics for Astronomical
Activities in the State of Arizona, FY 1982-1983

Agency	Number of Employees	Total Expenditure ($1,000)	State Funds ($1,000)	Value of Physical Plant ($1,000)	Astronomy Visitors' Expenditure[1] ($1,000)	Number of Tourists
Kitt Peak National Observatory	284	$13,200		$158,000	$330	90,000
National Radio Astronomy Observatory	25	1,093		9,000	49	
Steward Observatory	140	5,135	1,957	4,350	160	
Whipple Observatory-SAO	25	1,053		50,000	64	3,000
Multiple Mirror Telescope Observatory	26	998	275	15,000	15	4,000
Lowell Observatory	25	930		10,000	125	17,000
U.S. Naval Observatory	9	527		15,000	3	1,000
McGraw-Hill Observatory	2	113		1,200	30	
Optical Sciences Lab	128	5,291	1,013	17,400	137	
Lunar and Planetary Lab	110	3,100	600	5,000	17	
Planetary Geology Group	27	536				
ASU Astronomy Group	7	223	163	350		
NAU Astronomy Group	4	148	148	320		
U of A Physics Department	27	801	97	2,050	25	
Flandrau Planetarium	14	366	178	3,500		100,000
ASU Planetarium	1	33	28	150		
Planetary Sciences Institute	8	348		65	20	
U MINN/ U CAL-San Diego	0	50		150		
TOTAL	862	33,945	4,459	291,535	975	215,000

[1] Computed on the basis of $30/day at astronomical sites, $75/day for "in-town" activities, and $1,000/month for long-term visits.

Sources: *David Burstein, Tim Mogan, Michael Kroelinger (Community Lighting Impact Project)
*Personal communication with Peter Strittmatter, Director of Steward Observatory

Table 74 Peak Storm Runoff in Cubic Feet Per Second.

The 10-year Event

WS	Current Runoff	Alt D Runoff (%Increase)	Alt E Runoff (%Increase)	Alt F Runoff (%Increase)	Alt PA Runoff (%Increase)
Frye	94	98 (4%)	102 (8%)	106 (13%)	98 (4%)
Deadman	104	110 (6%)	106 (2%)	112 (8%)	106 (2%)

Table 75 Peak Storm Runoff in Cubic Feet Per Second.

The 100-year Event

WS	Current Runoff	Alt D Runoff (%Increase)	Alt E Runoff (%Increase)	Alt F Runoff (%Increase)	Alt PA Runoff (%Increase)
Frye	202	207 (2%)	213 (5%)	218 (8%)	207 (2%)
Deadman	243	252 (4%)	247 (2%)	255 (5%)	247 (2%)

WATER USE

50 gal/day per worker
5 gal/day per visitor

Alternative D and PA

25[1] workers need 1.4 acre-feet/yr or 0.9 gal/min
10,000[2] VOY need 0.15 " " or 0.1 "
1.55 acre-feet/yr or 1.0 gal/min
+ fire needs 0.18 " " stored (15,000 gal/site[3])
1.73 acre-feet/yr

Deadman produces 179 acre-feet/yr average for Alternative D, we need 1% of annual yield to the management area edge.

[4]During low flow years of 16.2 acre feet, 11% is used (from the low flow year of 81 acre feet at the USGS gage, assuming 20% of total yield for Deadman Creek at the gage comes from the management area.

Average flow is 0.25 cfs or 112 gpm, we need 0.9%. Measured flows are as low as 15 gpm, in which case we need 6.7%.

At USGS gage, low flow years, we would use 1.73/81=2.1% of total yield.

Alternative E

79[1] workers need 4.42 acre-feet/yr or 2.74 gal/min
10,000[2] VDY need 0.15 " " or 0.1
4.57 acre-feet/yr or 2.84 gal/min
+ fire needs 0.14 " " stored (15,000 gal/site[3])
4.71 acre-feet/yr

Deadman produces 171 acre-feet/yr average for Alternative E, we need 2.7% of annual yield to the management area edge.

[4] During low flow years of 16.2 acre feet, 29% is used (from the low flow year of 81 acre feet at the USGS gage, assuming 20% of total yield for Deadman Creek at the gage comes from the management area.

Average flow is 0.24 cfs or 108 gpm, we need 2.6%. Measured flows are as low as 15 gpm, in which case we need 19%.

At USGS gage, low flow years, we would use 4.71/81=5.8% of total yield.

Alternative F (from page 213, Office of Arid Land Studies Environmental Data Report)

80[1] workers need 4.48 acre-feet/yr or 2.78 gal/min
50,000[2] VDY need 0.75 acre-feet/yr or 0.5 gal/min
5.23 acxe-feet/yr or 3.28 gal/min
± fire needs 0.51 acre-feet/yr stored (15,000 gal/site[3])
5.74 acre-feet/yr

Deadman produces 183 acre-feet/yr average for Alternative F, we need 3.1% of annual yield to the management area edge.

[4] During low flow years of 16.2 acre feet, 35% is used (from the low flow year of 81 acre feet at the USGS gage, assuming 20% of total yield for Deadman Creek at the gage comes from the management area).

Average flow is 0.25 cfs or 112 gpm, we need 2.9%. Measured flows are as low as 15 gpm, in which case we need 22%.

At USGS gage, low flow years, we would use 5.74/81=7.1% of total yield.

[1] From Appendix 4
[2] From Office of Arid Land Studies Environmental Data Report, page 321
[3] From Office of Arid Land Studies Environmental Data Report, page 213
[4] Average yield for Deadman at USGS gage is 950 ac-ft/yr. About 20% is produced within the management area (179/950=0.19). The low year of record is 81 acre-feet. Therefore, the amount produced within the management area in a low flow year is 81 x 0.2 = 16.2 acre-feet.
[5] From Office of Arid Land Studies Environmental Data Report, pages 213 and 380

References

Office of Arid Land Studies Environmental Data Report, Proposed Mt. Graham Astrophysical area Pinaleno Mountains, Graham County, Arizona. 1985. Office of Arid Land Studies, University of Arizona.

Potter, Loren D., James R. Gosz, and Clarence A. Carlson, Jr. Water Resources in the Southern Rockies and High Plains. 1984. University of New Mexico Press, Albuquerque.

The "Management Presciptions Applicable to All Areas of Forest" (Standards and Guidelines) contained in the Coronado National Forest Plan (July 1986) also apply to the 3500 acre area, Management Area 2A. These standards and guidelines are not listed here. The following standards and guidelines outline specific management direction for Management Area 2A (3500 acre area).

FOREST SERVICE PREFERRED ALTERNATIVE (PA)

Management Emphasis and Intensity: Manage to provide opportunities for astrophysical research, perpetuation of wilderness values, and unique wildlife and vegetative species. Provide for a variety of dispersed recreation opportunities while allowing for minimum level of astrophysical facilities development. Any dormitory and/or visitor center will be located off forest.

Use restrictions will be imposed as necessary to protect physical, biological and astrophysical qualities of the area. Sawtimber and fuelwood harvest will only be done to enhance wildlife and recreation values and may occur only after consultation with the U.S. Fish and Wildlife Service. Watershed conditions will be maintained or improved.

Summary of Management Emphasis	Acres	
Wilderness	1,000	
Zoological/Botanical	569	(Mt. Graham Red Squirrel & Spruce-Fir)
Astrophysical Use:		
Exclusive	7	
Restricted	123	
Dispersed Recreation	1,001	

Management Area Description: Coniferous forest lands that have been determined suitable for special area designations, astrophysical and recreational uses. Slopes generally less than 40% in the Spruce-Fir vegetative type and generally greater than 40% in the mixed conifer vegetative type. The area includes potential critical habitat for the Mt. Graham red squirrel.

Capability Area Types: 4M (mountain grassland), 9CHM (coniferous forest Douglas Fir-Pine), and 9DHM (coniferous forest Spruce-Fir). Total acres = 3,500

Specific Management Prescription

Timber Suitability:

Tentatively suitable for timber production = 3500 acres
Not appropriate for timber production = 3500 acres
Suitable for timber production 0 acres

Proposed vegetation manipulation:

Sanitation and salvage activities may occur for the purpose of insect and disease control after consultation with the U.S. Fish and Wildlife Service.

Reforestation may occur for the purposes of improving wildlife habitat.

Management Practices	Activities	Standards and Guidelines

Dispersed Recreation (DU 1)	A14, A15 L23	1. Maintain trails to level 3. See Glossary "Trail Maintenance".

2. Use of motorized vehicles is restricted to Forest Roads 507 and 669. All trails are closed to motorized vehicles.

3. Manage dispersed use at the following service levels:
699 Acres Standard (ZBA and astrophysical use area)
1801 Acres Less than Standard

4. Manage ROS classes as follows:

Class	Acres
Primitive (Wilderness)	1000
Semi-primitive Motorized	1391
Roaded Natural	1102
Urban	7

5. Develop an interpretive program for the zoological/botanical area considering the following techniques:

   a. Employing volunteer interpreters and educators.
   b. Publishing plant and animal guides and visitor etiquette brochures.
   c. Building environmental displays.
   d. Conducting visitor programs.

6. Astrophysical and/or physical science interpretation and educational programs may take place.

7. The following applies to the 7 acre astrophysical exclusive use area:

   Prohibit all hunting, camping, hiking, and campfires.
   Limited daylight public access. Roadway closed at night. Radio transmissions controlled.
   Fencing may be used to limit access to exclusive use area.

8. The following applies to the 123 acre restricted use area:

   Prohibit hunting, headlights, night time campfires, and pets.
   Restrict public access to daylight drive-in only; restrict wet weather driving; radio transmissions controlled.

9. Public access and use of FR 669 remains open.

		10. A forest permit will be required for plant collection and for research activities that involve placing anything wihtin the ZHA or restricted use area.
Visual Resource Management (DU 2)	A03	Manage the following acres at the indicated visual quality objectives: 1000 Acres preservation 28% 2370 Acres retention 68% 123 Acres partial retention 4% 0 Acres modification 0% 7 Acres max. modification < 1% Trees would remain dominant and continous along sky line. Trees would be used to assist in screening structures. Telescope structures would use colors that blend into the landscape except for possibly southerly aspects. Astrophysical areas would be shaped and revegetated to assist in screening structures. Astrophysical sites will be designed to best fit the natural landscape.
Cultural Resource Management (DU 3)	A02	If site AR03-05-04-103 can not be avoided, it will be evaluated formally in terms of the National Register of Historic Places eligibility criteria. Site AR03-05-04-102 would have a specific course of action to mitigate impacts to the site developed in consultation with the Zuni Tribe, the State Historic Preservation Office, and the Advisory Council on Historic Preservation. Additional specific standards and guidelines for cultural resource management is shown in the Coronado National Forest Plan under management prescription applicable to all areas of the Forest.
Developed Recreation O&M (DU 5) and Recreation Site Construction & Reconstruction (DU 6)	A08, A09 A11, A13 A16, A06, A05 L20, L23, L19	1. A public snowplay area will be developed and maintained by Steward Observatory. A snow plowed area for parking will also be provided and maintained by Steward Observatory 2. A public picnic site, restroom facility, scenic viewpoint, and amateur astronomy vista will be developed and maintained by Steward Observatory in the exclusive use area. 3. All public facilities provided by Steward Observatory will receive standard service management to provide optimum service.
Wilderness Recreation 0 & M (DU 8)	B02, B03 L23	1. Maintain trails to following standards: 70% level 1 30% level 2 See Glossary "Trail Maintenance". 2. Use of motorized vehicles is prohibited except as approved for emergency or other special needs.

3. Maintain the following ROS classification composition:
   1000 acres primitive

4. Manage wilderness use as follows:
   standard 0 acres
   less than standard 1000 acres

Wildlife & Fish 0 & M (DU 10)

C01, C02, C12

1. Within the ZBA the general objective is to emphasize nonconsumptive plant and wildlife recreation enjoyment and study. Management plans for designated national zoological areas will be completed in cooperation with state and federal wildlife agencies and other wildlife and plant oriented groups and agencies.

2. Assess the needs for and design of studies for both the red and tassel-eared squirrels (Abert squirrel) in the Management Area. Initiate all studies in cooperation with the appropriate state and federal agencies.

3. Specific standards and guidelines for management of wildlife are shown in the Coronado National Forest's plan under the forest wide prescription for activities appropriate to this management area. These are intended to meet the following objectives:

   a. Maintain and improve current habitat for federally listed plant and animal species and work toward delisting.

   b. Assist in the establishment and implementation of recovery plans for all Federally listed Threatened or Endangered species.

   c. Maintain or improve current habitat capability levels of occupied habitat, with no more than a 15% loss of local habitat capability by any single project, for:
      Mt. Graham red squirrel
      black bear
      Arizona trout
      white-tail deer
      raptors
      twin-spotted rattlesnake
      blue-throated hummingbird
      buff-breasted flycatcher
      spotted owl

   d. Inventory and analyze population levels and habitat quality for all management indicator species in order to meet monitoring plan objectives.

   e. In mixed conifer and aspen stands Maintain at least 80% of the existing primary and secondary cavity nesting habitat during any activity, within the proposed activity zone of influence.

4. Within the ZBA and astrophyscial restricted area allow non-game recreation use demand to occur while maintaining and improving occupied habitat for species listed above. Implementation of an effective environmental education program (See dispersed recreation management guidelines) will lessen the impacts of non-consumptive uses on the area.

Wildlife Habitat Maintenance (DU 11)	C09, C10 C11	Maintenance and improvement of structural and nonstructural improvement activities will be commensurate with the Wilderness Act and guidelines shown in the Coronado National Forest's Plan Forest wide prescription.
Fish Habitat Improvement (DU 13)	C03, C04 C05, C06	
Game Habitat Improvement (DU 14)	C07, C08	
Non-game Habitat Improvement (DU 15)		
T & E Habitat Improvements (DU 12)		They are intended to meet the following objectives:

1. Maintain and improve habitat capability, by not allowing more than 15% reduction in local (within 2 mile radius or less of the center of any proposed project) habitat capability, for:
   Mt. Graham red squirrel
   black bear
   Arizona trout
   buff-breasted flycatcher
   and other identified species
   Follow guidelines or
   approved species recovery plans and memoranda of understanding.

2. Maintain horizontal and vertical plant diversity to improve old growth and cienega quality in coordination with existing or future recovery plans.

3. Delist threatened and endangered species and reoccupy historical habitat with other identified species following guidelines of approved recovery plans and memorandums of understanding. Also improve habitat for federally listed plants and animals following these same guidelines.

4. Reforest existing fuelbreaks and clearcuts to increase habitat for high vegetative density dependant species including the Mt. Graham red squirrel.

5. Monitor squirrel populations and habitats annually through intensive inventory and analysis.

Range Management 0 & M (DU 16)	D02, D06	Manage rangeland at level A (no livestock). Management excludes livestock grazing except for recreational animals to protect other values or eliminate conflicts with other users.

Timber Sale Preparation & Administration (DU 19, 21)	E06 E07, 478, 479	1. Within the ZBA and astrophysical restricted area, removal of vegetation is limited to research and educational activities under permit, sanitation and salvage operations, and maintenance and improvement of wildlife habitat and visual quality. 2. Any timber harvest activities with appropriate stand examinations will be done only to benefit specific wildlife or recreation values after consultation with appropriate parties, e.g. U.S. Fish and Wildlife Service, Forest biologist, and Arizona Game and Fish Department.
Watershed & Soil Maintenance & Improvements (DU 33, 34) (DU 45, 46)	F05, F03 F06, K06 552, 553	1. Maintain satisfactory watershed condition. 2. Watershed maintenance and improvement may consist of channel work (including debris clearing and structures) and revegetation (seeding and/or planting) using native species. Additionally in the astrophysical restricted use area, contour structures including earth structures (such as dikes), trenches, and felled trees may be used. 3. Watershed restoration within wilderness may consist of channel stabilization (including debris clearing and structures) and revegetation (seeding and planting). Nonnative species will be used only in emergency situations when suitable native species are not available. Watershed restoration within the dispersed recreation area may consist of channel stabilization (including debris clearing and structures), and revegetation (seeding and planting) using native or nonnative species. 4. Manage all programs to eliminate or minimize onsite and downstream water pollution. Wastewater (sewage and gray water) will be handled with approved septic tank/drain field systems. During construction phases, areas would be cleared only for construction planned for in that year. All toxic waste chemicals and materials will be hauled off the Forest to a suitable treatment or disposal facility. Garbage and trash will be hauled off Forest to a suitable disposal site. Topsoil will be stockpiled and redistributed to provide a fertile base, and slopes will be revegetated with native species. Cut material (soil and rock) from construction not used as fill or for revegetation will be hauled off the Forest to a suitable disposal site. Construction and operation activities would not be allowed within the cienega watersheds except in the widening and improving of FR 507.

		5. All domestic and construction water needed on site would be hauled from City of Safford's Deadman Canyon water supply or other locations off the Forest.
		6. The current character of the cienegas will be maintained (including annual free water fluctuations, channel characteristics, water quality, and composition and density of riparian vegetation). Surface water flows will not be diverted or impounded within the cienegas.
Minerals Management (DU 36)	G07	1. Common materials may be removed for the purpose of meeting other management objectives except within wilderness or zoological/botanical areas.
		2. Recommend withdrawal from mineral entry and mineral leasing on all 3,500 acres to protect essential habitat for Federal and State listed threatened and endangered species, recreational opportunities and recreation/astrophysical facility investments.
Special Use Management (DU 41)	J01	1. Allocate 130 acres of land on and around High Peak for astrophysical use. Seven acres will be for exclusive astrophysical use while 123 acres will be classified for restricted use by the public. Five telescopes could be developed: the 10-meter submillimeter telescope (SMT), Texas 5-meter, Arizona/Ohio Large Optical/IR, Vatican Observatory Advanced Technology 1.8-meter Telescope (VATT) and one large optical/IR telescope.
		2. Restrict only those uses necessary for safety and to protect the quality of observations and the environment. Public use restrictions are shown under recreation management.
		3. Astrophysical support facilities, dormitory and/or visitor center, will be located off forest. Astophysical support facilities located on Forest: generator building, Texas support building, equipment garage, meteorological tower/communications building, shop area, site engineer's residence, water storage tanks, and helicopter landing pad (approximately 350 square feet for emergency use only).
		4. All astrophysical development will conform with the total required facilities concept (allocation for the minimum area that would be needed for facilities and still meet the need of the special use applicant FSM 2728.22c).
		5. On Forest the powerline will be buried. Steward Observatory will provide electric power to Columbine Administrative Site.

Road & Trail Maintenance (DU 48, 50)	L19	1. Forest Road 507 will remain unpaved but will be widened to an average of 16 feet with an average curve radius of 22 feet and maintained at Level 4. See Glossary "road maintenance". Steward Observatory will bear all associated costs with the maintenance and widening of FR 507. 2. Dust abatement could be accomplished near telescope facilities using materials agreed to by the Forest Service. 3. Trails will be maintained at level 3. See Glossary "trail maintenance". 4. The trailhead at High Peak will be restricted at night to walk-in access only. 5. Snowplowing provided by Steward Observatory will keep Swift Trail (State Highway 366) and FR 507 open for limited access such as in level 2 road maintenance. Generally access will not be suited for passenger vehicles. Tire chains and/or four-wheel drive would be required above the snowline. 6. Close. drain and revegetate all unneeded spur roads as they are identified. Funding will be provided by Steward Observatory to reroute FR 507 to avoid the "wall" at mile post 3.6. The "wall" will be put to bed and revegetated.
Fire & Fuels Management (DU 56, 57)	P08, PO9 P12, P14 P15, P16	1. Steward Observatory would be notified of schedule, size, and location of all prescribed fires in the Pinaleno Mountains. 2. The management area is within fire suppression zone 1. (See Glossary "Fire Zone 1"). 3. Within foreground distance zones of sensitivity level 1 and 2 (trails, roads, and use areas) require 100% treatment of all construction slash.
Insect & Disease Management	P34, P35 P36	1. Within the wilderness, outbreaks of insects or disease will be controlled using integrated pest management concepts when there is a clear and imminent danger to timber or other values outside wilderness. 2. Outbreaks of insects or disease will be controlled using integrated pest management concepts when there is a significant danger to the recreation uses, unique vegetation or wildlife species, or there is a threat to other uses outside the zoological/botanical area. 3. On all other areas, monitor for insect and disease outbreaks. Where opportunities exist, attempts will be to reduce or prevent damage from insect and disease using integrated pest management techniques and concepts.

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