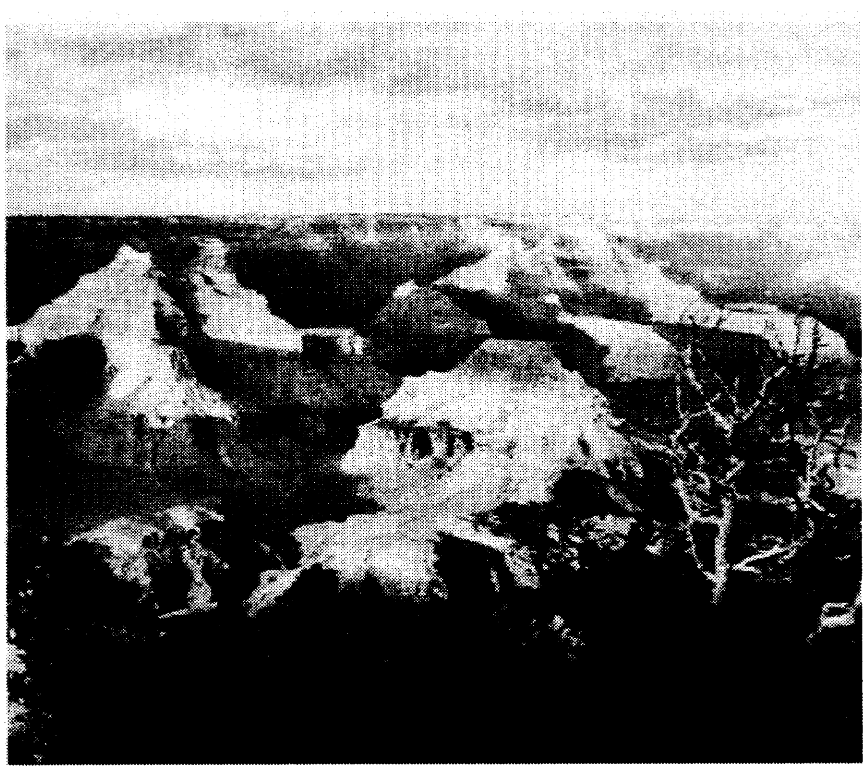
Supplemental
Environmental Assessment
June 1999

Special Flight Rules in the Vicinity of Grand Canyon National Park



Prepared For

U. S. Department of Transportation
Federal Aviation Administration

DRAFT

Supplemental Environmental Assessment

Special Flight Rules in the Vicinity of Grand Canyon National Park

The Federal Aviation Administration (FAA), as lead agency, with the National Park Service and the Hualapai Indian Tribe as cooperating agencies prepared this Draft Supplemental Environmental Assessment (DSEA). The DSEA was prepared pursuant to the National Environmental Policy Act (NEPA) of 1969 as amended, FAA Order 1050.1D, `Policies and Procedures for Considering Environmental Impacts', Section 106 of the National Historic Preservation Act, Section 7 of the Endangered Species Act, and other applicable laws and regulations.

In February 1999 (64 FR 6131, February 8, 1999) the FAA advised the public of its intent to prepare this DSEA. The DSEA assesses the effects of proposed actions by FAA and the Department of the Interior to assist in the substantial restoration of natural quiet in the Grand Canyon National Park (GCNP) in accordance with Public Law 100-91.

The FAA, issued proposed rulemaking that: (1) limit the number of commercial air tours in the Special Flight Rules Area (SFRA) in the vicinity of GCNP; and, (2) establish new and modify existing airspace in the SFRA. Additionally, the FAA issued a Notice that establishes new and modifies existing air tour routes for commercial air tour aircraft in the SFRA. These actions, issued concurrently with this DSEA, represent the proposed actions analyzed in this environmental document.

The FAA has determined that it will be in the public interest to open the comment period to allow interested persons the opportunity to comment on the DSEA. Consequently, the public has sixty days from issuance of this DSEA to comment on the assessment of the effects from the proposed actions as contained herein.

John S. Walker
Program Director for Air Traffic Airspace Management (ATA-1)

JUL - 2 1999
Dated

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Grand Canyon Map

June, 1999

ERRATA SHEET

The route labeled BDN is not Blue Direct North. It is Blue Direct. The route was labeled in error.

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Chapter One
BACKGROUND AND PROPOSED ACTION

This chapter provides a brief background of the Proposed Actions previously analyzed and environmental documentation that has been accomplished by the Federal Aviation Administration (FAA) in cooperation with the Department of the Interior (DOI) concerning rulemaking and commercial air tour route modifications proposed as next steps to substantially restore natural quiet to the Grand Canyon National Park (GCNP) as mandated by Pub. L. 100-91. A complete regulatory history of the need for restoration of natural quiet to GCNP is found in the December 1996 Environmental Assessment Special Flight Rules in the Vicinity of Grand Canyon National Park (Final EA). Additionally, this chapter summarizes the purpose and need for substantial restoration of natural quiet to the GCNP and the federal actions being proposed at this time. This environmental assessment supplements the Environmental Assessment prepared for the December 1996 Final Rule and the Written Reevaluations prepared for the May 1997 Notice of Proposed Rulemaking for Flight Corridors and the October 1997 Notice of Clarification.

Appendices A through I provide detailed technical background and results, as well as a record of consultation with Native American Tribes and the Distribution List for this document. Endnotes are provided just prior to the appendices.

1.1 BACKGROUND

On December 31, 1996, the FAA published a final rule amending Part 93 of the Federal Aviation Regulations by adding a new subpart to codify the provisions of Special Federal Aviation Regulation No. 50-2, Special Flight Rules in the vicinity of GCNP. This new subpart modified the dimension of the GCNP Special Flight Rules Area (SFRA); established new and modified flight free zones; established new and modified existing flight corridors; established reporting requirements for commercial air tour operators in the SFRA; established fixed flight free time periods for commercial air tour operations (also known as sightseeing operations) in Zuni Point and Dragon corridors during certain time periods (curfews); and limited the number of aircraft that could be used for commercial sightseeing operations in the GCNP Special Flight Rules Area (SFRA). Each operator was limited to the highest number that it had used between July 31 and December 31, 1996 (61 FR 69302). The provisions contained in the final rule were to become effective on May 1, 1997.

Published concurrently with the final rule on December 31, 1996, was a Notice of Proposed Rulemaking (NPRM) on noise limitations for aircraft operations in the vicinity of GCNP (Noise Limitations/Quiet Technology NPRM) and Notice of Availability of Proposed Commercial Air Tour Routes. The Noise Limitations/Quiet

Technology NPRM was a transition to quiet air tour aircraft technology. It proposed to define air tour aircraft in terms of "noise efficiency" or noise per passenger seat, rank aircraft in noise efficiency categories, phase out operations over time, beginning with the noisiest, provide for incentives for the use of the most noise efficient aircraft. It also proposed to establish the temporary cap for the most noise efficient aircraft, and a "National Canyon Corridor" for such aircraft on an altered proposed route Blue 1A. A Draft Environmental Assessment was issued for public comment until March 31, 1997, along with the Noise Limitations NPRM. All three of the above referenced actions comprised an overall strategy to assist the NPS in achieving its statutory mandate, imposed by Public Law 100-91, to provide for substantial restoration of natural quiet and enhance the visitor experience in GCNP. The FAA estimated that, if the Noise Limitations rule was adopted, 57.4 percent of the Park would experience natural quiet for at least 75 percent of each day by the year 2008.

During the comment period on the Notice of Availability of Proposed Commercial Air Tour Routes, the FAA received valuable information from comments, as well as suggestions for alterations and refinements of the route structure, from officials of the GCNP and National Park Service (NPS) that could potentially produce noise reduction benefits and also address other related impacts. Both the FAA and the DOI concluded that a number of the suggested changes could produce a significantly better rule for GCNP users, the aviation operators, and interested Native American tribes. The FAA determined that permitting the complete final rule to become effective on May 1, 1997, would be contrary to the public interest.

On February 21, 1997, the FAA published another final rule that delayed the implementation of certain sections of the final rule. Specifically, the effective date of the Flight Free Zones (FFZ), flight corridors, and Special Flight Rules Area was delayed until January 31, 1998. FAA also reinstated and extended the expiration date of certain portions of SFAR 50-2 (62 FR 8861; February 26, 1997). The curfew on operations in Dragon and Zuni Corridors on the east end of the GCNP, the cap on the number of aircraft, and the reporting requirements were not affected. These actions were implemented on May 1, 1997.

May 1997 Corridors NPRM and Revised Air Tour Routes

On May 12, 1997 (62 FR 38233; May 15, 1997), the FAA issued a Notice proposing to modify two FFZs within GCNP with two corridors through the FFZ. The FAA also issued a revised Notice of Availability of Proposed Commercial Air Tour Routes. The first corridor, through the Bright Angel flight free zone, would be used for the most noise efficient aircraft only. The second corridor, through the Toroweap/Shinumo flight free zone over the National Canyon area of the GCNP, would be for the most noise efficient aircraft for westbound traffic after December 31, 2001. This corridor was developed to address the concerns of the Havasupai Tribe regarding potential impacts on cultural sites, should the corridor be implemented as proposed in December 1996. The revised National Canyon corridor was designed to continue to provide a viable air tour route through the center of the canyon (Blue 1A), yet in a location and manner that would minimize potential impacts on Supai Village and Havasupai cultural sites.

To evaluate the potential impacts of the NPRM, FAA prepared a Written Reevaluation of the December 1996 Final EA. Based upon this Reevaluation, the conclusions of the FONSI were found to be substantially valid and no EA supplementation was required.

On July 10, 1998 (63 FR 38233; July 15, 1998), the FAA, in consultation with NPS, withdrew this NPRM because the agencies determined not to proceed with a commercial air tour route in the vicinity of National Canyon and to consider other alternatives. This was in part due to concerns about substantial restoration of natural quiet. In addition, the FAA amended the Noise Limitations NPRM to withdraw the portions in which the FAA had first proposed a National Canyon Corridor (63 FR 38232; July 10, 1998).

October 1997 Notice of Clarification

Based on initial surveys of air tour operators as well as operations specifications, the FAA had determined that the cap on aircraft in the December 1996 final rule would permit approximately 136 aircraft to operate within the area covered by flight restrictions.

After the final rule was published, however, the FAA obtained additional data showing that it had underestimated the number of eligible air tour operators. During May 1997, the FAA, therefore, conducted a survey of air tour operators and visited sites to identify in detail the number and type of aircraft engaged in GCNP air tours in 1996.

To confirm the May 1997 survey aircraft count, reconcile the May survey results with the 1995 survey, and obtain more comprehensive data about numbers of air tours conducted in 1995, the FAA conducted a follow-up site visits with each GCNP air tour operator in July 1997.

The FAA then reevaluated the economic analysis and, for a second time, reevaluated the environmental analysis completed for the final rule and published its results in a notice of clarification and request for comments (62 Fed. Reg. 58, 898; October 31, 1997). Incorporating the newly obtained information, the FAA estimated that in 1995, the same 31 GCNP air tour operators flew nearly 103,000 air tours, utilizing at least 260 aircraft and carrying over 821,000 passengers. By comparison, the estimates originally reported in the regulatory evaluation of the Final Rule were 70,000 air tours, 136 aircraft, and approximately 655,600 passengers. The new data increased the estimated costs of the Final Rule from $42 to 47 million and reduced the estimated benefits from $172 to 144 million over the period 1997-2008.

The new data led the FAA to reconsider its assumptions about the effectiveness of the cap on aircraft to limit growth by most air tour operators to meet demand. The new data did not otherwise affect the validity of the noise and air quality analyses in the December 1996 Final EA. The analyses depended on the number of flights, not aircraft. The 1997 surveys also revealed the potential for five daily operations on the Black 4 route and six daily operations on the Black 5 route in the Marble Canyon area. The October 1997 Written Reevaluation of environmental impacts indicated that, even after considering the revised estimate of the number of aircraft operating in the Park, the final rule will substantially restore natural quiet in 41.7 percent of the Park. With unconstrained growth, the area of the Park to which natural quiet has been substantially restored would decrease to 34.2 percent in 2008. The FAA determined that, although the new information changed the environmental analysis, the changes did not warrant modification of the final rule. Although the eligibility of a greater number of aircraft, 260 aircraft rather than 136, to operate would cause the final rule to be less effective in achieving substantial restoration of natural quiet over time, the Final Rule still represented progress toward that end. The FAA concluded that the Noise Limitations rulemaking and finalization of the air tour routes, when completed, would result in attainment of the statutory goal (62 Fed. Reg. 58900, 58 905). However, FAA and NPS agreed to delay the final route selection so that further review and discussions could be undertaken on the route through proposed National Canyon Corridor.

Public Meeting in Flagstaff, AZ

On April 28, 1998, the FAA met with a panel comprised of representatives of affected parties to attempt to recommend and further define the routes and corresponding airspace before FAA proceeded with rulemaking. The FAA presented a tentative route through the Sanup FFZ for consideration (63 FR 18964; April 16, 1998). The affected parties, however, were unwilling to consider the routes as distinct from other actions, particularly prior to a ruling by the court in Grand Canyon Air Tour Coalition v. FAA.

Grand Canyon Air Tour Coalition v. FAA

In early 1997, seven environmental groups led by the Grand Canyon Trust, air tour operators, local government entities, and the Hualapai Tribe filed a lawsuit challenging the December 1996 final rule in the U.S. Circuit Court for the District of Columbia. The case was argued on November 6, 1997. During oral argument, the Court suggested that that air tour operators might be willing to comply in good faith with a limitation on the number of air tour operations. In a decision dated September 4, 1998, the U.S. Circuit Court of Appeals for the District of Columbia deferred to the judgment and technical expertise of the FAA in certain areas and determined that the challenges in other areas were not ripe in light of the phased nature of FAA's proposed solution to the problem of aircraft noise. Grand Canyon Air Tour Association v. FAA, 154 F.3d 455 (DC Cir. 1998).

The Court held that the way the agencies defined the term *natural quiet* and *substantial restoration of natural quiet* satisfied the National Park Overflights Act. The Court specifically relied upon FAA's assurances in rejecting the argument of the Grand Canyon Trust that issuing a rule that does not contemplate achievement of Congress' goal for ten years was inherently unreasonable. The Court indicated that it would take the Federal Government at its word that it still anticipates meeting the goal of substantial restoration by 2008 by using the Noise Limitations rule and the route structure to make up the gap in 2008 that results from the new data on number of aircraft. FAA also advised the Court that it would consider a cap on overflights.

Effective Date of Certain Portions of the Final Rule Delayed Until January 31, 2000

Pending finalization of new routes, on December 17, 1997, the FAA took action to delay implementation of the FFZs, flight corridors, and SFRA and to extend portions of SFAR 502 until January 31, 1999 (62 FR 66248). On December 7, 1998, the FAA again took action to delay implementation of the above mentioned sections and to extend certain portions of SFAR 50-2 until January 31, 2000 (63 FR 67544).

1.2 PURPOSE AND NEED

The purpose and need of this action is to assist NPS in achieving the statutory mandate imposed by Pub. L. 100-91 to provide for the substantial restoration of natural quiet and enhance the visitor experience in GCNP. The FAA recognizes the need to accommodate air tours to the extent that such operations are consistent with the essential values of the GCNP. The study area relating to this objective is shown in **Figure 1-1.**

"[S]ubstantial restoration of natural quiet" has been defined by the NPS to mean "that 50 percent or more of the park achieve 'natural quiet' (i.e., no aircraft audible) for 75 to 100 percent of the day."[1] Natural quiet refers to the natural ambient sound conditions found in parks, referring to the absence of mechanical noise but accepting the non-mechanical "self-noise" of visitors (i.e., talking, walking, etc.). Using this definition, the NPS concluded that substantial restoration of natural quiet could not be achieved with provisions of the May 1988 Special Federal Aviation Regulation (SFAR) 50-2. The revisions to the SFAR 50-2 thus far have not achieved substantial restoration of natural quiet to GCNP. Although improvements have been made, they have been eroded by the growth of the air tour industry during that time. **Figure 1-2** illustrates the projected increase in aircraft noise levels through the year 2008 without additional revisions to SFAR 50-2 as amended in December 1996.

1.3 CONSULTATION AND SCOPING

On February 3, 1999 the FAA initiated scoping for this Supplemental EA (FR 6131, February 8, 1999). The comment period ended March 5, 1999. The FAA received twenty comments during the scoping period. The scoping comments are summarized in Appendix G. The major comments included concern the viability of air tour routes through the center of the Canyon, proposed commercial air tour limitations, the air tour routes proposed, ability to achieve substantial restoration of natural quiet, and the implementation of quiet technology aircraft. The comments were considered in the development of this Supplemental EA.

The NPS is a cooperating agency in preparing this Supplemental EA. In addition, the FAA invited Native American Tribes with adjacent reservations and ancestral ties to the Grand Canyon to participate as cooperating agencies. The Hualapai Tribe expressed an interest and have provided comments. A draft cooperating agency agreement with the Hualapai Tribe is being prepared.

In their comments the Hualapai Tribe defined protection of the resources of the Grand Canyon from adverse impacts of aircraft overflights for the purpose of Pub. L. 100-91 as the absence of significant impact on or impairment of the environment and uses of the Grand Canyon outside of the GCNP from aircraft overflights.

As the proposed and alternative commercial air tour routes overfly Tribal lands adjacent to and outside the GCNP, the study area for this Supplemental EA includes the entire SFAR 50-2. The study area is shown in Figure 1-2.

The mandate of the Overflights Act does not extend to areas of the Grand Canyon located outside the boundaries of the GCNP. Although the scope of the mandate is limited to the GCNP, the FAA recognizes its responsibility under applicable environmental laws to consider impacts on potentially affected resources outside the GCNP.

1.4 PROPOSED ACTION

The Proposed Action is the same as described in the Final EA and amended in the May 1997 Reevaluation and the October 1997 Notice of Clarification. However, it has been further refined to consider concerns expressed by interested parties. The Final EA Proposed Action modified the dimension of the GCNP SFRA, established new and modified existing flight free zones, established new and modified existing flight corridors, established reporting requirements for commercial sightseeing companies operating in the SFRA, established a curfew, and limited the number of aircraft that can be used in commercial sightseeing operations in the GCNP SFRA. The May 1997 Reevaluation analyzed the development of two corridors through established FFZs (National Canyon and Bright Angel Corridors) and the commercial air tour routes as described in the 1996 Notice of Availability of Proposed Commercial Air Tour Routes and modified in May 1997. The Notice of Clarification evaluated further minor modifications in the commercial air tour routes considered in May 1997, and differences between the numbers of operations modeled in the Final EA and May 1997 Reevaluation and the operations surveyed at the GCNP in July 1997. This supplemental EA will consider the December 1996 Final Rule, and the following proposed actions: June 1999 Notice of Availability of Proposed Commercial Air Tour Routes, the June 1999 NPRM Modification of the Dimensions of the GCNP SFRA Airspace and FFZs, and the NPRM to limit commercial air tour operations:

- Modification of the eastern portion of the SFRA and the Desert View FFZ to address concerns raised by Native Americans.

- Modification of the Sanup FFZ to provide for a planned revision to a commercial route over the northwestern section of the GCNP.

- Provision of an additional commercial route over the northern section of the Sanup plateau for those aircraft transiting between Las Vegas, Nevada and Tusayan, Arizona.

- Limitation on the number of commercial air tour aircraft in the SFRA and revision of the reporting requirements for commercial air tours in the SFRA.

Except for the air tour routes eastward from Las Vegas to Tusayan, expansion of the Desert View FFZ, and the elimination of incentive corridors through National Canyon, the Proposed Action in this Supplemental EA is similar to the Proposed Action analyzed in the December 1996 Final EA, as reevaluated in May 1997 and October 1997.

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Study Area

FIGURE 1-1

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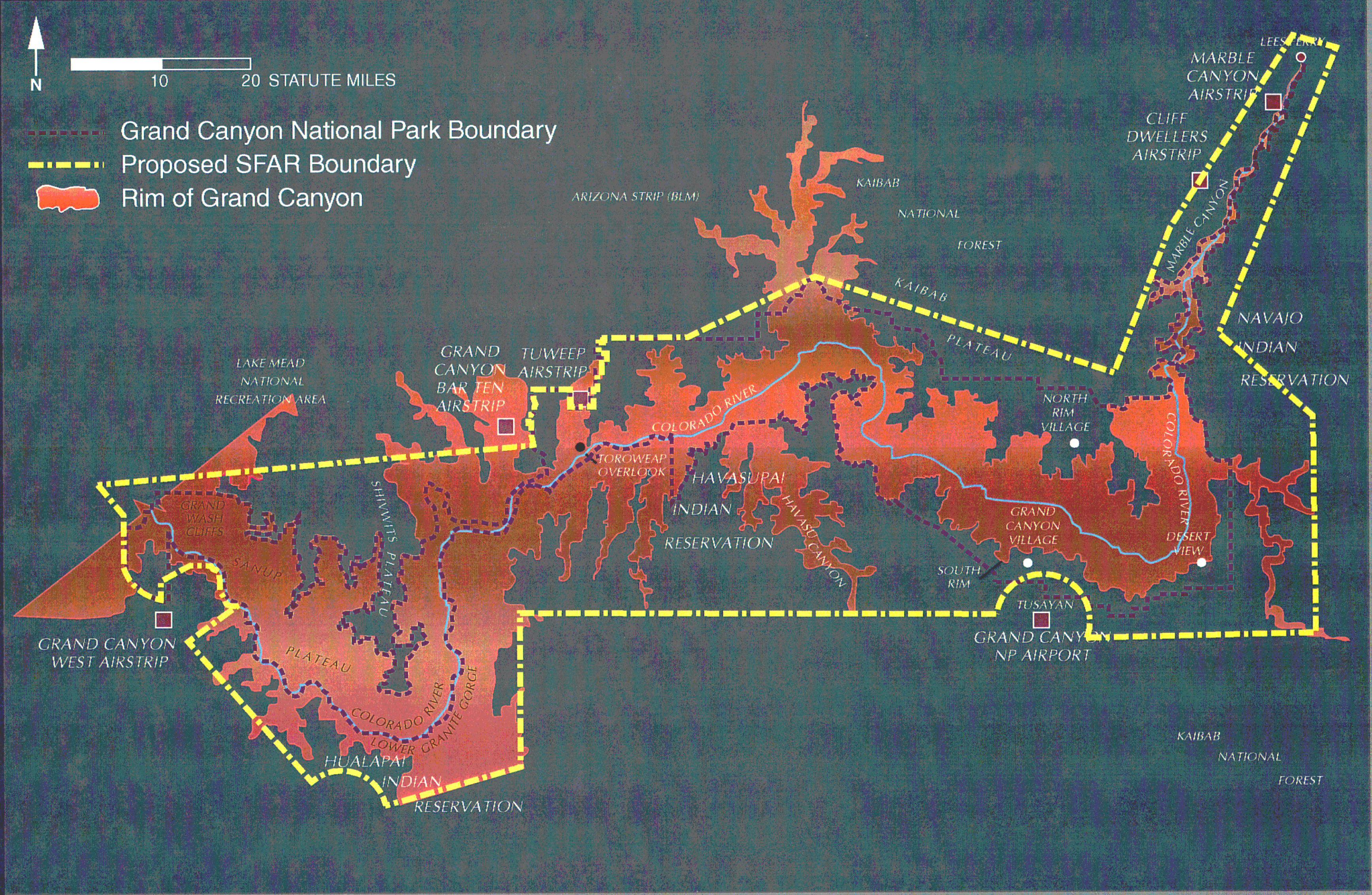

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No Action Projected Increase in Aircraft Noise Levels

FIGURE 1-2

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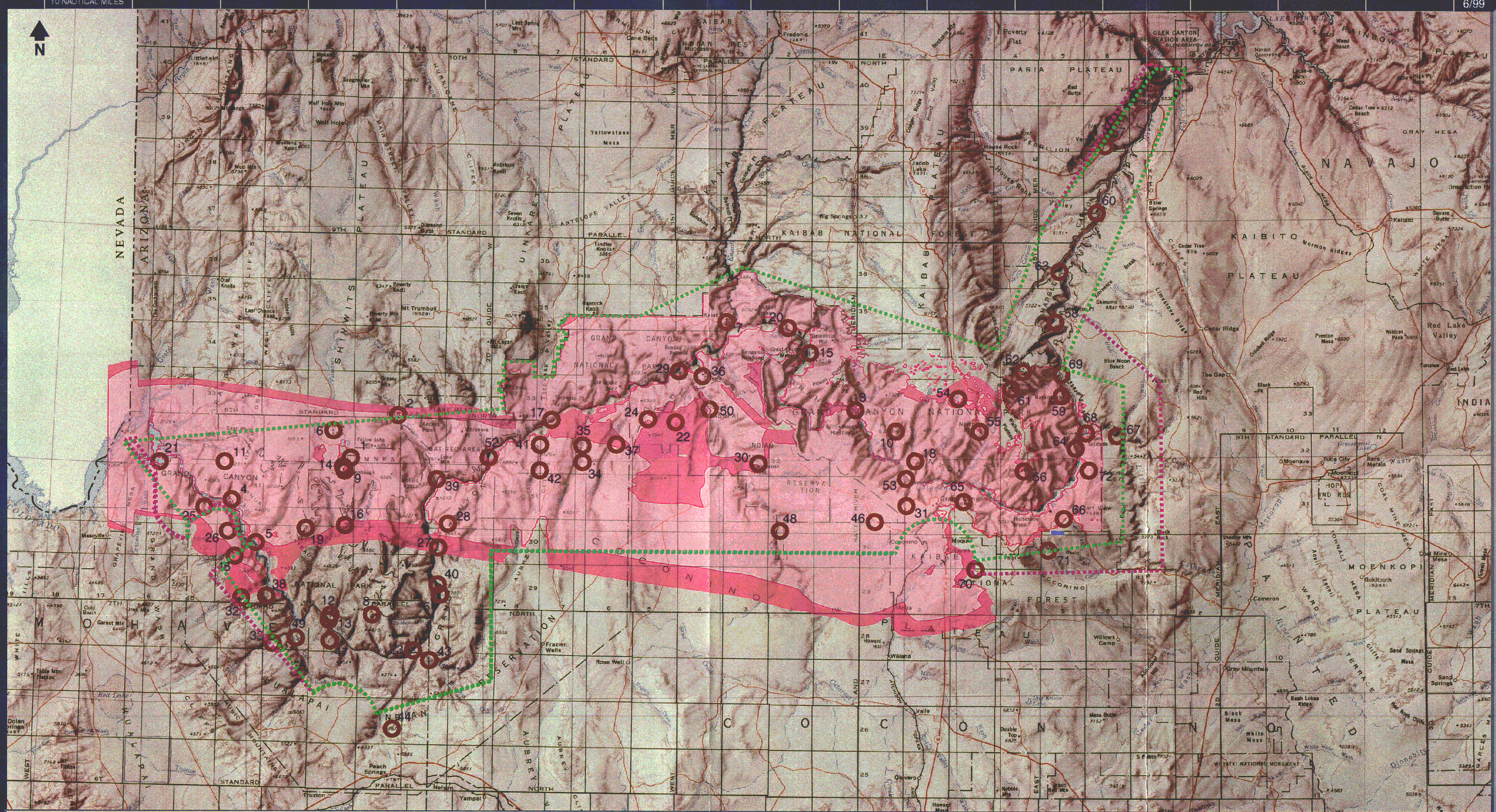


Existing SFAR Boundary (No Action)

Proposed SFAR Boundary

Representative Locations

1998 No Action - Aircraft Audible More Than 25% of the Time

2008 No Action - Aircraft Audible More Than 25% of the Time

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Chapter Two
ALTERNATIVES

Since 1995 the FAA and NPS, in consultation with Native American tribes living in or associated with the Grand Canyon and other interested parties, have been working to develop and refine alternatives that meet the statutory mandate to substantially restore natural quiet to the GCNP. This chapter summarizes previously studied alternatives as identified in the December 1996 Final Rule and Final EA, the May 1997 Written Reevaluation and the October 1997 Notice of Clarification, provides a history of route alternatives considered since May 1997, and lastly sets forth a description of the alternatives recommended for consideration within this document.

This Supplemental EA evaluates the environmental effects of maintaining the current airspace structure with the existing commercial air tour routes (No Action alternative) and three potential alternatives. These alternatives include modification to the Special Flight Rules Area (SFRA) boundary, modification to flight corridors and flight-free areas (FFZ)s, and three differing commercial air tour route alternatives. The alternatives are considered with or without implementing a limitation on the number of commercial air tours operating in the study area. A detailed description of the alternatives considered in this document is contained in Section 2.3. FAA Order 1050.1D, Policies and Procedures for Considering Environmental Impacts[2] provides guidance in assessing alternatives per NEPA and Council on Environmental Quality (CEQ) regulations.

Based on this Supplemental EA, the FAA will determine whether a finding of no significant impact may be issued or that an environmental impact statement is required.

2.1 PREVIOUSLY CONSIDERED ALTERNATIVES

This section provides descriptions of the alternatives considered within three progressive environmental documents that analyzed the potential environmental impacts associated with modifying SFAR 50-2 as established in 1988 (53 FR 20264, June 2, 1988). All previously proposed alternatives where compared to maintaining the existing airspace regulations over the Grand Canyon as described in SFAR 50-2.

Final Rule and Final EA December 1996

The Proposed Action alternative amended Part 93 of the Federal Aviation Regulations by adding a new Subpart U that codifies and amends the provisions of SFAR 50-2 as follows:

- Modified the dimensions of the Grand Canyon National Park SFRA and raised the altitude of this controlled airspace to 17,999 feet MSL.
- Established new and modified existing flight-free zones by expanding the Bright Angel and Desert View FFZs, merging the Shinumo and Toroweap/Thunder River FFZs into one FFZ, and creating a new Sanup FFZ.

- Established new and modified existing flight corridors, by modifying the Zuni Point and Dragon Corridors, and eliminating the Fossil Canyon Corridor.

- Established fixed flight-free periods (curfews) for commercial sightseeing operations departing from Grand Canyon Airport as follows:

  1. Summer season (May 1-September 30) 6 p.m. to 8 a.m. daily.

  2. Winter season (October 1-April 30) 5 p.m. to 9 a.m. daily.

- Established minimum sector altitudes as follows:

  1. Commercial sightseeing flights.

     (a) <u>North Canyon Sector.</u> Lees Ferry to North Canyon: 5,000 feet MSL.

     (b) <u>Marble Canyon Sector.</u> North Canyon to Boundary Ridge: 6,000 feet MSL.

     (c) <u>Supai Sector.</u> Boundary Ridge to Supai Point: 7,500 feet MSL.

     (d) <u>Diamond Creek Sector.</u> Supai Point to Diamond Creek: 6,500 feet MSL.

     (e) <u>Pearce Ferry Sector.</u> Diamond Creek to the Grand Wash Cliffs: 5,000 feet MSL.

  2. Transient and general aviation operations.

     (a) <u>North Canyon Sector.</u> Lees Ferry to North Canyon: 8,000 feet MSL.

     (b) <u>Marble Canyon Sector.</u> North Canyon to Boundary Ridge: 8,000 feet MSL.

     (c) <u>Supai Sector.</u> Boundary Ridge to Supai Point: 10,000 feet MSL.

     (d) <u>Diamond Creek Sector.</u> Supai Point to Diamond Creek: 9,000 feet MSL.

     (e) <u>Pearce Ferry Sector.</u> Diamond Creek to the Grand Wash Cliffs: 8,000 feet MSL.

- Established minimum corridor altitudes as follows:

  1. Commercial sightseeing flights.

     (a) <u>Zuni Point Corridor.</u> 7,500 feet MSL.

     (b) <u>Dragon Corridor.</u> 7,500 feet MSL.

  2. Transient and general aviation operations.

     (a) <u>Zuni Point Corridor.</u> 10,500 feet MSL.

     (b) <u>Dragon Corridor.</u> 10,500 feet MSL.

     (c) <u>Tuckup Corridor.</u> 10,500 feet MSL.

- Capped aircraft used for sightseeing in the SFRA to those that were in service after July 31, 1996.

On February 21, 1997, the FAA issued a final rule that delayed the implementation of certain sections of the December 31, 1996 final rule (62 FR 8862; February 26, 1997).

Specifically, this action delayed the effective date, until January 31, 1998, of those sections for the rule that address the SFRA, FFZs, and flight corridors, respectively §§ 93.301, 93.305, and 93.307. In addition, certain portions of SFAR No. 50-2 were reinstated and the expiration date extended. With the goal to produce the best commercial air tour routes possible, implementation was delayed to allow the FAA and the DOI to consider comments and suggestions to improve the proposed route structure. The curfew, aircraft cap, and reporting requirements of the final rule went into effect on May 1, 1997.

May 1997 Written Reevaluation

Comments received on the Notice of Availability of Proposed Commercial Air Tour Routes (December 1996) and the NPRM on Noise Limitations for Aircraft Operations in the Vicinity of the Grand Canyon National Park prompted the FAA to amend two of the FFZs within the GCNP by establishing two corridors and modifying some routes (also referred to as the 1997 Proposed Action commercial air tour routes). The incentive corridors in the Noise Limitations NPRM were the subject of the May 1997 Written Reevaluation of the Final EA.

A description of the proposed corridor and commercial air tour routes that modify or differ from the Final EA Proposed Action alternative which were analyzed in the Written Reevaluation follows:

Bright Angel FFZ. The first corridor, through the Bright Angel FFZ, would be an incentive corridor to be used only by the most noise efficient aircraft. For purposes of the May 1997 Written Revaluation the noise efficient aircraft were defined in the December 1996 NPRM. The most noise efficient aircraft are identified as Category C. This proposed corridor would pass through the Bright Angel FFZ along the northern boundary of the current Bright Angel FFZ as defined in SFAR 50-2. The proposed Bright Angel Corridor would have a three-fold benefit. First, fewer aircraft would be flying over the northern rim of the canyon along Saddle Mountain, where the NPS has pointed out some noise sensitivity. Second, noise from the air tour aircraft would be dispersed between the northern boundary of the new Bright Angel FFZ and the proposed corridor, thereby reducing the level of concentrated aircraft noise along any one route. Third, opening this corridor only to the most noise efficient aircraft would provide a valuable and tangible incentive for the air tour operators to convert to quieter aircraft well before they are required to do so. The GCNP could thereby experience the benefit of an earlier reduction in the level of aircraft noise.

Toroweap/Shinumo FFZ. The second corridor, through the Toroweap/Shinumo FFZ and referred to as the National Canyon Corridor, would go through the National Canyon area and would create a viable commercial air tour route through the central section of the Park while addressing concerns of the Native Americans. This corridor was revised from that proposed in the December 1996 NPRM for Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park. The proposed corridor would not affect the existing Tuckup Corridor currently used by general aviation. All aircraft would be permitted to use the National Canyon Corridor until December 31, 2001, after which time westbound traffic would only be permitted to traverse the corridor in Category C aircraft.

The following summarizes the changes considered to the National Canyon Corridor before the proposal was withdrawn.

- First, the corridor would feed into an altered proposed route that is shorter than that previously proposed in the Notice of Availability of Proposed Air Tour Routes for GCNP in December 1996. By eliminating the portion of the route north of Supai Village, the corridor would eliminate air tour flights around Supai Village, the home of the Havasupai Tribe, and minimize and/or avoid increased overflights of the vast majority of their traditional cultural properties (TCPs). It would also minimize socioeconomic impacts to their economy which is based heavily on tourism which in turn is based on the isolated and natural character of the northern part of the reservation.

- Second, the redefined corridor would traverse a much smaller segment of the Toroweap/Shinumo FFZ than the corridor proposed in the December 1996 Noise Limitations NPRM. While the corridor proposed in the May 1997 NPRM would be open to all aircraft until December 31, 2001, rather than only the most noise efficient aircraft as in the previous proposal, the overall effect of aircraft noise would be lessened by routing air traffic over less frequently used, less noise-sensitive areas. The FAA believed that permitting only the most noise efficient aircraft to be used in westbound traffic of the National Canyon Corridor after December 31, 2001, would further reduce noise in the corridor.

- Third, this proposal would permit the establishment of a viable commercial air tour route in the central region of the GCNP, which would be available to all aircraft. The operators informed the FAA that the Blue One route, as depicted on the chart referenced in the December 31, 1996, Notice of Route Availability, would not be a viable air tour, and that the proposed Blue One Alpha route was an example of a viable commercial air tour route. This proposal would avoid the economic harm which otherwise could be expected to accrue to air tour operators should they be deprived of a viable commercial air tour route through the central region of the GCNP.

- In addition, the proposed commercial air tour route over the central region of the park, open to all aircraft, would promote air safety. Subsequent to the December 1996 Notice of Route Availability, air tour operators advised that if there were not a viable commercial air tour route in the central region of the GCNP, they would divert their operations to the routes south of the Sanup FFZ. FAA believed this would result in compression of traffic and potentially unsafe operating conditions. Opening the corridor would enhance air traffic safety by removing a factor that could lead to compression of traffic in the routes south of the Sanup FFZ.

These two corridors were in response to comments received on the Grand Canyon rulemaking action and the December 1996 Notice of Route Availability, a preliminary FAA evaluation assessing the environmental merit of such routes pursuant to these comments, and ongoing discussion with Native American tribal government units and their representatives. The 1997 Proposed Action commercial air tour routes were subsequently revised from the routes modeled in the Final EA to accommodate the proposed new corridors and Native

American concerns about impacts on cultural resources.

October 1997 Notice of Clarification

The Notice of Clarification Final EA Proposed Action evaluated further minor modifications in the commercial air tour routes considered after the May 1997 Written Reevaluation with operational levels surveyed at the GCNP in July 1997. The Notice of Clarification applied a new annual operational growth and redefined operational levels on several of the commercial air tour routes. Several sensitivity analyses where modeled for changes to operations on individual tracks and an earlier turn was assumed for traffic on two the return tracks to Las Vegas. Additionally, two route change alternatives were analyzed: a conservative assumption regarding the turn around routes in the Sanup area (turn around at Diamond Creek); and the National Canyon Corridor route was adjusted in attempt to further mitigate Native American concerns.

On December 17, 1997, the FAA took action to further delay the implementation of the SFRA, FFZs and flight corridor changes proposed in the December final rule until January 31, 2000 (62 FR 66248). Again, it should be noted that these actions did not affect or delay the implementation of the curfew, aircraft cap, or reporting requirements of the rule, which were effective May 1, 1997.

2.2 COMMERCIAL AIR TOUR ROUTE ALTERNATIVES CONSIDERED

Since May 1997, the FAA and the NPS have considered a number of commercial air tour route proposals through the western portions of the study area that provide air tour operators with a safe air tour route while moving towards the legislatively mandated goal of substantial restoration of natural quiet and preserving cultural resources. **Figure 2-1** illustrates the commercial air tour routes currently flown at the Grand Canyon for commercial SFAR operations. This figure shows the route names and numbers identified within this section.

The commercial air tour route proposals described in this section were either developed internally by FAA or the NPS or suggested by interested parties. The proposals considered by the FAA since May 1997 include the following.

<u>Proposal 1, (Blue-2 and Green-4)</u>. Routes would remain the same as they are today until reaching Separation Canyon. From Separation Canyon to Diamond Creek they would cross the Colorado River and overfly the Hualapai Reservation.

This route was not retained for detailed study because of Hualapai Tribe concerns that it would increase overflights of Hualapai Traditional Cultural Properties (TCPs) and NPS concerns about Kelly Point, the primary destination point in the eastern part of the Lake Mead Recreational Area.

<u>Proposal 2, (Blue-2 and Green-4).</u> Routes would remain the same as they are today except the turn around for Blue-2 would be moved to occur between Merwhitica and Horse Flat Canyons. Blue-2 would then continue north of the river. The route east of Surprise Canyon would be deleted.

This concept was dismissed based on operational safety concerns. The turn into the high terrain and the lack of easily identifiable landmarks to enable pilots to remain north of the Colorado River raised safety concerns related to turning into rising terrain.

Proposal 3, (New Blue-1, Blue-2 and Green-4). The existing Blue-1 route through National Canyon would be eliminated. New Blue-1 would enter at Pearce Canyon and continue along the north side of the Colorado River to Diamond Creek. It would then cross the river and proceed northeast bound to intersect the current route labeled Blue-2B. New Blue-1 would parallel Blue-2B until approximately 2 nautical miles (NM) south of Parashant Wash, there it would proceed directly to Grand Canyon airport. Blue-2 and Green-4 would follow the routes as they are currently flown, except they would turn around at Spencer Canyon.

These route proposals were presented at the Flagstaff meeting in February 1998. These routes were not retained for detailed study because of safety concerns raised by Clark County related to minimal lateral separation of the proposed Blue 1 and existing Blue 2 at the same altitude. A variation of this proposal is part of Alternative 3.

Proposal 4, (Blue-2 and Green-4). The current routes would be moved so that they would overfly the Sanup Plateau side of the Colorado River and would turn around at Surprise Canyon.

The Hualapai Tribe favored this route because it had the least impact on Grand Canyon West and the TCPs on the south side of the Colorado River. However, these routes were not retained for detailed study because of safety concerns related to terrain clearance similar to the preceding proposal. The altitude of the Plateau would not allow flights at 5,500 feet so they would have to operate at 7,500 feet. This would cause compression with aircraft already operating at that altitude and higher altitudes.

Proposal 5, (New Blue-1 and Blue-2). New Blue-1 and Blue-2 would be consolidated at Pearce Canyon and proceed north of the river to Burnt Canyon. New Blue-1 would proceed from Burnt Canyon across the Sanup Plateau to Surprise Canyon and continue on to intercept a combination of the existing Blue-2A and 2B routes.

At Burnt Canyon, Blue-2 would again become a separate route and make a right turn crossing the Colorado River. The turn would be completed before Horse Flat Canyon, then continue northwest bound until Quartermaster Canyon. Blue-2 would then cross back to the north side of the river until it passes Bat Cave, then proceed west out of the SFRA.

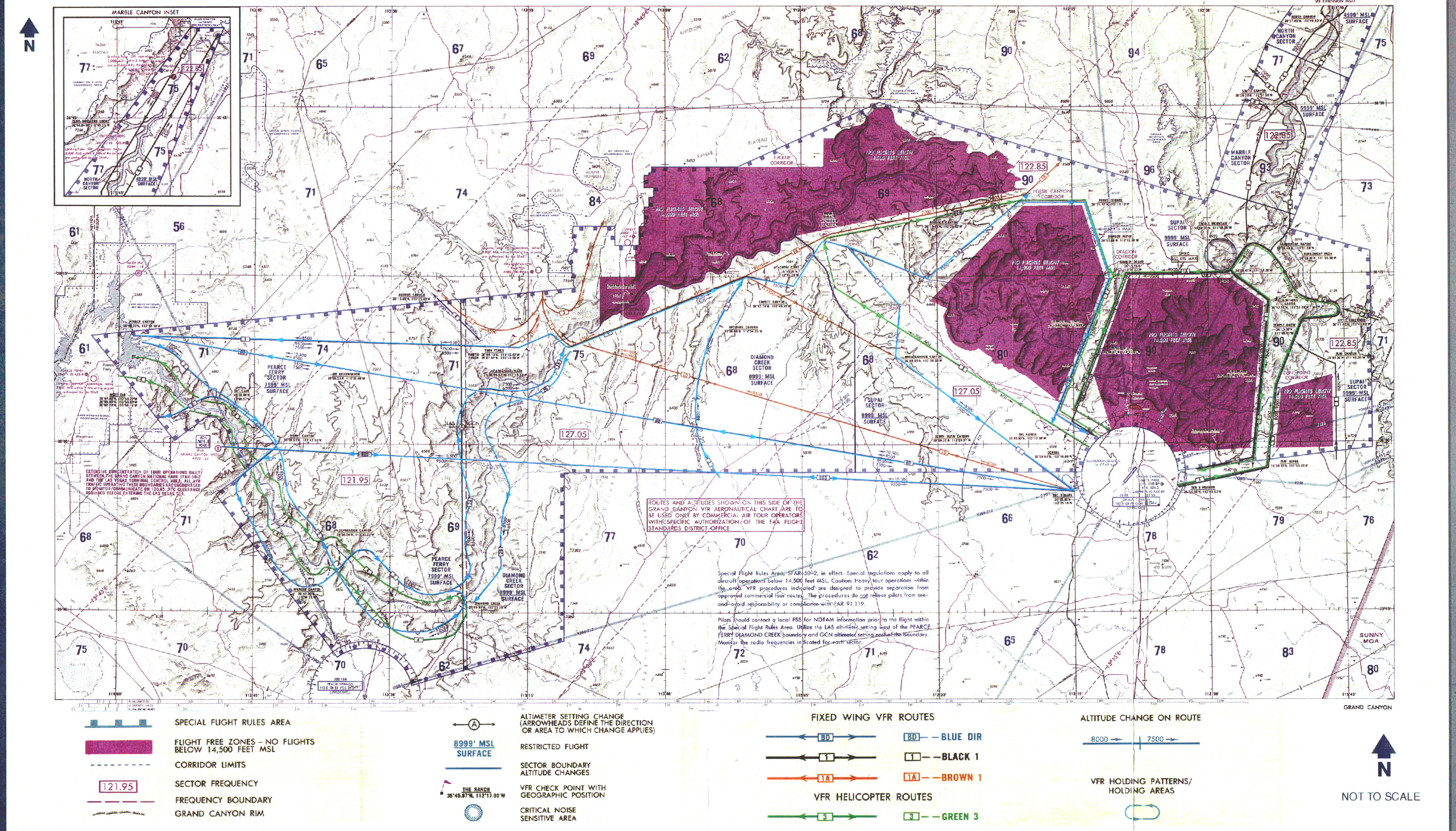
New Blue-1 was dismissed from detailed study because of environmental concerns. The ethnographic study prepared by the Hualapai Tribe indicates that there are TCPs in the canyons near Diamond Creek. New Blue-1 would adversely impact these TCPs. New Blue-1 was also dismissed in light of NPS' concern that the additional aircraft noise would interfere with the goal of substantial restoration of natural quiet in the GCNP and Kelly Point, a primary destination point in the eastern part of Lake Mead National Recreational Area. Blue-2 was not retained for further study because of the descending 180-degree right turn which limits the pilot's field of vision. The turn in Blue-2 was rejected for safety concerns.

Proposal 6, (No Fixed Wing Traffic on Blue-2). Blue-2 would be eliminated and a transit route would be established to allow both fixed wing and helicopter operations to land at Grand Canyon West on the Hualapai Reservation. The

Supplemental Environmental Assessment — Current Grand Canyon VFR Aeronautical Chart

FIGURE 2-1

6/99



SOURCE: GRAND CANYON VFR AERONAUTICAL CHART (COMMERCIAL AIR TOUR OPERATORS), NOAA, 1ST EDITION, APRIL 4, 1991.

Hualapai Tribe expressed concern that fixed wing traffic will significantly increase over time and that noise associated with turns in the area inhabited by big horn sheep, will exacerbate the effects of noise from Grand Canyon West and drive away Desert bighorn sheep that graze in the area. Because there is no evidence of potential adverse impacts upon Desert bighorn sheep, the FAA did not pursue this alternative. This concept would severely impact the viability of operations by air tour operations from the Las Vegas vicinity. This alternative which would eliminate air tours is not consistent with the purpose and intent of the National Park Overflights Act, which contemplates that air tour operations will be adjusted as necessary to achieve the goal of substantial restoration.

Proposal 7, (Blue-2 and Green-4). Blue-2 would enter at Pearce Canyon and continue north of the river to Surprise Canyon. At Surprise Canyon Blue-2 would make a right turn and cross the Colorado River. The turn would be completed before Blue-2 reaches Horse Flat Canyon, then Blue-2 would continue northwest bound until it reaches Quartermaster Canyon. Blue-2 would then cross back to the north side of the river and continue northwest bound until the route passed Bat Cave where it would turn westbound out of SFRA. This is the same Blue-2 route configuration that was considered in July 1998, except the altitude in this proposal for Blue-2 would be entry at 7,500 feet mean sea level (MSL) and exit at 6,500 feet MSL. Green-4 would enter and exit at 6,000 feet MSL with this proposal and would remain on the north side of the Colorado River.

This version of Blue-2 was not retained because the volume of flights are likely to result in compression. There are also safety issues during poor weather because only one altitude would be available for flights in each direction. The Green-4 portion of this proposal was dismissed because of safety concerns related to both the inbound and outbound legs of the route on the same side of the Colorado River at the same altitude.

Proposal 8, (New Blue-2 and Green-4). The configuration of the current Green-4 route would remain the same but it would become a "stacked" route. The route would be assigned two distinct altitudes separated vertically by 1,000 feet for helicopter operations. Green-4A would enter the SFRA at 5,000 feet MSL and exit at Grand Canyon West airport, serving tourists landing on the Hualapai Reservation. Green-4B would enter at 6,000 feet MSL and follow the current route for Green-4 on the south side of the Colorado River and complete a 180 degree turn prior to Horse Flat Canyon. It would then proceed northwesterly on the north side of the river to exit SFRA.

New Blue-2 would enter at the same location as the current Blue-2 then turn southwesterly at the Burnt Canyon marker. The route would then turn and cross the Colorado River at Quartermaster Canyon. The turn would be completed prior to Horse Flat Canyon and proceed northwest on the north side of the river to exit via the same route as the current Blue-2. This route was proposed with the turn resembling either a tear-drop or horseshoe pattern.

The Green-4A and 4B portions of this proposal were dismissed because of complexity and safety concerns. The proposal negated the use of the altitude 5,500 feet MSL for fixed-wing commercial air tour operations. Approximately 86 percent of the helicopters would use Green-

4A since they land on the Hualapai Reservation. Creating a second helicopter altitude for 14 percent of the operations would displace the current fixed wing aircraft, creating a compression and safety concern.

Proposal 9, (Blue-2, Green-4, and New Blue Direct South) Blue-2 would be the same route as that considered in Proposal 7 with the altitudes of 7,500/5,500 feet MSL eastbound and 8,500/6,500 feet MSL westbound. Green-4 would be changed to move the altitude back to 5,000 feet MSL utilizing both sides of the river and revised to enter SFRA on the south side of the Colorado River, proceed southeast bound to Horse Flat Canyon, make a left turn to cross the river and proceed to Pearce Ferry on the north side of the river.

The current Blue Direct South route entry point would be moved from abeam Grand Canyon West Airport to coincide with the existing Blue-2 west-end entry point. The New Blue Direct South route would proceed from the entry point directly to a geographical area referred to as "the square" west of the Grand Canyon Airport (GCN). The square is used for air traffic control purposes at GCN.

This tentative air tour route proposal was presented to the Hualapai Tribe at the meeting in Mesa, AZ on March 9, 1999. It was modeled using the FAA's airfield and airspace simulation model, SIMMOD. Due to the potential safety concerns identified as a result of the SIMMOD study (where the Blue Direct South traffic at 8,500 feet merged with the existing Blue-2 traffic at the same altitude), this tentative route structure has been revised as follows and included as part of the Proposed Action in this Supplemental EA. The number of altitudes available for use on the route identified as New Blue Direct South has been reduced from two to one eastbound at 9,500 feet MSL. All of the traffic that would have utilized the altitude of 8,500 feet MSL would either move to the New Blue Direct North route or remain outside of SFRA airspace. This would also help to reduce potential impacts on the area of concern identified by the Hualapai Tribe in its ethnographic study as Dr. Tommy's Mountain, also commonly known as Gus' Plateau. There would be no commercial air tour aircraft overflying the Plateau below 9,500 feet MSL.

2.3 ALTERNATIVES STUDIED IN DETAIL

CEQ regulations and FAA Order 1050.1D state that the evaluation of alternatives should "present the environmental impacts of the proposal and alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options for the decision maker and the public."[3] Accordingly, this section compares the relevant environmental effects of the No Action and the proposed alternatives.

Descriptions of the airspace changes, commercial air tour route changes, and commercial air tour limitations for each alternative follow. These alternatives were developed in cooperation with the NPS and with consideration of concerns expressed by other interested parties.

2.3.1 Alternative 1 – No Action

Consideration of the "No Action" alternative is required by NEPA. This alternative serves as a basis of comparison for the other alternatives. The No Action alternative assumes that the existing SFAR 50-2 (53 FR 20264, June 2, 1988) remains in place.

Airspace Changes. The No Action alternative would maintain the existing SFAR 50-2 procedures for operations of aircraft in the airspace above the Grand Canyon. The SFRA dimensions would remain from the surface to 14,499 feet above mean sea level in the area of the Grand Canyon. Figure 2-1 illustrates the existing SFAR boundary, FFZs and the existing commercial air tour route locations.

Commercial Air Tour Route Changes. The commercial air tour routes illustrated on Figure 2-1 would remain in place.

Operational Limitations. The No Action alternative would not place any additional operational limitations on commercial air tour operators conducting air tours over the Grand Canyon within the SFRA. It is assumed that the cap on number of air tour aircraft implemented as part of the Final Rule in December 1996 remains in place.

2.3.2 Alternative 2 – Central Route (Preferred Alternative)

Airspace Changes. The airspace changes in the December 31, 1996 Final Rule, as described in Section 2.1, are assumed to be implemented. Proposed changes are described below.

Figure 2-2 illustrates the airspace changes considered for Alternative 2. The 1996 Final Rule/1999 Proposed FFZs shown on the figure include those that will take effect in January 2000 pursuant to the 1996 Final Rule. Additionally, they represent the proposed changes.

SFRA and Desert View FFZ

In this action, the FAA is proposing to modify the Grand Canyon SFRA by moving the eastern boundary five nautical miles to the east. Additionally, the FAA is proposing to modify the Desert View FFZ by moving the eastern boundary five nautical miles to the east.

The current design of the eastern portion of the SFRA and the Desert View FFZ allows entry and exit as well as travel over several TCPs on the eastern side of GCNP, causing concerns to several Native American tribes. These sites and tribal concerns about these sites were identified through on-going consultation with affected tribes in accordance with Section 106 of the National Historic Preservation Act (NHPA) and the American Indian Religious Freedom Act. Specific locations of TCPs are not disclosed in accordance with Sec. 304 of the NHPA which provides for confidentiality. The impacts of air tours over these TCPs will be reduced or avoided by the proposed modification of the eastern portion of the SFRA and the Desert View FFZ and adjusting the entry and exit points of the commercial air tour routes accordingly through route redesign.

Bright Angel FFZ

The FAA is also proposing to modify the Bright Angel FFZ to provide a provisional incentive corridor, one nautical mile in width, through the Bright Angel FFZ to be used at some future date only by aircraft meeting a noise efficiency/quiet technology aircraft standard. This is identical to the corridor originally proposed in May 1997 and withdrawn in 1998. The FAA acknowledges that rulemaking to establish a standard for noise efficient/quiet technology aircraft is pending. Until such a standard is developed and adopted, the Bright Angel incentive corridor will not be available for commercial operations. The proposed incentive corridor would pass along the northern boundary of the current Bright Angel FFZ (as defined in SFAR 50-2).

Even without a standard for noise efficient/quiet technology aircraft it is intuitively clear that the proposed Bright Angel Corridor would have a three-fold benefit. First, fewer aircraft would be flying over the northern rim of the canyon along Saddle Mountain, where the NPS has pointed out some noise sensitivity. Second, noise from the air tour aircraft would be dispersed between the northern boundary of the Bright Angel FFZ and the proposed corridor, thereby reducing the level of concentrated aircraft along any one route. Third, opening this corridor only to the most noise efficient aircraft would provide a valuable and tangible incentive for the air tour operators to convert to quieter aircraft. The GCNP could thereby experience the benefit of a reduction in the level of aircraft noise. This incentive route is not modeled for noise impacts within this document, its benefit and/or impact will be analyzed in a forth coming EA for a supplemental NPRM for Noise Limitations for Aircraft Operations in the Vicinity of the Grand Canyon Nation Park.

Sanup FFZ

The FAA is proposing to modify the Sanup FFZ because increased aircraft operations on new Blue Direct South (BDS) would be over the northern portion of the newly created Sanup FFZ (December 1996 Final Rule), at altitudes less than 3,000 feet above the elevation of some areas of the Sanup plateau. At this altitude, these aircraft operations may have a noise impact. Operations would increase on BDS because existing routes through National Canyon are eliminated. It is with this in mind that the FAA believes that the northern portion of the Sanup FFZ, that would lie beneath BDS, should be eliminated from the FFZ to accommodate safely an additional route between Tusayan, Arizona and Las Vegas, Nevada. Therefore, the FAA is proposing to modify the Sanup FFZ by moving the northern portion of the FFZ south approximately one mile south of the BDS route.

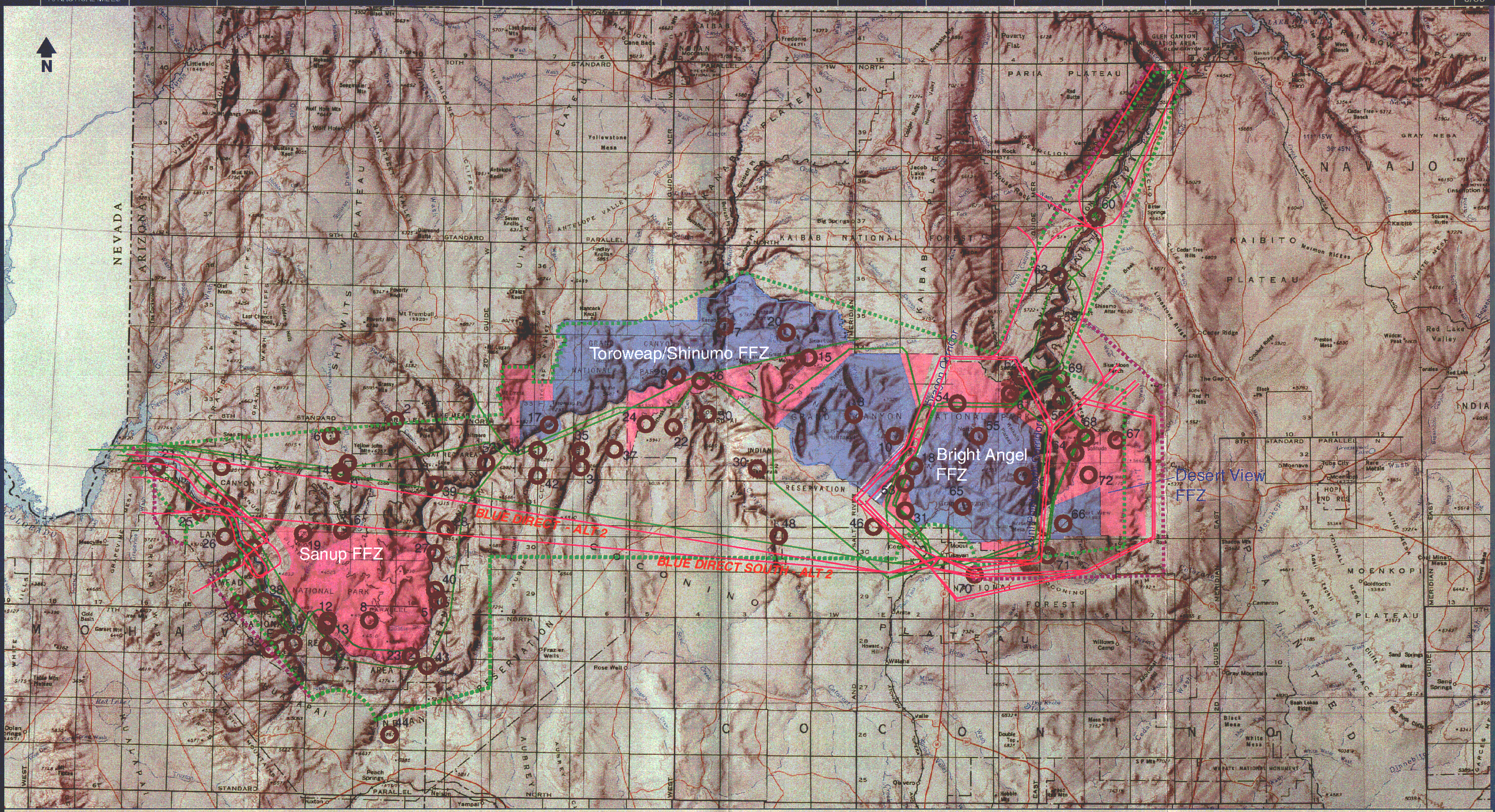
Additionally, to provide for a proposed revision of the current Blue 2 commercial route over the northwestern portion of the GCNP, the FAA is proposing to modify the Sanup FFZ by moving the northwestern portion of the FFZ east approximately one mile east of the Blue 2 route.

Commercial Air Tour Route Changes. As with the 1996 Proposed Action and 1997 Written Reevaluation, commercial air tour routes are eliminated from the center of the Grand Canyon National Park with expansion of the Toroweap/Shinumo FFZ. Similarly to the 1996 Final EA, commercial air tour routes no longer traverse south of the Sanup. The largest change since the 1996 Final EA and 1997 Written Reevaluation occurs due to the expansion of the Desert View FFZ in response to Native American concerns. Commercial air tour routes are modified to reflect changes to the Bright Angel and Desert View FFZ expansions. Specifically, Alternative 2 includes the Blue Direct and Blue Direct South routes. With the exception of the direct routes, all other routes are the same for all of the proposed alternatives. Figure 2-2 illustrates Alternative 2 compared to the No Action alternative.

Operational Limitations. A limitation on the number of commercial air tours in the

Supplemental Environmental Assessment — No Action Compared to Alternative 2 (Preferred Alternative)

FIGURE 2-2



Existing FFZ
1996 Final Rule/1999 Proposed FFZ
Representative Locations
Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Existing Commercial Air Tour Routes - Alternative 1 (No Action)
Proposed Commercial Air Tour Routes - Alternative 2

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

SFRA would be implemented. Commercial air tours would be limited to the levels reported to the FAA for the period May 1, 1997 to April 30, 1998.

A sub alternative to Alternative 2 will also be considered. The sub alternative allows commercial air tours to continue to grow at a predicted rate of 3.3 percent annually. It should be noted that recent reporting information indicates that the annual growth rate is currently tracking at approximately 2.9 percent. The FAA believes that using the 3.3 percent growth rate for potential impact analysis within this document will provide conservative results.

2.3.3 Alternative 3 – Northern Route

Airspace Changes. The airspace changes proposed for Alternative 2 are also considered for Alternative 3. See section 2.3.2 for a detailed description. **Figure 2-3** illustrates the airspace changes considered for Alternative 3.

Commercial Air Tour Route Changes. Alternative 3 includes the same changes proposed for Alternative 2 except that Alternative 3 includes the Blue Direct and Blue Direct South routes. Figure 2-3 illustrates Alternative 3 compared to the No Action alternative.

Operational Limitations. A limitation on the number of commercial air tours in the SFRA would be implemented. Commercial air tours would be limited to the levels reported for May 1, 1997 through April 30, 1998.

A sub alternative to Alternative 3 will also be considered. The sub alternative allows commercial air tours to continue to grow at a predicted growth rate of 3.3 percent annually.

2.3.4 Alternative 4 – Southern Route

Airspace Changes. The airspace changes proposed for Alternatives 2 and 3 are also considered for Alternative 4. See section 2.3.2 for a detailed description. **Figure 2-4** illustrates the airspace changes considered for Alternative 4. The selection of Alternative 4 for implementation may require revisions to the Sanup FFZ as the FFZ could be expanded in the northerly direction and reduced along the southern edge to allow the transit route to be completely outside of the FFZ regardless of altitude restrictions.

Commercial Air Tour Route Changes. Alternative 4 includes the same changes proposed for Alternative 2 except that Alternative 4 includes the Blue South Direct and Blue Direct routes. Figure 2-4 illustrates Alternative 4 compared to the No Action alternative.

Operational Limitations. A limitation on the number of commercial air tours in the SFRA would be implemented. Commercial air tours would be limited to the levels reported for May 1, 1997 through April 30, 1998.

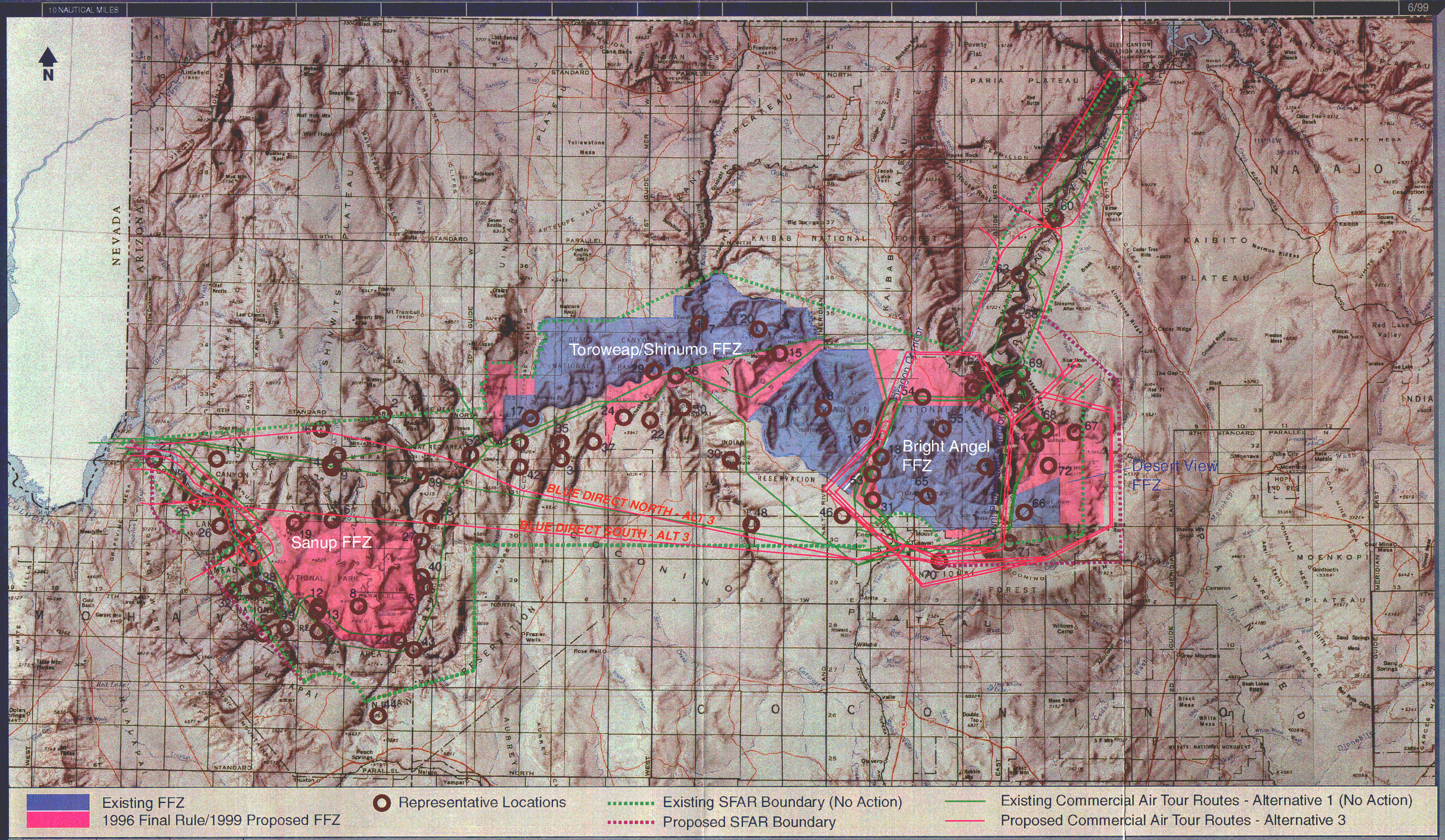
A sub alternative to Alternative 4 will also be considered. The sub alternative allows commercial air tours to continue to grow at a predicted growth rate of 3.3 percent annually.

2.3.5 Summary Comparison Evaluation of Alternatives

This section presents a summary of the alternatives in comparative format in order to define the issues and identify the appropriate alternative. **Table 2.1** summarizes this comparison. The environmental impacts summarized herein are discussed, by impact category, in Chapter Four.

Supplemental Environmental Assessment No Action Compared to Alternative 3

FIGURE 2-3

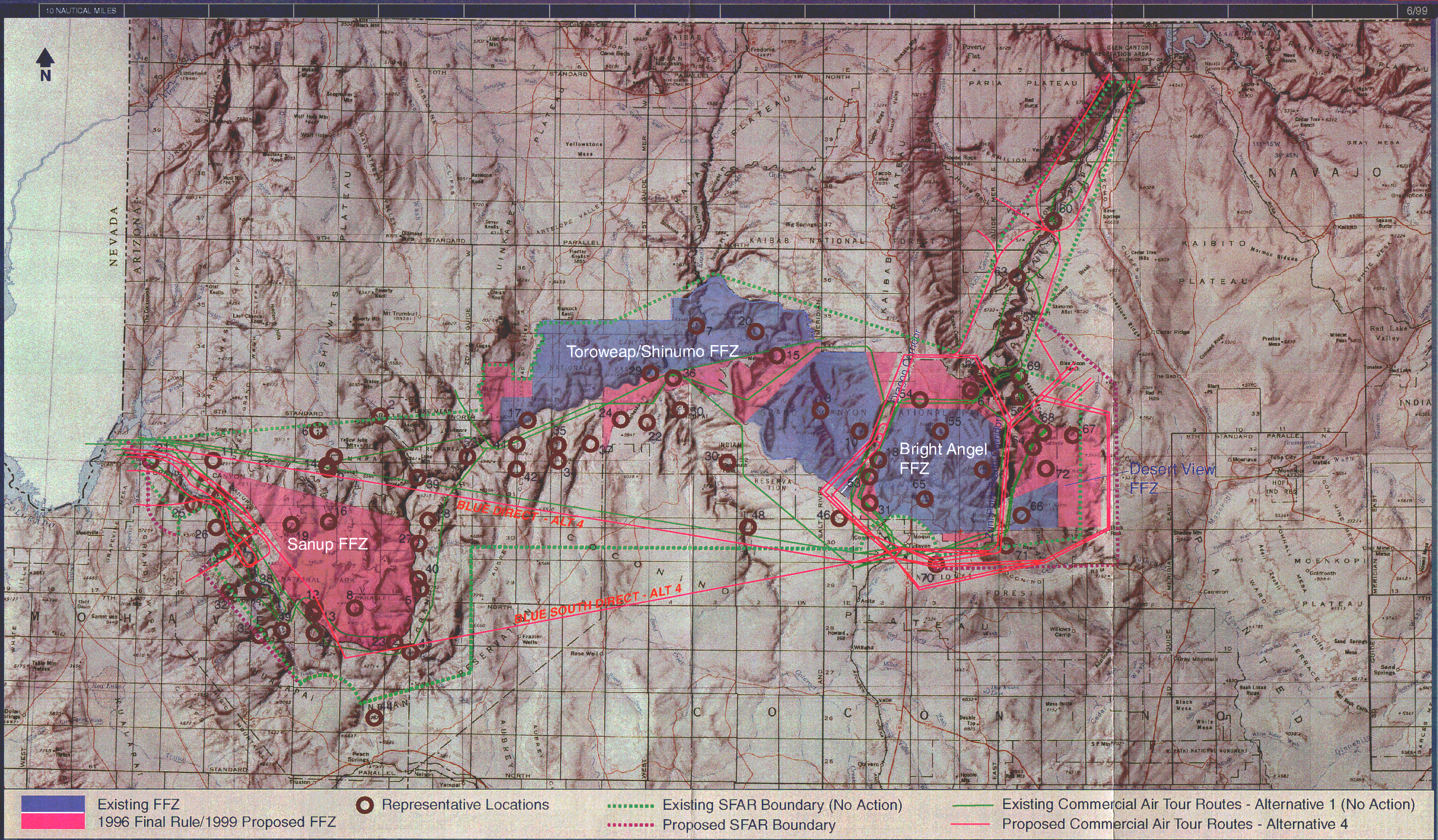


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Supplemental Environmental Assessment No Action Compared to Alternative 4

FIGURE 2-4



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Table 2.1

Summary Comparison of Alternatives

Evaluation Factor	Alt. 1 - No Action	(A) Alt. 2 - Central Route (Preferred Alternative) (B) Alt.2 with Continued Growth	(A) Alt. 3 - Northern Route (B) Alt. 3 with Continued Growth	(A) Alt. 4 - Southern Route (B) Alt. 4 with Continued Growth
Potential for Adverse Noise Impacts [1]	Not Significant	(A) Not Significant (B) Not Significant, noise improvements erode over time	(A) Not Significant (B) Not Significant, noise improvements erode over time	(A) Not Significant (B) Not Significant, noise improvements erode over time
Historic, Archaeological, and Cultural Resources Impacts [2]	Yes	(A) Not Significant (B) Not Significant	(A) Not Significant (B) Not Significant	(A) Potentially Significant (B) Potentially Significant
DOT Section 4(f) Impacts [2]	Not Significant	(A) Not Significant (B) Not Significant	(A) Not Significant (B) Not Significant	(A) Not Significant (B) Not Significant
Visual Impacts [2]	Not Significant	(A) Not Significant (B) Not Significant	(A) Not Significant (B) Not Significant	(A) Potentially Significant (B) Potentially Significant
Socio/Socioeconomic Impacts	No [4]	(A) No (B) No	(A) No (B) No	(A) No (B) No
Environmental Justice Impacts	No	(A) No (B) No	(A) No (B) No	(A) No (B) No
Endangered Species Impacts [3]	No	(A) May affect, not likely to adversely effect (B) May affect, not likely to adversely effect	(A) May affect, not likely to adversely effect (B) May affect, not likely to adversely effect	(A) May affect, not likely to adversely effect (B) May affect, not likely to adversely effect
Purpose of Action: Reduces aircraft noise impact within GCNP	No	(A) Yes (B) No	(A) Yes (B) No	(A) Yes (B) No
Restores Natural Quiet	No	(A) No (B) No, noise reduction benefits erode over time	(A) No (B) No, noise reduction benefits erode over time	(A) No (B) No, noise reduction benefits erode over time

[1] Significance defined using Part 150 Land Use Compatibility Standards except for cultural resources.
[2] Section 106 ongoing consultation may determine impacts that must be mitigated.
[3] Consultation with U. S. Fish and Wildlife ongoing.
[4] "No" as used in the table indicates no impact for the environmental category considered.

Chapter Three
AFFECTED ENVIRONMENT

The description of the affected environment focuses on Grand Canyon characteristics which are relevant to the issue of air tour activity and the anticipated environmental impacts of the alternatives, including the no action alternative. Noise from aircraft overflights is the primary impact. As discussed in more detail in Chapter Four, noise levels being considered here may affect the following impact categories from FAA Order 1050.1D: historic/archaeological/cultural resources; natural resources; DOT Section 4(f); and wild and scenic rivers. In addition, effects on Native American communities and wilderness will be addressed.

The following section updates the 1996 Final EA with information provided by the Hualapai Tribe and NPS. It also reflects implementation of the General Management Plan for the GCNP.

3.1 REGIONAL CONTEXT

The Grand Canyon is a unique natural and cultural resource. Major portions of the Grand Canyon are included in the GCNP. In addition, portions of the Grand Canyon are within the reservation boundaries of the Hualapai, Havasupai, and Navajo Tribes. The Grand Canyon attracts more than five million visitors from around the world annually who view the canyon from motor vehicles, river boats, aircraft and by foot, horse, mule, and bicycle. Within the Grand Canyon, the GCNP is designated as a World Heritage Site, and more than ninety percent of the GCNP is eligible to be designated as a Wilderness Area. The area potentially affected by the alternatives includes lands within the SFRA boundary (as shown in Figure 1-1). The following sections describe the Grand Canyon and its surrounding areas within the potentially affected area.

The 1995 GCNP General Management Plan/Environmental Impact Statement contains detailed information about the GCNP. GCNP lies within Coconino and Mohave Counties in the State of Arizona, and is located close to the States of Utah and Nevada (see Figure 1-1). The park is bounded by Kaibab National Forest and the Bureau of Land Management's Arizona Strip District to the north, by Glen Canyon National Recreational Area to the northeast, by the Navajo Indian Reservation to the east, by Kaibab National Forest and the Hualapai and Havasupai Indian Reservations to the south, and by Lake Mead National Recreation Area to the west.

Coconino County, Arizona, contains the three main entrances to GCNP and the communities most directly affected by the social and economic effects of park operations. Most South Rim visitors spend at least one night in Coconino County. Communities in Coconino County and Utah's Kane and Washington Counties are service areas for visitors to the North Rim and Tuweep. Coconino County is the second largest county in area in the United States. In addition to encompassing much of the area of GCNP, it contains all or portions of the Navajo, Hopi, Havasupai, Hualapai, and Kaibab Paiute Indian reservations.[4] The Kaibab Paiute Indian reservation, located at the Arizona-Utah border, does not bound any portion of the GCNP and is outside the affected area. However, the tribes maintain an ancestral interest in the Grand Canyon. The San Juan Southern Paiute Tribe resides in Coconino County but do not have reservation lands.

3.2 GRAND CANYON

The canyon itself ranges from 1 to 18 miles wide and is over one mile deep in places. The Grand Canyon lies entirely on the southern portion of the Colorado Plateau. The higher elevations of the plateau are forested, while the lower elevations are a series of desert basins and deeply incised canyons. Elevations range from approximately 1,200 feet on the canyon floor at the western end to over 9,000 feet on the North Rim. On both rims, the topography is generally flat, making land travel relatively easy. In contrast, topography below the rims is characterized by steep talus slopes, precipitous cliffs, crumbly decomposing rock ledges, and long narrow side canyons.

The Grand Canyon contains significant examples of most of the natural themes represented within the Colorado Plateau physiographic region, including: plains, plateaus, and mesas; work of volcanism; sculpture of the land; river systems and lakes; geologic history; boreal forest; and dry coniferous forest and woodland. The Grand Canyon also offers a geologic record covering the first three eras of geological time (2.5 billion years), making it one of the most complete records of geological history found anywhere in the world.

3.3 NATIVE AMERICAN COMMUNITIES

Six Native American communities, represented by eight separate tribal governments, have ancestral ties to the Grand Canyon. The Colorado River, the canyon, the larger landscape in which these occur, and many of the park resources are considered sacred by many within these Native American communities. Within this larger landscape are sites, locations, and resources that are of traditional significance to all tribes in some cases, and to only some tribes in others. These Native American traditional cultural properties are tangible historic properties potentially eligible for listing on the National Register of Historic Places because of their association with cultural practices and beliefs rooted in history and their importance in maintaining the cultural identity of Native American communities.

The following is a summary of each community's spiritual and traditional interests in the canyon.[5]

Havasupai

The Havasupai Tribe is a federally recognized Indian Tribe. The Havasupai Reservation lies within and on both rims of Cataract (Havasu) Canyon and is bordered by the Hualapai Indian Reservation to the west, Kaibab National Forest to the east, the GCNP to the north, and private sector lands to the south. As it flows toward the Colorado River, the Havasu Creek essentially divides the Reservation. Havasupai ancestral lands cover an area from the Colorado River in the north to the Bill Williams Mountains and the San Francisco Peaks in the south, the Aubrey Cliffs in the west, and the Little Colorado

River gorge to the east. The area between the mouth of the Little Colorado River and the mouth of the Mohawk Canyon is the historical foundation of the Havasupai people. Limited archaeological evidence suggests use of this area dates back to 700 A.D., although the majority of Havasupai remains within Grand Canyon date to after 1300 A.D. Red Butte, located outside the park, is considered to be the birth place of the Havasupai. Hance Trail, in GCNP, has religious significance, as it is part of their migration route north from Red Butte into the Grand Canyon. The Havasupai are extremely reluctant to divulge the location of other sacred sites. In addition to their reservation, the Havasupai have access to the portion of the GCNP that lies between the river and the Havasupai Reservation for subsistence hunting and gathering.

Although they hunted and gathered wild plants throughout their territory on the rim and in the canyon, the Havasupai also farmed in Havasu Canyon, Indian Garden, and Fossil Bay. Residences were located below Hermits Rest on the same plateau as Indian Garden and as far east as Desert View, where a Havasupai family lived below the present watchtower. The Havasupai population is presently concentrated in Supai Village in Havasu Canyon and scattered settlements on the plateau. The FAA, during consultation with the tribe and in coordination with the NPS, has endeavored to protect the privacy of the tribe.

Hualapai

The Hualapai Tribe is a federally recognized Indian Tribe whose ancestral lands cover millions of acres in and around the Grand Canyon. The Hualapai Indian Reservation, established in 1883, is located along the south rim of the Grand Canyon and the Colorado River in northwestern Arizona on a portion of those ancestral lands. The Hualapai Reservation encompasses approximately one million acres of land and extends for 108 miles of the Colorado River, from mile post 165 to mile post 273.

About two-thirds of the Reservation is located on the lower elevation of the Hualapai Plateau, and the eastern third is located on the higher elevation Coconino Plateau. Terrain elevations fluctuate from 2,000 feet at the bottom of the Grand Canyon to 7,000 feet. Vegetation varies widely throughout the Reservation. At the western end, the vegetation in the vicinity of the Grand Canyon rim is primarily desert scrub land, chaparral and desert grassland. "Hualapai" means People of the Tall Pines, and this vegetative cover is found on the central and eastern portions of the Reservation in the vicinity of the Canyon rim. Hardwood trees are found at higher elevations and along streams.

The Hualapai Tribe has an enrolled membership of about 2,200 persons. Approximately 1,800 persons reside on the Hualapai Reservation, including about 1,000 enrolled tribal members. Most of these residents live in Peach Springs, the Tribal capital. Peach Springs is located near the southern edge of the Reservation on Highway 66, approximately 16 miles south of the canyon rim as the crow flies and 50 miles east of Kingman, Arizona. The tribal economy is based on tourism, river rafting, cattle ranching, hunting expeditions, timber cutting, government services, and traditional crafts.

The vast majority of the Hualapai Reservation is undeveloped. Under Tribal law, development of any kind is prohibited in canyons considered sacred to the Hualapai people. Non-Hualapai may not enter these canyons. The Hualapai Tribe manages its lands for wildlife protection, cultural resources preservation, and forestry. The Tribe has set aside an area along the southern rim of the Grand Canyon for tourism and recreation.

Hopi

The Hopi Tribe is a federally recognized Indian Tribe. The Hopi Reservation is surrounded by the Navajo Reservation and is divided by the Dinnebito Wash and Polacca Wash as they drain toward the Little Colorado River. According to Hopi tradition, the Hopi people began their emergence into the present world through the *Sipapu,* a travertine cone in the Little Colorado River gorge outside the boundaries of the park. From that place, they spread throughout the southwestern United States.

The migrations of some of the clans included residence in the Grand Canyon. Archaeological investigations substantiate these claims, indicating they have used the canyon since about 700 A.D.

Hopi people continue to use the Grand Canyon for important ceremonial and ritual purposes. Some of their most sacred sites are inside and immediately adjacent to the park, such as the Hopi Salt Mines on the Colorado River inside the park.

Navajo

The Navajo Nation is a federally recognized Indian Tribe. The Navajo Reservation borders GCNP from Lee's Ferry to the confluence of the Little Colorado River. The Navajo tribal government is divided into local governances called chapters. The Cameron and Gap-Bodaway chapters border GCNP.

Archaeological and linguistic evidence suggest that the Athapaskan-speaking ancestors of the people now known as the Navajo migrated into the American Southwest sometime between about 1000 A.D. and 1500 A.D. They spread into the area to the east of the Colorado River and north of the Little Colorado River during the 19th century.

The Navajo view the Colorado River and the Little Colorado as sacred beings.

San Juan Southern Paiute, Kaibab Paiute, Shivwits Paiute, and Paiute Tribes of Utah

The Kaibab and San Juan Southern Paiute Tribes are federally recognized Indian Tribes, while the Shivwits are not at this time. Kaibab, Shivwits, and San Juan Southern Paiutes are three separate tribes, however, their beliefs, ties to the Grand Canyon, and concerns are similar. Therefore, they will be discussed as one people, the Southern Paiute. The NPS General Management Plan for the GCNP indicates that the Southern Paiute are located within the Navajo reservations although there is no specific reservation designation shown on standard location maps. Additionally, the Kaibab Reservation (considered Southern Paiute by the General Management Plan for the GCNP) is located on the northern border of Arizona and is approximately 23 miles at its closest point to the GCNP.

Archaeological evidence of Southern Paiute use of the area may be found dating as early as 1150 A.D. The traditional boundary for the Southern Paiute within Grand Canyon extended from the junction of the Paria and Colorado Rivers downstream to Kanab Creek.

Zuni

The Pueblo of Zuni is a federally recognized Indian Tribe. The Zuni, while not residents of the affected environment, have ancestral ties to the Grand Canyon. The traditional area of Zuni land use is bounded by the San Francisco Peaks and portions of the Little Colorado River in the north. Archaeological sites, traditional cultural properties, and other sacred locations along the Colorado River corridor and the Little Colorado River are important to Zuni traditional and cultural values, providing important spiritual linkages to the place of emergence for the Zuni people.

3.4 GRAND CANYON NATIONAL PARK

GCNP encompasses 1.2 million acres of the Grand Canyon in northern Arizona (see Figure 1-1). GCNP was designated a World Heritage Site in 1978, one of the few areas in the world meeting the selection criteria for both natural and cultural resources. GCNP served 4,928,509 visitors in 1993 and has both undeveloped (natural) and developed areas as defined by the NPS.[6] The majority of the park is part of the NPS Natural Management Zone, comprised of proposed wilderness areas and non-wilderness areas and trails. Each of the developed areas (South Rim, North Rim, Tuweep, and the corridor trails) tend to have unique characteristics.[7] These characteristics are generally related to the level of development. The major areas most relevant to this study are briefly described in the following sections.

In response to the 1995 General Management Plan for GCNP, the NPS at Grand Canyon has taken the following major actions to reduce noise from all sources in the park (actions affecting only specific areas of the park are discussed in the appropriate sections below):

- Since 1997, the NPS at GCNP has contracted for the use of an MD-900 NOTAR (NO TAil Rotor) helicopter, one of the quietest helicopters available, to accomplish NPS emergency and administrative needs. The park has one of the most extensive review and approval processes in the nation to ensure that non-emergency use of NPS contract aircraft is appropriate and is conducted in a manner that minimizes noise and other impacts on park resources and visitors.

- In part to reduce noise, motor vehicles were restricted in 1998 on many primitive roads and trails on the North and South Rims, and in proposed wilderness and non-wilderness areas.

- A draft wilderness management plan, which was reviewed by the public in 1998, proposed standards for the park's proposed wilderness areas (over 90 percent of the park) concerning the number of occurrences of human noises per hour or day (e.g., aircraft, motors on the river, other parties on trails or in camps).

- Remote ranger stations in the park are primarily solar-powered, with gasoline or diesel generators rarely used as backup.

- Noise reduction considerations are beginning to be included in equipment selection criteria and facility design and operational practices for NPS and park concessions.

- Buses are prohibited from idling their engines at parking areas and overlooks.

3.4.1 South Rim

The South Rim is located on the eastern end of GCNP, just north of the town of Tusayan. According to the park's General Management Plan, the South Rim will remain the focus for most park visitors. However, limits will be placed on the use of private automobiles, primarily by limiting people to transit systems and alternative transportation (e.g., bicycles) in Grand Canyon Village and West Rim Drive.

In addition to the noise reduction actions recently implemented park-wide, the following actions have been implemented on the South Rim:

- Planning and design efforts are in the final stages for: constructing a light rail system between Tusayan and Grand Canyon Village; constructing a transportation and orientation center at Mather Point; and using electric buses and other alternative transportation systems in the Grand Canyon Village area. All of these will reduce automobile traffic and congestion on the South Rim, thereby presumably reducing noise.

- Procedures have been implemented to limit the use of train whistles to the minimum necessary for safe operation.

The South Rim will also continue to provide diverse opportunities to view the canyon and to experience solitude in natural settings as well as social exchange in developed areas.[8] While the visitor experience on the South Rim is, to a large extent, currently oriented around the automobile, the General Management Plan calls for limits on the number of vehicles parking on the South Rim, restricting private vehicles from many areas, and encouraging visitors to use transit, pedestrian paths, and bicycles for their primary access.[9] The South Rim includes Grand Canyon Village, Desert View, Hermit's Rest, and numerous rim viewpoints.

3.4.2 North Rim

The North Rim is also located on the eastern end of GCNP, approximately ten air miles north of (and across the canyon from) the South Rim. The park's General Management Plan calls for the North Rim to provide a low-key, uncrowded atmosphere that offers visitors opportunities to be intimately involved with the environment. Under the General Management Plan, the North Rim will continue to accommodate less than ten percent of the park's visitors and roads into the North Rim will continue to be closed to vehicles during the winter. Also, more visitors will be encouraged to visit the area between Point Imperial and Cape Royal to relieve congestion in the Bright Angel Point area, and to continue to visit Point Sublime via dirt road (see Figure 1-1).

3.4.3 Marble Canyon

Marble Canyon is a narrow arm of GCNP through which the Colorado River enters GCNP. Marble Canyon extends northward from the North Rim about 40 air miles to Lees Ferry. The GCNP boundary is less than five air miles wide for the length of Marble Canyon (see Figure 3-1).

3.4.4 Tuweep

Tuweep lies approximately 50 air miles to the west and 15 air miles north of and on the opposite side of the canyon from Grand Canyon Village. Tuweep served approximately 11,000 visitors in 1993, and is unique within the Grand Canyon because it is remote yet provides unpaved car access. The NPS goal for this area is that it "continue to provide uncrowded, primitive experiences that are dominated by nature and solitude," including minimal visitor facilities.[10] Toroweap overlook is a prime visitor site in this area. In addition, Tuweep Airstrip, a State-owned strip with an unpaved 3,500 foot runway, is located approximately five air miles north of Toroweap Overlook and immediately adjacent to the park boundary.

3.4.5 Inner Canyon

The Inner Canyon includes about 90 percent of the park area, including most of the backcountry trails and campsites in the park, and the Colorado River. The park's General Management Plan calls for managing almost all of the Inner Canyon as wilderness. Exceptions include the Cross-canyon Corridor which includes Phantom Ranch and the other developed sites below the rim, and possibly the Colorado River (see Figure 1-1).

In addition to the noise reduction actions recently implemented park-wide, commercial river outfitters are voluntarily converting to new low emission, low noise four-stroke outboard motor technology in an effort to reduce motor boat noise concerns on the Colorado River through the park's inner canyon (about one-fifth of the fleet was converted in 1998). NPS motor boats use only the new low noise motors, however, the NPS has reduced its use of motors on river patrols to about half the time, using oars only for the other patrols. No motors are allowed on the Colorado River at all from September 16 to December 15 each year.

3.5 CLIMATIC CONDITIONS

The climate at the Grand Canyon is diverse and directly affects flights over the area. This is due to elevation changes and to the unique effect the canyon itself has on weather.

The region experiences weather extremes during both summer and winter. In the context of air tour activity and aircraft overflights, summer conditions (May 1 - September 30) are generally more critical for several reasons. First, more tourist and resultant air tour activity occurs during the warm season. Second, aircraft performance tends to be decreased during hot weather. This makes hot weather aircraft performance parameters critical when evaluating noise abatement options. Hot conditions also tend to require pilots to increase aircraft engine speed to generate the additional thrust needed to offset decreased hot air performance. Increased engine speed generally results in greater noise emissions. Third, the propagation characteristics of noise tend to be affected by hot conditions such that sound travels farther.

In the summer at the North Rim, days are generally clear and crisp with occasional afternoon thunderstorms or heavy rain; evenings are chilly. Average summer high and low temperatures are 75 and 43 degrees Fahrenheit, respectively. The North Rim receives more precipitation than any other location in the park, with an average of 25 inches per year.

During the summer at the South Rim, afternoon thundershowers and occasional heavy rains can be expected. Average summer high and low temperatures are 82 and 51 degrees Fahrenheit, respectively.

At Phantom Ranch (at the bottom of the canyon) daytime temperatures are extremely high during the summer months, with highs and lows averaging 106 and 78 degrees Fahrenheit, respectively.

Summer days in the Grand Canyon region are warm and turbulent. Thunderstorms develop almost daily over some parts of the region from late June through early September as a result of local convectional disturbances due to excessive heating of the ground. These storms can be frequent, heavy and violent, but are usually localized. Turbulence, hail, rain, snow, lighting, severe updrafts and downdrafts, and icing conditions may be associated with these thunderstorms. The storms usually last less than 30 minutes but pilots must modify their flight routes to avoid such weather. The FAA recommends that pilots stay at least 10 to 20 miles away from thunderstorms.

"Density altitude" is also a factor which must be considered in developing management alternatives involving aircraft. It is a measure of air density which is used by pilots as an index in calculating the performance capability of aircraft. Density altitude becomes a critical factor in all warm-weather and high-altitude flight planning. High density altitude is a hazard since it reduces all aircraft performance parameters. Elevation (or altitude), humidity, and temperature all determine air density. When all three are high, density altitude is high and normal horsepower output is reduced, propeller and wing efficiency decrease, and an airplane requires a longer takeoff roll before becoming airborne. Additionally, rate-of-climb is decreased and a higher true airspeed is required. Flights are sometimes planned for the early morning or late afternoon hours to offset the effects of density altitude, as well as to take advantage of decreased turbulence.

Turbulence in the Grand Canyon is usually caused by differential heating of the canyon's surface or by strong winds. Updrafts caused by differential heating are often used by pilots to assist aircraft in climbing, sometimes a difficult task on a hot summer day when an aircraft is fully loaded. Canyon flying is much like mountain flying, and abrupt changes of wind direction and velocity must be anticipated.

Winter conditions are also extreme and vary widely. The North Rim is closed during the winter due to as much as ten feet of snow. Average winter high and low temperatures are 39 and 18 degrees Fahrenheit, respectively.

The South Rim is always open, generally receiving less than three feet of snow. Average winter high and low temperatures are 43 and 20 degrees Fahrenheit, respectively.

Winters at Phantom Ranch are also mild, with maximum temperatures averaging 56 degrees Fahrenheit and the lows rarely dipping below freezing. The canyon below the rims receives about eight inches of precipitation each year.

During winter months, the Grand Canyon region experiences snowstorms and low-level stratus clouds. There are also short periods of temperature inversions when clouds fill the canyon (cold air drains into and is trapped within the canyon) while the rims are being warmed by direct sunshine.

3.6 PHYSICAL RESOURCES

The Grand Canyon is noted for its diverse topographical and geological features. It also holds a historical record dating back millennia. This section, describes these physical and cultural resources. These characteristics affect the distribution of visitors and residents and the expectations visitors have for their experience at various sites. Moreover, certain areas tend to be more sensitive to aircraft noise. The difference in elevation may also affect aircraft performance at different park locations.

3.6.1 Popular Trails and Sights at GCNP

Most visitors to the Grand Canyon arrive at the South Rim. The majority of visitors view the canyon from the rim but do not explore the canyon below the rim. Of those that venture onto the corridor trails (the trails which provide main visitor access to destinations below the rim and connect the North and South Rims), most are day-hikers. Day-hikers hike a short enough distance to allow their return to the canyon rim before sunset. The primary trails are the North and South Kaibab Trails and the Bright Angel Trail.[11] In addition, the inner canyon trails which receive the most use outside the corridor include the Hermit, Grandview, Tanner, South Bass, Hance/Red Canyon, and Thunder River Trails.

Within the impact analysis area (depicted in Figure 1-1), popular sites include Hermit's Rest (on the South Rim), Bright Angel Point, Phantom Ranch, Point Sublime, Point Imperial, Toroweap Point, and Supai Village.

3.6.2 Grand Canyon West Tourism and Recreation Areas in the Hualapai Reservation

Grand Canyon West is an area of approximately 9,000 acres in the northwest corner of the Hualapai Reservation. The Hualapai Tribe has designated the Grand Canyon West area for economic development through tourism and recreational uses. Since 1988, the Hualapai Tribe has worked with air and bus services based in Las Vegas, Nevada, to bring visitors to Grand Canyon West. Grand Canyon West receives approximately 100,000 visitors annually. Current improvements at Grand Canyon West consist of a paved airstrip, a terminal building, a visitor center with shops and restrooms, paved roads to scenic vistas, mobile homes for Grand Canyon West employee lodging, water tanks, a dining facility, and a scenic vista at Guano Point where lunch is served to visitors, and hiking trails along the Grand Canyon Rim. An undeveloped Grand Canyon viewing area at Quartermaster Point is part of the Grand Canyon West tours conducted by a Hualapai tribal corporation. The Tribe has invested 15 million dollars on these improvements and on infrastructure to accommodate further tourism development at Grand Canyon West.

In addition, a Hualapai tribal enterprise conducts float trips down portions of the Colorado River. The Tribe grants trespass permits for vehicles that use the Diamond Creek Road to access the Colorado River. The Tribe also regulates trophy big-game hunting on the plateau and smaller canyons along the Grand Canyon through permits for Desert bighorn sheep, elk, antelope, and mountain lion, and all hunters must be accompanied by a tribal guide. The number of permits is limited to ensure conservation of game species.

The Hualapai Tribe has designated Grand Canyon West for further development to serve larger numbers of visitors and accommodate overnight visitors. The Tribe anticipates that development will include moving the airport away from the rim and constructing a lodge at Quartermaster Canyon, one or more restaurants, a museum/cultural center, and additional hiking trails.[12] The Tribe intends that all structures will have low profiles with Canyon view windows designed to provide visitors with scenic vistas while minimizing the visual impact of the building from the Canyon Rim area and the Colorado River. With these improvements, the Tribe projects that visitors will increase to approximately 500,000 annually in six years. The Tribe's plans for Grand Canyon West are the primary means identified by the Tribe to address its high unemployment rate while preserving the Tribe's natural and cultural resources. Areas designated for development at Grand Canyon West are away from important traditional cultural site areas. The Tribe also plans to improve the habitat at Grand Canyon West to increase wildlife native to the area.

3.6.3 Historic/Cultural/Archaeological Sites in the GCNP

Historic properties in GCNP listed on the National Register of Historic Places consist primarily of buildings associated with tourism, park administration and operations, and mining enterprises. In total, 884 buildings are included in the park's list of classified structures, 61 of which are archaeological sites with standing walls.[13]

Four historic districts and two historic buildings on the South Rim are listed on the National Register of Historic Places. These and other eligible properties are identified in the 1995 GCNP General Management Plan/Environmental Impact Statement. Eligible properties receive the same protection as listed properties (in the National Register) under the NHPA. The Grand Canyon Village Historic District includes some 238 buildings, four of which have been designated as National Historic Landmarks—the "El Tovar" Hotel, the Grand Canyon park operations building, the Grand Canyon powerhouse, and the Grand Canyon railroad station. The Mary Jane Colter Historic District (also designated a national historic landmark) consists of four buildings—Hopi House, Lookout Studio (both of which are also in the Grand Canyon Village Historic District), Hermits Rest, and Desert View Watchtower. The Grandview Mine and Orphan Mine historic districts, the latter having been determined eligible for listing in 1994, are representative examples of mining operations in the park. Two other national register properties are located on the South Rim—the water reclamation plant and the Tusayan Ruins.[14]

Three historic districts on the North Rim are listed in the National Register of Historic Places. These include the Grand Canyon Inn (North Rim Inn) and Campground District, the Grand Canyon North Rim Headquarters Historic District, and the Grand Canyon Lodge Historic District, the latter a designated National Historic Landmark.[15]

Other historical districts in the park include the Cross-Canyon Corridor District and the Trans-Canyon Telephone Line District. The Cross-Canyon Corridor District includes 44 buildings and structures as well as the Bright Angel, South Kaibab, North Kaibab, and connecting river trails. Among the principal structures in the district are four trailside rock shelters and the Phantom Ranch complex, including the five original stone buildings designed by Mary Jane Colter for the Fred Harvey Company along Bright Angel Creek at the bottom of the Grand Canyon in 1922.[16]

Archaeological resources are also prevalent. The earliest suggestion of human use of the Grand Canyon is a Folsom projectile point discovered in the Marble Canyon area, which may have been left there as early as 10,500 years ago. Consistent, well-documented evidence of human use of the Grand Canyon appears in the form of small figures made of split-willow twigs that represent game animals and date to about 2,500 B.C. Habitation levels of the canyon appear to have been relatively stable until around 500 A.D., when small groups of basketmakers began living in modest villages of circular pit-houses with mud and brush roofs, and using a distinctive gray pottery. The population of the canyon then began to grow considerably. The population increased dramatically by 1100 A.D.; of the more than 2,700 archaeological sites known within the park, 70 percent were occupied between 1050 A.D. and 1150 A.D.[17]

Only a small portion of the park has been formally surveyed for archaeological sites, but more than 3,700 have been recorded. The river corridor, the southern extension of the Walhalla Plateau on the North Rim (known as Walhalla Glades), portions of the Grand Canyon Village, the trans-canyon corridor, and portions of East Rim Drive have been systematically surveyed for archaeological resources; these are all areas that receive heavy visitation and disturbance by modern visitors. The remainder of the canyon has not been thoroughly inventoried. Archaeologists estimate there may be as many as 61,000 sites in the park. The density of sites in surveyed areas averages 1 site in 20 acres and ranges from 1 site for every 7 acres in the vicinity of the Grand Canyon Village to 1 site in 349 acres on Swamp Ridge. The estimated density for the North Rim is 1 site in every 14 acres and 1 site in every 31 acres on the South Rim.[18]

Site density on the South Rim is high, with archaeological materials nearly continuous from Buggeln Hill (east of the Kaibab monocline) to Desert View. In addition to the prehistoric materials, the area contains remains suggesting limited and continuous use into historic times. The area near the Hance trailhead is known to be sacred to the Havasupai.[19]

The North Rim has some of the most important archaeological sites in the park, especially in the Walhalla Glades area. The expansion and exploitation of the North Rim by ancestral Puebloan peoples is evidenced by the extensive remains found on the North Rim, particularly in Walhalla Glades. Intensive surveys of this 4,000-acre area have located hundreds of sites. There are only three known archaeological sites near Bright Angel Point, but none within the existing development area. One small masonry structure lies near the Rim Transept trail and is currently interpreted to the public.[20]

There are a large number of archaeological remains in the Tuweep area; the entire Esplanade consists of a dispersed scatter. Three recorded sites are within the campground and are sustaining ongoing impacts from visitor use.[21] The corridor trails were used prehistorically and pass many archaeological sites of varying size and importance. The trails have been surveyed for archaeological resources, but subsequent checks have indicated that the existing data are of poor quality. Archaeological sites near trails often receive some of the greatest impacts from erosion and illicit collection. Human burials associated with ancestral Puebloan occupation have been found at an archaeological site near Cottonwood Camp on the North Kaibab Trail.[22]

Phantom Ranch contains one well-studied pueblo and a number of features associated with it. Human burials have been found nearby. Besides having considerable evidence of Puebloan use, Indian Garden was the home of several Havasupai families until well into the 20th century.[23]

3.6.4 Historic/Cultural/Archaeological Sites in the Hualapai Reservation

The Hualapai Tribe are descendants of the 14 bands of the Pai (people) from the Grand Canyon and vicinity in the northwest quarter of Arizona. The Hualapai have occupied and used the lands and water lying within their aboriginal territory, including their present Reservation, for more than a thousand years. The Colorado River itself is a significant landmark for the Hualapai, both physically and spiritually. The Colorado River is the northern boundary of the Hualapai Reservation. The Hualapai traditionally practiced agriculture and hunted game extensively in and around the Grand Canyon and tributary canyons. Traditional Hualapai dwellings are small, dome-shaped structures, known as wicki-ups, constructed with small poles and branches covered by juniper bark or thatched. Traditional structures also include rock shelters, sweat houses, and rectangular, flat-roofed shade houses. Traditional ceremonial sites continue to be used today.

By an agreement between the Hualapai Tribe and the NPS dated August 20, 1996, the Hualapai Tribal Historic Preservation Officer (THPO) (the Director of the Department of Cultural Resources of the Hualapai Tribe) assumed certain responsibilities of the State Historic Preservation Officer, including those for § 106 of the NHPA, for the Hualapai Reservation.

In March 1998, the FAA and the Hualapai Tribe entered into a Statement of Work (SOW) providing for the Hualapai Department of Cultural Resources to conduct a study to assist the FAA in identifying, documenting, and evaluating TCPs within the area of potential effect (APE) for FAA actions over the Hualapai Reservation. The FAA actions covered by the study are actions in compliance with Public Law 100-91, planning the revisions to the SFRA in the vicinity of the GCNP and the associated air tour routes. The SOW provides for three phases of study.

Since the SOW was signed, the FAA has revised the proposed tour routes. The federal agencies and the Tribe are in the process of revising the APE to account for the route changes and associated noise exposure. Therefore, the FAA and the Tribe will amend the SOW to add the areas on the Hualapai Reservation within the new APE that the Hualapai Tribe identifies as especially critical and sensitive. Based upon the Ethnographic Study report dated March 1999, at least seven areas of concern may be affected by the Proposed Action. Consultation under § 106 on these additional areas will be completed prior to the FAA's issuance of a Final Decision on the proposed air tour routes. The FAA anticipates entering into a Programmatic Agreement with the Hualapai Tribe to comply with § 106.

The Hualapai Department of Cultural Resources has provided the FAA with extensive information about TCPs located on the Hualapai Reservation and archaeological sites associated with those TCPs in a draft report for Phase I recently submitted pursuant to the SOW. The draft report will be revised to include areas added to Phase I by the amendment to the SOW. The Hualapai Tribe has also provided information to the FAA in written comments and correspondence on previous route proposals and verbally in meetings with the FAA since 1996. Through these communications, the Hualapai Tribe has indicated that the natural quiet, privacy, and natural viewscape of the TCPs on the Hualapai Reservation are important characteristics of these sites that are considered to contribute to their eligibility for listing on the National Register of Historic Places.

Specific information about TCPs and associated archaeological sites on the Hualapai Reservation is not disclosed here to protect those resources. Section 304 of the NHPA, as amended, and § 9(a) of the Archaeological Resources Protection Act of 1979 authorize the restriction of information about the location, nature, and character of cultural and archaeological resources where disclosure may create a risk of harm to the resources or their setting. As explained in NPS' National Register Bulletin 29, "Guidelines for Restricting Information About Historic and Prehistoric Resources," "[c]ultural resources are often fragile, and their value as a physical representation of the past and as a source of information about human activities can easily be destroyed by theft, vandalism, and unauthorized public visitation." When a "resource is used in traditional cultural practices, such as those by Native Americans and Pacific Islanders, and disclosure would likely result in a desecration of the property," then the resource's location and character should be restricted. The Hualapai THPO has advised the FAA that the disclosure of the location and/or character of the TCPs and associated archaeological sites on the Hualapai Reservation would likely result in theft, vandalism, desecration, and unauthorized public visitation of those sites.

3.6.5 Wild and Scenic River Segments in GCNP

GCNP includes 277 miles of the Colorado River, one of the longest and most challenging recreational whitewater rivers in the world, with 160 recognized rapids. The NPS reports that the Colorado River within the GCNP as well as many of its major tributaries meet the criteria but has not been designated as part of the national wild and scenic rivers system.[24] The NPS is required by its Management Policies (1988), consistent with applicable legislation, to manage its lands which meet the criteria for this designation the same as if they were so designated. This is to preserve the resources pending Congressional action.

3.7 NATURAL RESOURCES

In addition to geologic resources previously described, the Grand Canyon region is one of the most ecologically diverse in North America. Plant communities vary from cool, moist, subalpine forests and meadows between 8,000 and 9,000 feet elevation, to those of the hot, dry Great Basin, Sonoran, and Mojave Deserts at elevations as low as 1,200 feet. Grand Canyon vegetation is primarily controlled climatically, "with precipitation, maximum summer temperatures, and minimum winter temperatures inter-acting to distribute plants into more or less discrete elevational zones."[25] As noted in Section 3.1, these characteristics contribute to GCNP's significance as a World Heritage Site.

3.7.1 Wilderness and Wildlife Resources in the GCNP

Over one million acres in the park meet the criteria for wilderness designation as part of the National Wilderness Preservation System. If combined with over 400,000 additional acres of proposed or designated wilderness contiguous to the park boundary, this area could become one of the largest, primarily desert wilderness areas in the United States.[26] The NPS is required by its Management Policies (1988), consistent with applicable legislation, to manage its lands which meet the criteria for this designation the same as if they were so designated. This is to preserve the resources pending Congressional action.

Because of the diverse geologic, ecologic, and climatic conditions within the park, there are about 1,500 plant species, 290 bird species, 90 species of mammals, 60 reptile and amphibian species, and 25 species of fish. These include three plant and nine animal species listed as endangered on the U.S. List of Endangered and Threatened Species (see **Table 3.1**).[27] Table 3.1 will be updated in the Final EA to reflect recent changes in the FWS candidate categorization. Only two of the endangered species are not ground-living. The endangered species most likely to be affected by the proposed SFAR modifications would be the avian species, specifically the American peregrine falcon and the California condor. Section 4.9 discusses the potential for impacts to these endangered species.

Additionally the Hualapai Tribe has provided a listing of the following species of special concern to the Tribe: mule deer; chuckwallas; eagles; hawks; falcons; cottontail rabbits; pronghorn antelope; and Desert bighorn sheep.

3.7.2 Wilderness and Wildlife Resources in the Hualapai Reservation

The Hualapai Tribe's Reservation encompasses nearly one million acres of land in the lower Grand Canyon. Due to the great diversity of wildlife habitats on these rugged lands, there is a great diversity of both game and non-game wildlife. Desert bighorn sheep, elk, deer, antelope, turkey, quail, and Mourning Doves are all species that are hunted on the Hualapai Reservation. Non-game wildlife include numerous small mammal species, including the endangered Hualapai Mexican Vole, a variety of birds, lizards, snakes, and amphibians.

The Hualapai people have traditionally depended on some of these wildlife species for their sustenance. Desert bighorn sheep, mule deer, chuckwallas, eagles, hawks, falcons, cottontail rabbits, and pronghorn antelope are all species that have been of great importance to the Tribe for food and for use in ceremonies and continue to be of special concern to the Hualapai people today.

The Colorado River provides a variety of habitats for wildlife, fish, and other aquatic organisms. Included are several endangered species such as the Southwestern Willow Flycatcher, razorback sucker, and humpback chub. In 1997, the Southwestern Willow Flycatcher was first documented to successfully nest in the lush riparian vegetation in lower Grand Canyon. In addition, over 50 other bird species nest on

Table 3.1

Species of Special Concern In and Adjacent to Grand Canyon

North Rim	Category
North Rim	
American peregrine falcon	E
Mexican spotted owl	T
Cliff milk vetch	C2
Grand Canyon rose	C2
Northern goshawk	C2
North Rim primrose	C2
Bittterweed	C3
Century plant	C3
Dutch primrose	C3
Eriogonum zionus var. coccineum	C3
Kaibab beardtongue	C3
Kaibab paintbrush	C3
Kaibab saber daisy	C3
Mogollon columbine	C3
Tawny turpentine bush	C3
Western fairy slipper	SR
South Rim	
American peregrine falcon	E
Hualapai Mexican vole	E
Sentry milk vetch	E
Mexican spotted owl	T
Grand Canyon catchfly	C2
Grand Canyon rose	C2
Northern goshawk	C2
Phacelia serrata	C2
Navajo Mountain Mexican vole	C2
Tusayan flameflower	C2
Camisionia specuicola var. specuicola	C3
Mogollon columbine	C3
Slender rock cress	C3
Arizona leather flower	C1 (only)
Tusavan rabbit brush	C2 (only)
Kaibab bladderpod	C2 (only)
Other Sensitive Species	
Greater Western mastiff-bat	C2
Houserock Valley chisel-toothed kangaroo rat	C2**
Pediomelum castoreum	C2**
Southwestern river otter	C2
Spotted bat	C2**
Whiting dalea	C2
Arizona shrew	C2
Camissonia confertiflora	C2
Cave myotis	C2
Ferruginous hawk	C2
Fringed myotis	C2
Loggerhead shrike	C2
Long-eared myotis	C2
Mt. Trumbull beardtongue	C2
Mexican Long-tongued bat	C2

	Category
Tuweep	
American peregrine falcon	E
Bunch flower evening primrose	C2
Grand Canyon rose	C2
Corridor Trails	
American peregerine falcon	E
Southwestern willow flycatcher	T
Roaring Springs prickly poppy	C2
Grand Canyon catchfly	C2
Chuckwalla	C2
Mogollon columbine	C3
Camissonia specuicola var. specuicola	C3
Bigelow onion	SR
Our Lord's candle	SR
Other Sensitive Species (continued)	
Black-footed ferret	E
California condor	E
Brady pincushion cactus	E**
Hualapai Mexican vole	E
Colorado Pike - minnow	E
Humpback chub	E
Bonytail chub	E
Kanab ambersnail	E
Razorback sucker	E
Desert tortoise	T
Bald eagle	T
Little Colorado spinedace	T
Navajo sedge	T
San Francisco Peaks groundsel	T
Silver pincushion cactus	T
Welshs milkweed	T
Parish Alkali Grass	PE
Fickeisen pincushion cactus	C1**
Coconino Arizona pocket mouse	C2
Ditch evening primose	C2**
Flannelmouth sucker	C2
Grand Canyon cave pseudoscorpion	C2
Yuma Myotis	C2
Long-legged myotis	C2
Lowland leopard frog	C2
Marble Canyon kangaroo rat	C2
Mt. Trumbull beardtongue	C2
Occult little brown bat	C2
Pale Townsend's big-eared bat	C2
Prospect Valley pocket gopher	C2
Roundtail chub	C2
Small-footed myotis	C2
Western burrowing owl	C2
Yellow-flowered desert poppy	C2
White-faced Ibis	C2

Table 3.1

Species of Special Concern In and Adjacent to Grand Canyon

North Rim	Category		Category
Greater western mastiff bat	C2	Speckled Dace	C2
Allen's big-eared bat	C2	Our Lord's candle	SR
Big free-tailed bat	C2	Blue curls	SR**
California leaf-nosed bat	C2	Navajo Bridge cactus	SR**
Grand Canyon flaveria	C3	Western red bat	SC-S
Carex scirpoidea var. curatorum	C3	Black-crowned night heron	S

** Only known outside the park

E = Endangered (U.S. Fish and Wildlife Service)
T = Threatened (U.S. Fish and Wildlife Service)
PE = Proposed endangered listing
SC = Candidate for State's threatened native wildlife list
S = Sensitive (U.S. Forest Service)
SR = Salvage restricted (as defined by Arizona Native Plant Law)
Category 1, 2, or 3 Candidate Species - taxonomic groups or species being considered for threatened or endangered status
C1 = data exist to support listing; additional data being gathered about precise habitat needs or boundaries for critical habitat designations.
C2 = data exist to possible support listing, but substantial data about biological vulnerability and threats lacking; further research and field study required.
C3 = no longer being considered for listing because of extinction, not classified as species, or more abundant or widespread than previously believed.

Sources: Sender (GRCA_Wildlife_Biologist@nps.gov) (1999, April 29). Endangered Species List. E-mail to Fred Bankert (Bankert_Fred@prc.com); NPS GMP DEIS, March 1995, pg. 136, updated from NPS GMP FEIS, July 1995, pg. 35.

the Hualapai Reservation along the Colorado River. In all, the remote nature of these lands offers a great variety and abundance of wildlife and spectacular wilderness experiences.

Plants of special concern, and ones that have been used traditionally by tribal members for food, medicinal purposes, and in ceremonial activities are the ponderosa pine, pinyon pine, Goodding's willow, sage brush, agave, mesquite, and other species known only to the Hualapai. The primary mineral of concern on the Hualapai Reservation is the hematite used for ceremonial activities. Other minerals of importance are, again, known only to the Hualapai people.

3.7.3 Noise Environment

The Grand Canyon is noted for its rich sound environment. Such sounds include the rushing water, the Canyon warbler's cascading song, the wind whistling through the pines, and thunder and lightening heralding a desert storm, as well as a sense of quiet. These are in contrast to the sounds of visitors talking, cars moving around the South Rim, tourist buses idling, aircraft flying, motorboats speeding up from Hoover Dam, mules baying, and so forth. Congress required the NPS to substantially restore "natural quiet" in the GCNP. "Natural Quiet" is a resource for which the GCNP was established and under the NPS Organic Act, as amended, is to be protected.

Ambient noise has been described as the continuous background sound environment (such as waves breaking on the shore, or a distant waterfall, or absolute silence in the absence of any wind or sounds from other sources). The ambient environment establishes the quieter moments in a setting and can mask intermittent sources (such as aircraft under some conditions). However, even in loud ambient settings, such as near waterfalls, distant sounds such as aircraft can sometimes be clearly audible.

The range in ambient sound levels, even from indigenous sources, can vary considerably from one location to another, or time to time at any given location. At one end of the spectrum is the sound level at the base of a powerful waterfall. At the other end of the spectrum is the near absence of any perceptible sound at all. These latter conditions may be found in areas devoid of flora or fauna. In the middle is an array of sound conditions which vary from moment to moment, hour to hour.

During non-inclement weather conditions, these variations result from three factors in natural environments:

- Wind (its interaction with foliage, irregular terrain, or the human ear)
- Water (movement in streams, falls, or wave action)
- Animal (near continuous, such as insect; or intermittent, such as birds, coyotes, etc.)

Figure 3-1 illustrates ambient noise within the noise study area.

3.8 POPULATION AND GROWTH CHARACTERISTICS

FAA Order 1050.1D requires that the affected environment section of an environmental assessment "identify, as appropriate, population and growth characteristics of the affected area...."[28] In the context of the proposed action, the appropriate demography to consider includes visitors to the GCNP and residents of affected communities, including Native Americans.

Therefore, the following sections describe the expectations of GCNP, Hualapai reservation visitors and, where data is available, indicators of visitor activity. Local communities are also discussed.

3.8.1 National Park Visitors

Understanding visitor expectations and the nature of visitor activity at GCNP is important in assessing aircraft noise impacts. The following discussion attempts to enhance the understanding of visitor types and park areas where restoring natural quiet is of greatest concern, keeping in mind the overall goal of substantial restoration of natural quiet.

Surveyed Visitor Expectations

The NPS surveyed GCNP visitors to rank the various reasons for their visit to the park. The results indicate the expectations visitors have for their experience at the park. The ability of the park to fulfill these expectations is considered by NPS as an important factor in visitor satisfaction, the success of the park, and the ability to meet mission requirements.

Throughout the National Park System, approximately 90 percent of visitors rated "enjoy[ing] the natural quiet and sound of nature" as moderately to extremely important. At GCNP, 90 to 95 percent of responses from a mail survey gave natural quiet a similar rating. Visitor type affected response rates substantially, especially among visitors rating natural quiet as "extremely important."

Table 3.2 summarizes the approximate value placed on natural quiet by different visitor types at GCNP.[29] It should be noted that the FAA has concern regarding the subjectivity of visitor survey data for the purposes of measuring aircraft noise impacts.

Table 3.2

Visitors to GCNP Rating Natural Quiet as Extremely Important

Visitor Type	Rating (approx. %)
Frontcountry	35%
Summer Backcountry	50%
Fall Backcountry	75%
River (Motor)	68%
River (oar)	88%

Source: National Park Service, Report to Congress, Fig. 9-4.

Survey results also clearly report that there are many other moderately to extremely important reasons for visits to GCNP. Overall, over 85 percent of visitors report exercise, learning, and family activity among the most important reasons.[30]

Visitor Activity

Table 3.3 shows recent activity levels by selected visitor types at GCNP. It is important to note that most classes of visitor activity at GCNP are limited or controlled in some way by the NPS to insure that there will be no derogation or impairment of resources and values.[31]

3.8.2 Hualapai Reservation Residents and Visitors

As noted above, the Hualapai Reservation has a resident population of approximately 1,800 persons. Residents include 1,000 enrolled Tribal members and 800 non-enrolled persons (primarily Native American), with the majority of this population residing at Peach Springs near the southern edge of the Reservation. Per capita income of Indian residents of the Hualapai Reservation was $3,630 in 1990. Over 56 percent of Indian residents were below the poverty level in the 1990 Census, and over 80 percent were below the U.S. Department of Housing and Urban Development's Very Low Income Standard in 1991. The Reservation unemployment rate is quite high: 56 percent according to 1995 BIA Labor Force data and up to 70 percent seasonally according to the Hualapai Tribe's most recent data.

When Hualapai Reservation residents are in Peach Springs, they can be assumed to have the noise and visual intrusion expectations of residents of similar small residential communities. However, Hualapai tribal members have different noise and visual intrusion expectations when they are engaged in ceremonies at traditional cultural sites. Tribal members have strong expectations of natural quiet at traditional cultural sites because their traditional activities usually require natural quiet. They also have strong expectations of privacy from outsiders and a natural viewscape. These are essential to the proper performance of traditional activities at traditional cultural sites.

3.8.3 Local Communities[32]

Several communities are located near GCNP, with the largest near the South Rim. These communities are dependent upon GCNP due to the tourist activity and employment generated by GCNP. GCNP depends upon these communities for traveler facilities that do not exist at the park and for permanent and seasonal employees. The communities with most immediate relevance to GCNP and this study are discussed briefly below.

Supplemental Environmental Assessment

Ambient Noise Levels in Grand Canyon Noise Study Area

FIGURE 3-1

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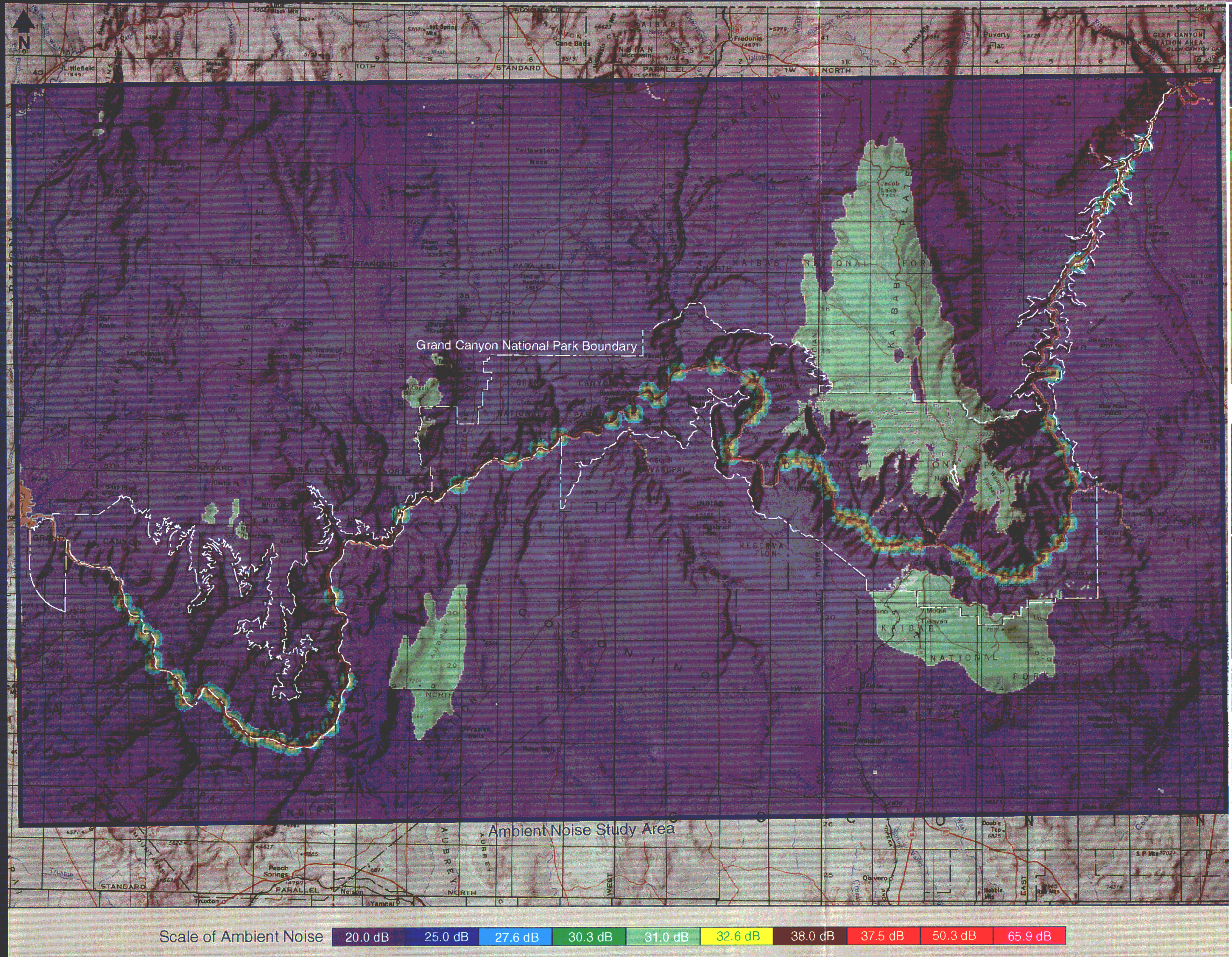
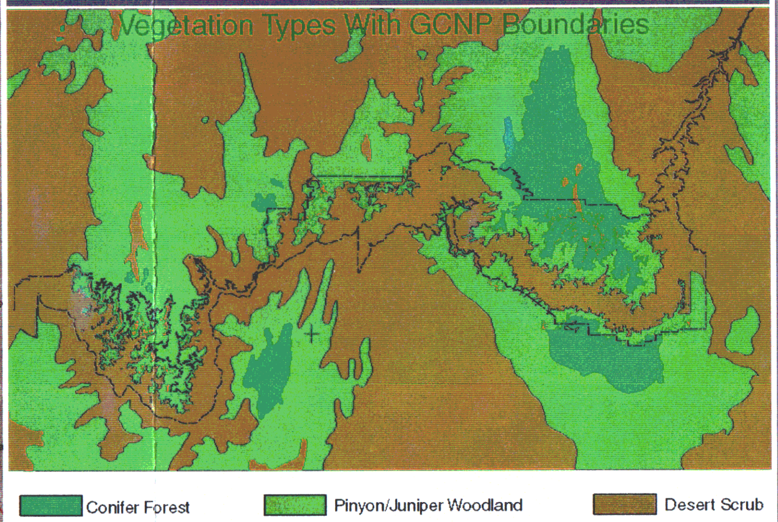
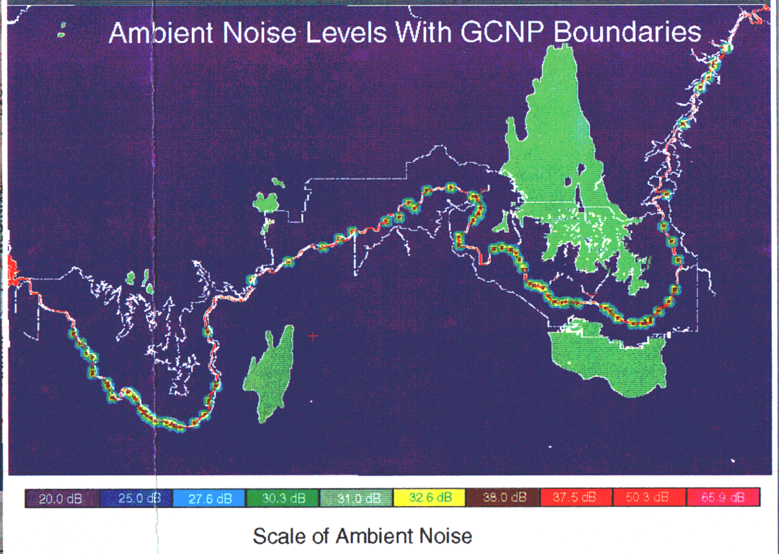




Relationship of Ambient Noise to Vegetation within the Analysis Area



10 STATUTE MILES

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Table 3.3

GNCP Visitor Activity Level

Total Visitors to GCNP	
1993	4,928,509
1994	4,702,989
1995	4,908,073
Inner Canyon Visitors	
1995 Overnight Backcountry Hikers*	47,563 people 115,478 user nights
1995 Colorado River Users*	23,459 people 168,602 user nights
1994 Mule Riders - day trips**	16,440 people
1994 Mule Riders - overnight trips**	4,766 people

* Numbers of overnight backcountry and river users are strictly limited by permit systems, use limits and scheduling.

** Numbers of mule riders are limited by concession contracts and facility capacities.

Note: 1994 numbers were used for mule riders because severe flooding and government shutdowns in 1995 severely reduced the number of mule riders from normal levels. While overnight backcountry hikers and river users were affected to some extent by the flooding and shutdowns, the total 1995 numbers for those groups are close to normal, and it was felt that those groups were not as adversely affected as mule riders for a number of reasons.

Source: National Park Service.

The South Rim communities are Grand Canyon Village, Tusayan, and Valle. These three communities are located on Arizona 64/U.S. 180. These communities are service areas for the majority of park visitors; they also function as residential areas for households of NPS and private service business employees. The economies of all three communities are oriented to serving park visitors.

Grand Canyon Village provides housing for NPS and concessionaire employees and their families. The village's population was reported to be 1,499 at the time of the 1990 census. During mid-summers, the addition of seasonal workers increases the village's population to about 2,100. The State of Arizona projects the year-round population of Grand Canyon Village to be 1,950 in 2010 (Arizona Department of Economic Security 1993a). Based on the current ratios for permanent-to-seasonal workers, the peak summertime population is projected to be 2,730 in 2010.

Tusayan is an unincorporated community three miles from the park's south entrance. The 1990 population of Tusayan was 555. Tusayan's population is estimated to increase to about 1,000 during the peak of the tourist season. The State of Arizona projects the year-round population of Tusayan to be 1,000 in 2010 (Arizona Department of Economic Security 1993a). Based on the current ratios for permanent-to-seasonal workers, the peak summertime population would be 1,800 in 2010. Tusayan's business district is almost exclusively oriented to serving tourists going to and from the park.

Grand Canyon National Park Airport (see Figure 3-1), south of Tusayan is the third busiest in Arizona, with 535,000 deplanements in 1993. Long-range plans are to expand the airport in anticipation of continued growth in air travel. Commercial air tour flights over the Grand Canyon are staged out of the airport area.

Valle is a small unincorporated community at the junction of Arizona 64 and 180. The 1990 census reported its population to be 123; its population increases during the tourist season. No population projections are available.

Communities outside the east entrance to the park include Page, Tuba City, Cameron, and Gray Mountain. U.S. 89 links these communities and is traveled by tourists visiting either the park's North or South Rims.

Much of the East Rim area is on the Navajo Reservation. Tuba City and Cameron are on the Reservation, and Page and Gray Mountain are adjacent to it.

The Colorado River and the Grand Canyon serve as barriers that isolate North Rim communities from the more populated areas of Coconino County. The North Rim communities include the developed North Rim area within GCNP (including Bright Angel Point), Jacob Lake, Fredonia, Kanab, and Marble Canyon. Visitors to the North Rim travel U.S. Alternate Route 89 east through Fredonia or west through Marble Canyon to Jacob Lake. From Jacob Lake, Arizona 67 provides a direct route to the park's North Rim.

3.9 RELATIONSHIP OF PROPOSED ACTION TO NATIONAL PARK SERVICE GOALS FOR GCNP

In its September 1994 report to Congress, the NPS reviewed its mandates, regulations, policies, and plans related to the protection of natural quiet and the provision of various visitor experience opportunities. From this review, a statement of management goals and objectives was developed to further assist the NPS in its evaluation of the effectiveness of SFAR 50-2.

1. Substantially restore natural quiet as a natural resource.
2. Provide recreation opportunities and experiences for park visitors, consistent with park policies, where the opportunity for natural quiet is an important component.
3. Mitigate any aircraft-related impacts on other natural and cultural resources.
4. Address issues of health, safety and welfare of on-ground visitors and employees.
5. Restore and maintain natural quiet by protecting the wilderness character of remote areas.
6. Provide primitive recreation opportunities without aircraft intrusions in most backcountry areas, most locations on the river, and at destination points accessed by both.
7. Provide developed recreation opportunities with limited aircraft intrusions for visitors at rim developed

areas and major frontcountry destination points.

8. Provide for protection of sensitive wildlife habitat areas and cultural resources.

9. Provide for welfare and safety of below-rim, backcountry, and rim visitors.

10. Provide a quality aerial viewing experience while protecting park resources (including natural quiet) and minimizing conflicts with other park visitors.

As with previous revisions to Subpart U of Part 93, the proposed actions addressed in this document would advance many of these NPS goals without derogating any. Enlarging the SFRA boundary by more than three percent responds to Native American interests (specifically, the Hopi and Zuni Tribes and the Navajo Nation). Modification and increasing flight-free coverage, and removing and realigning flight corridors represent substantial steps furthering NPS goals for GNCP.

Chapter Four
ENVIRONMENTAL CONSEQUENCES

This chapter presents the analysis conducted to determine the environmental impacts of the No Action Alternative and the three proposed Alternatives under consideration in the GCNP and the surrounding area, hereafter referred to as the GCNP study area. The primary goal of the Proposed Action, as implemented through the proposed alternative, is to substantially restore natural quiet. The chapter summarizes the unique conditions underlying this analysis. The environmental factors considered are those contained in FAA Orders 1050.1D and the 1995 Report to Congress (NPS Report on Effects of Aircraft Overflights on the National Park System, July 1995). The primary environmental consideration in the GCNP study area is noise. The analysis presented herein indicates that the noise environment for the entire study area is improved by all of the proposed alternatives. The analysis also demonstrates that progress towards restoration of natural quiet can be achieved with any of the proposed alternatives, however without implementation of an operational freeze these results are diminished over time. At certain representative locations, predicted noise levels increase with the proposed alternatives when compared to the No Action alternative, however for the majority of locations a decrease is observed.

4.1 NOISE

This aircraft noise modeling study was conducted to predict sound levels from tour aircraft activity in the vicinity of GCNP. The scope of the study area was defined by the smallest rectangle encompassing the entire GCNP boundary which includes the area of noise exposure from the commercial air tour routes. The total area amounts to approximately 13,510 square statute miles, 145.5 statute miles east-to-west by 92.9 statue miles north-to-south. The study area is shown in Figure 3-1.

The purpose of the study was to compare a No Action Alternative and Proposed Alternatives (which consider commercial air tour routes) with or without the implementation of commercial air tour limitations. This comparison is: to identify the alternative that best accommodates the goal of substantially restoring natural quiet, with or without commercial air tour limitations; to examine whether any significant adverse effects could be expected; and to disclose any benefit as well as impacts that would result from the federal action. The analysis was conducted to meet two objectives:

1. Determine whether the Proposed Action when compared to the No Action and two other alternatives will result in any significant noise impacts, either within or outside of GCNP.

2. Determine the effectiveness of the Proposed Action, with consideration of the No Action Alternative and two other alternatives, in providing substantial restoration of natural quiet to GCNP.[34]

The noise analysis was conducted by the FAA's Office of Environment and Energy, in conjunction with the Volpe National

Transportation Systems Center Acoustics Facility (Volpe Center). The FAA and NPS provided data used in the modeling process.

The analysis estimates aircraft sound levels by providing values of equivalent sound levels for a specified time period, T (L_{AeqT}) and percentage of time, T, within which aircraft are audible (%TA_T). For definitions of L_{AeqT} and %TA_T, refer to **Appendix B.** These noise metrics are described in more detail below.

Because of the unique physical and natural environment in the study area, technical considerations were associated with this modeling task which are not normally employed in aircraft noise studies. The following sections address the technical issues, discuss the modeling assumptions used in the analysis, and compare the findings and results for the four Alternatives.

4.1.1 Noise Criteria

Traditionally, the scope of issues to be addressed relates to proposed airport and airway expansion projects. The analysis of aircraft noise focuses on communities and parks in the vicinity of airports and military airfields. In these situations, interference with activities such as education, adverse health effects, conversation, sleep, listening to radio or television, and traditional recreational activities are the important issues. The Proposed Action and alternatives under consideration in this Draft Supplemental EA reflect the mandate of the National Park Overflight Act. The issues have been expanded and modified here to address the statutory requirements applicable to the GCNP. The following explains the separate criteria used to evaluate the effects of the Proposed Action and alternatives considered in this Supplemental EA.

Significant Noise Impacts for Study Area

Generally, the FAA used the land use compatibility guidelines in 12 CFR Part 150, Appendix A, Table 1, to evaluate the potential significance of increases in noise on land uses in the study area, including residential land uses and traditional recreational activities. Under these guidelines significant noise impacts occur if the Day-Night Average Sound Level (DNL, represented by the symbol L_{dn}) of 65 dB is exceeded subsequent to any of the Proposed Alternatives, but not prior to the actions. This criterion of L_{dn} 65 dB is examined in terms of an equivalent sound level for a 12-hour period, L_{Aeq12h}. The L_{dn} criterion translates to L_{Aeq12h} = 68 dB (see **Appendix C**). Contours of L_{Aeq12h} and computations of levels at representative locations are used to judge this type of noise impact.

The FAA relied upon these guidelines where the land uses specified in Part 150 were relevant to the value, significance, and enjoyment of the land uses in the study area. Effects on Dr. Tommy's Mountain, a TCP and any other cultural resources that are identified during consultation with the Hualapai Tribe pursuant to the NHPA will be evaluated by considering the activities associated with it and whether a quiet setting was a generally recognized feature or attribute of its significance. Section 106 consultation is ongoing. Effects on any other TCP identified will also be evaluated using this criteria.

Restoration of Natural Quiet in GCNP

The second criterion examines progress toward restoring natural quiet. In the Report to Congress (RTC), for aircraft overflights, the NPS defined "substantial restoration of natural quiet" in the Grand Canyon in the following quantitative way:

> ...substantial restoration requires that 50% or more of the park achieve 'natural quiet' (i.e., no aircraft audible) for 75 - 100 percent of the day. [RTC p 182]

This definition establishes several requirements for the criterion used to judge restoration of natural quiet. First, the criterion must consider aircraft-produced sound in terms of audibility. Second, audibility of aircraft must be examined for the entire area of the park. Third, audibility of aircraft needs to be examined throughout the day, which is defined as the 12-hour daytime period of primary visitor activity.

With these considerations, the criterion for judging progress toward substantial restoration can be described in the following terms. *Substantial restoration of natural quiet will be judged to be achieved when tour aircraft are audible for less than 25 percent of the day in more than half of the park area. Hence, to meet the NPS definition of substantial restoration, the total area of GCNP that experiences audible aircraft for more than 25 percent of the day must be less than half (50 percent) of the park.*

In this analysis, the noise metric that represents the percentage of time aircraft are audible during the 12-hour daytime period of primary visitor activity is the $\%TA_{12h}$ metric. According to the definitions listed above, when the 25 $\%TA_{12h}$ contour (the area where $\%TA_{12h} > 25$ percent) for a particular Alternative occupies less than half of the area of GCNP, then that Alternative has achieved substantial restoration of natural quiet at the Park.

Because the primary impact of aircraft sound in this context is its impact on natural quiet within the GCNP boundary, progress toward substantial restoration of natural quiet (increasing areas experiencing natural quiet) is an important indicator of no significant noise impacts. The FAA and the NPS have recognized that although sound levels may increase in some areas of the Park, progress toward the goal of substantial restoration is measured on a park-wide basis.

Ambient Sound Levels. For this study, the NPS provided the FAA with ambient sound levels for the area encompassed by the GCNP boundary. These GCNP ambient levels are shown in Figure 3-2.

The NPS ambient file was based on field measurements conducted for the NPS in GCNP (HMMH memorandum 295860.05, February 5, 1999—see **Appendix D**). The NPS assigned areas of land cover to one of three vegetative categories. These categories and their associated ambient sound levels are: pinyon/juniper woodland at 20 dB, desert scrub at 20 dB, and sparse conifer forest at 31 dB. The NPS-assigned areas influenced by the sounds of moving water are represented by two general categories: Colorado River rapids and water-affected. Within the Colorado River rapids category is a range of acoustic conditions from 25.0 dB to 65.9 dB for distances of 1,950 and 150 meters, respectively, from major rapids and falls. The water-affected category of 38.0 dB includes areas with perennial running water not included in the Colorado River rapids category. Figure 3-2 depicts all these categories and their ambient levels. Comparable ambient levels were applied outside the GCNP within the study area according to vegetation.

The NPS provided the FAA with two sets of ambient values, L_{50} and L_{90}. The FAA selected the L_{50} noise levels, which is the ambient sound exceeded 50 percent of the time, to represent the full range of natural sound levels. See Appendix D for details.

Audibility. The NPS has adopted the percent time audible metric for assessing noise and defining natural quiet in GCNP. This metric is defined as the percentage of time aircraft noise is audible to a human observer at a receptor location during the daytime period of primary GCNP visitor activity.

As part of the December 1996 Final EA, the FAA defined the threshold for evaluating substantial restoration of natural quiet as sound of up to three decibels above the ambient level. (See Final EA at Section 4-4.) Use of this methodology to estimate the percent of time that aircraft would be audible was upheld in Grand Canyon Air Tour Coalition v. FAA, 154 F.3d 455 (DC Cir. 1998). To more accurately reflect the potential for aircraft noise impacts in the GCNP based on the specific characteristics of the different areas of the Park, the NPS recently adopted, after publishing notice in the Federal Register and affording an opportunity for public comment, a noise evaluation criteria. (Change in Noise Evaluation Methodology for Air Tour Operations Over Grand Canyon National Park, 64 FR 3969; January 26, 1999).

As set forth by the NPS in its January 26, 1999 FR notice, different thresholds will be applied to each of two zones in evaluating progress toward achieving substantial restoration of natural quiet at GCNP. The NPS two-zone noise evaluation system reflects differences in visitor use, geography, facilities development, and regulatory constraints for specific geographic areas. **Figure 4-1** depicts the zones within GCNP and the study area for which these two audibility conditions apply.

As explained in the Federal Register Notice, a noticeability standard for time above analysis is used (average natural ambient level plus 3 decibels) for Zone One (about one-third of the Park), as well as the entire study area outside of the GCNP. In previous environmental assessments related to GCNP rulemaking since 1996, the noticeability standard was used singularly for the entire GCNP and study area. Zone One generally encompasses the Park's developed areas plus the Marble Canyon and Sanup regions. For Zone Two (about two-thirds of the Park), an audibility standard (average natural ambient level minus 8 decibels) is used to reflect higher noise sensitivity and active listening.

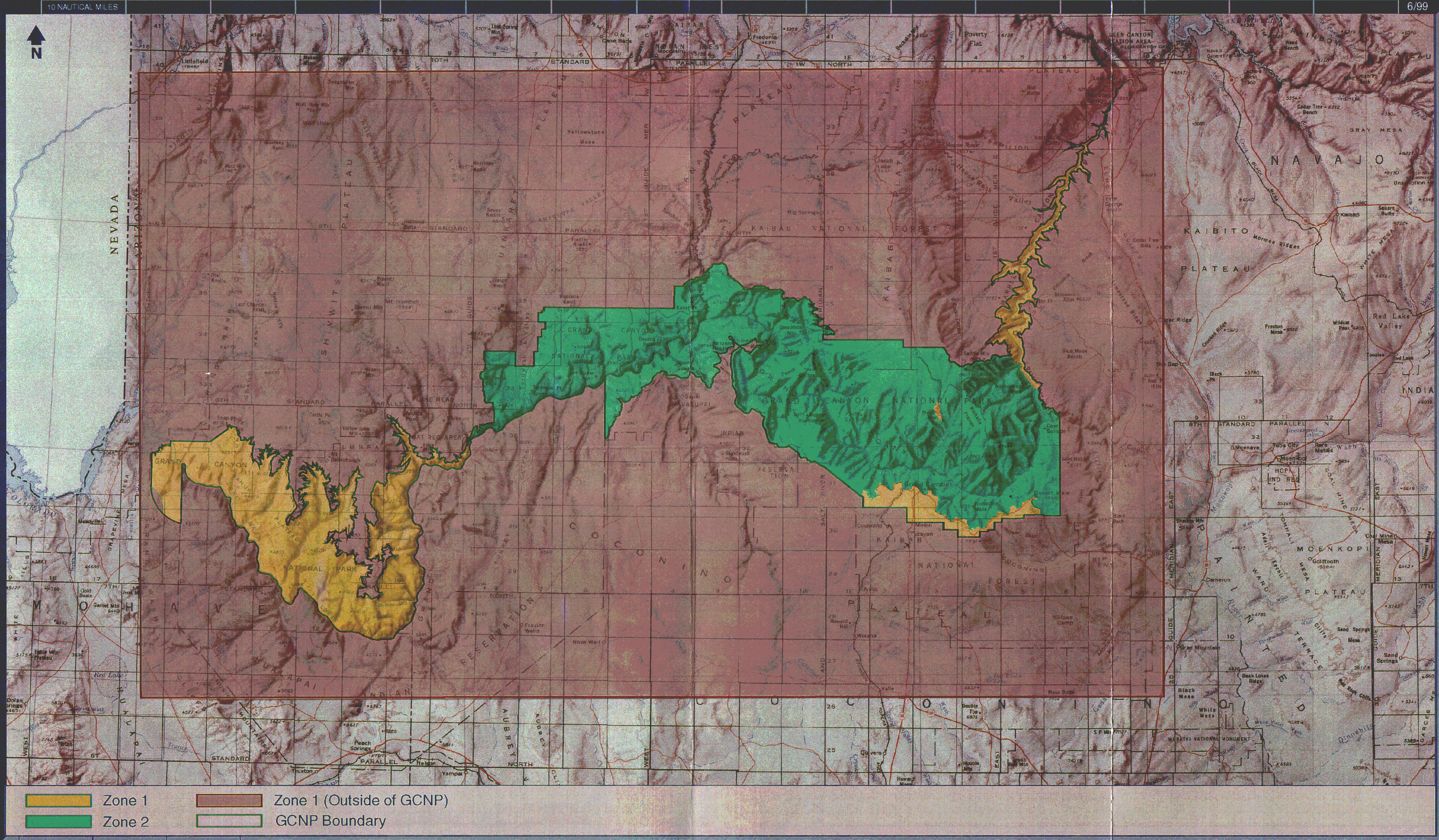
Audibility of aircraft depends upon many factors such as the level and frequency spectra of the aircraft sounds, the level and frequency of ambient or non-aircraft sounds, and the attentiveness of the listener. For Zone One, using A-weighted levels, the +3 dB criterion assumes that the frequency characteristics of the ambient and the aircraft are relatively similar. The +3 dB sensitivity criterion is commonly accepted in the acoustics community as the smallest change in sound level audible to the human ear. For example, given an ambient A-weighted sound level of 40 dB, the introduction of an aircraft into the ambient environment, which raises the sound level to 43 dB (a 3 dB increase), would be noticeable to a person with average hearing.

Studies conducted in GCNP for the NPS have shown that individuals who are *actively*[35] listening can hear aircraft at lower levels than the ambient sound levels (HMMH memorandum 294530.22, May 15, 1997—see **Appendix D**). This occurs because aircraft sound often contains tones that are not present in the ambient sound. These tones can lead to audibility levels

NPS Noise Evaluation Zones Within the Grand Canyon Noise Study Area

FIGURE 4-1

6/99



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

below that of the ambient levels. The NPS studies concluded an active listener could hear aircraft when their sound levels were between 8 and 11 dB below ambient.

The two zones for audibility are used in the computations to effectively modify the ambient data. The modified ambient data at each receptor location defines the time above threshold for calculating the percentage of time that aircraft are audible.

4.1.2 Noise Modeling

Noise metrics are computed that relate to these effects, namely L_{dn} or similar "average" sound level metrics. Also, because of the GCNP goal of natural quiet, simply hearing aircraft-produced sound is also considered an impact. Hence, the computer modeling needs to provide a metric that quantifies how much of the time aircraft can be heard.

The Integrated Noise Model (INM) is the FAA's standard computer methodology for assessing and predicting aircraft noise impacts. Its use in regulatory actions is governed by FAA Order 1050.1D, "Policies and Procedures for Considering Environmental Impacts" under the NEPA. Since 1978, the INM has been widely used by the aviation community both nationally and internationally to evaluate noise impacts from new airports, runways, arrival and departure routes, flight procedures, and fleet forecasts. The FAA has continuously refined and updated the INM's system capabilities, aircraft noise and performance data, and computer technology. Based on the above, the FAA determined that a modified version of INM 5 is an appropriate tool to use for this analysis.

Specific modifications to the model include the development of a new "circuit" or round-trip aircraft profile capability to simulate tour operations. This capability allows combinations of departure, arrival, and level flight procedures with unlimited altitude changes, including descents below airport elevation. Additional modifications to the model are described in the next three sections: Propagation Distance, Expanded Receptor Grid for Contour Analyses, and Suppression of Overground Attenuation Algorithm.

The INM noise calculation methodology and aircraft noise and performance database meet the standards of the Society of Automotive Engineers (SAE), Aerospace Information Report (AIR) 1845, "Procedure for the Calculation of Airplane Noise in the Vicinity of Airports," March 1986 and the International Civil Aviation Organization (ICAO) Circular 205-AN/1/25, "Recommended Method for Computing Noise Contours Around Airports," 1988.

Propagation Distance

An important technical consideration for the study area analysis includes accounting for the actual distance between the aircraft (noise source) and the listener. The abrupt elevation changes in the vicinity of the canyon make this a particular concern. For a given aircraft overflight altitude, the sound level experienced by a person at the Canyon rim will be higher than the sound level experienced by a person several thousand feet lower on a trail in the Inner Canyon. Factors such as terrain, meteorological conditions, and natural and vegetative characteristics are increasingly likely to alter the propagation and characteristics of aircraft sound as the distance from the receptor to the aircraft increases. Also, the amount of sound absorbed or reflected by the ground can alter the sound levels heard.

Since 1993, the INM has been capable of calculating the effects of varying terrain elevation on slant distance from the aircraft to a receptor on the ground. This capability was previously limited to a 1-degree latitude by 1-degree longitude area of approximately 2,300 square statute miles, with the reference point at the center of the grid. For this study, the area of terrain analysis is expanded to 4-degrees latitude by 2-degrees longitude. Consequently, changing slant distance from aircraft to receptor is considered for the entire Grand Canyon noise study area.

Elevation data used in the INM are obtained from Micropath Corporation of Golden, Colorado, and are derived from U.S. Geological Survey information. These three-arc-second elevation data provide a basis for noise contour calculations and noise assessments at specific points.

Expanded Receptor Grid for Contour Analyses

Since its inception, the INM has based noise level contour computations on a fixed, regularly-spaced grid of 289 receptors (17-by-17). The 289 receptors, along with information about aircraft flights and flight proximity's to a receptor, are used to guide the process of subdividing the base noise-grid in an effort to improve noise-contour precision. For most airport analyses, a distance of 6,250 ft. (approximately one nautical mile) is maintained between receptor locations in the base grid. Maintaining this spacing is essential in ensuring accuracy in the decision-making process associated with subdividing the noise grid. As a consequence, the 17-by-17 point grid of receptors in the base regular grid was expanded to 125-by-125 points for GCNP analyses. This expansion ensured that the 6,250-foot spacing associated with most typical INM-related analyses was maintained throughout the entire GCNP analysis area.

Suppression of Overground Attenuation Algorithm

Based on the FAA review of the technical considerations affecting this study, the FAA modified the INM to eliminate computation of lateral overground attenuation, which is oriented toward acoustically soft grassy terrain unlike that found in most of GCNP.

In determining the appropriateness of the above modifications for this analysis, FAA performed a check of reasonableness of INM predictions using data obtained from actual measurements in the Grand Canyon. This check, as presented in **Appendix D**, compared measured and INM-predicted sound exposure levels (SEL, denoted by the symbol L_{AE}) for individual flyover operations and L_{Aeq1h} values at GCNP. The results from INM analysis with the overground attenuation suppressed correlate closely with actual measured data in the Canyon.

Other Noise Models

There are a number of aviation noise models in use for specialized purposes. Many of these models contain different assumptions and sound propagation algorithms as compared with the INM.

Of relevance to this analysis is the NPS development of a computer model designed specifically for analyzing audibility of aircraft in park environments. The NPS has used this model, called the National Park Service Overflight Decision Support System

(NODSS), in support of its evaluation of aircraft noise impacts at GCNP. NODSS uses different methodology than that accepted under FAA guidelines, including the calculation of the d′ metric for audibility. Unlike the modified version of the INM described herein, NODSS calculations are frequency-based (1/3 octave band) to account for the tonal nature of the source. The modified version of INM time audible metric (Percent Time Audible using a variable ambient and the +3 dB and –8 dB noise evaluation factors) offers a viable comparison of modeled results with NPS noise predictions and noise criteria.

The current INM, as modified by the FAA, complies with all known standards and recommended practices for the prediction of aircraft noise. It produces reasonably accurate predictions of aircraft noise exposure in the vicinity of the GCNP. While there is no evidence that either the INM or the NPS models are inaccurate, field validation is an important activity in any model development. As part of a comprehensive noise management plan, the FAA and the NPS are planning to conduct an evaluation of respective noise assessment methodologies. A study program will be developed that includes a noise measurement program at GCNP to support a model validation study, correlation of metrics, and collection of ambient data.

4.1.3 Aircraft and Operational Data for Modeling

This section describes the comparative analysis of noise impacts between the No Action Alternative and the three Proposed Alternatives. The Proposed Alternatives are described in more detail in Section 2.3.

In order to compute sound levels, considerable information was used, including selection of aircraft types, flight tracks flown (see Figures 2-2 through 2-4), and numbers of operations on each flight track. All input data for modeling both the No Action Alternative and the Proposed Alternatives, including aircraft noise, aircraft operations, and aircraft performance, are discussed below. Information for modeling the airspace that results from the Proposed Alternatives was developed by FAA Offices of Air Traffic and Flight Standards.

Aircraft Types

There are various types of aircraft operating in the study area, some of which are not included directly in the INM database. In such instances, official INM equivalent aircraft were used for the current analysis. An INM equivalent aircraft is an aircraft that performs similarly and has similar Noise-Power-Distance (NPD) data as compared with the aircraft in actual operation. Approved equivalents are included in the INM database based on aircraft noise and performance data. The specific INM-equivalent noise data, operational data, and INM-equivalent performance data are discussed separately in the following sections.

Aircraft Noise Data

Table 4.1 presents the aircraft types that are currently flying in the SFRA and the FAA-approved/INM-equivalent aircraft. The noise versus distance data use for INM predictions were developed by the Volpe Center based on measurements taken in October and November of 1996 at Crows Landing, California. NPD data were collected for departure, level flight, and approach flight conditions. The MD900, a

Table 4.1

Categories of Aircraft Flying in SFAR

Current Tour Aircraft	INM Equivalent Aircraft
Cessna 401/402/421 Beechcraft B76 Piper 31-325	Beechcraft B58P (BEC58P)
Cessna 206/207 Beechcraft A36 Cessna 180/182	General Aviation Single-Engine Variable-Pitch Propeller(GASEPV)**
de Havilland DHC-6-300	de Havilland DHC-6-300***
Cessna 208 Cessna 172 Cessna 177	General Aviation Single-Engine Fixed-Pitch Propeller(GASEPF)*
Bell 206 B Bell 206 L	Bell 206L - 0.1 dB†
Aerospatiale 350D	A350D + 1.5 dB††
McDonnell-Douglas MD600 NOTAR	MD900 NOTAR***

* The general aviation, single-engine, fixed-pitch propeller aircraft (GASEPF) is a generic aircraft meant to represent a composite of all common, single-engine craft, with fixed-pitch propellers not specifically represented in the INM data base.

** The general aviation, single-engine, variable-pitch propeller aircraft (GASEPV) is a generic aircraft meant to represent a composite of all common, single-engine craft, with variable-pitch propellers not specifically represented in the INM data base.

*** Noise curves are based on measurement program at Crows Landing, 1996.

† The -0.1 dB adjustment factor contains two corrections. The first corrects the INM noise level data from a speed of 116 kts (as currently in the HNM database) to a speed of 90 kts, which is considered typical for GCNP tour operations. The second adjusts the Blade Tip Mach number correction for the above speeds.

†† The 1.5 dB adjustment factor contains two corrections. The first corrects the INM noise level data from a speed of 127.8 kts (as currently in the HNM database) to a speed of 90 kts. The second adjusts the Blade Tip Mach number correction for the above speeds.

relatively new, state-of-the-art helicopter, was tested at conditions similar to how air tours operate at GCNP.

During the same Crows Landing measurements, NPD data were also collected for the de Havilland DHC-6-300 Twin Otter equipped with the Raisbeck/Hartzell "quiet" propellers found on all DHC-6 aircraft currently operating in the study area. Data were collected for departure and approach conditions as well as two level flight conditions, tour (flaps 10, 94 knots) and cruise (flaps retracted, 125 knots) (Volpe Center memorandum, March 19, 1999).

The helicopters in operation in the vicinity of GCNP are modeled with three types: the Aerospatiale AS-350D, the Bell 206L, and the MD900. These helicopters and the DHC-6 are modeled in the INM with profile points rather than procedure steps. Profile points enable the user to set the location, speed, and thrust exactly. Appendix D provides detailed information on helicopter modeling within INM. Because the INM uses thrust as the independent variable for calculating source noise, this method of specifying thrust allows the user to also specify source noise at all points in the flight track.[37] This is the procedure used in the modeling to exactly coordinate the modeled tour profiles with the noise data collected at Crows Landing. See Appendix D for specifics relative to modeling helicopter operations within INM for the Grand Canyon.

Operational Data

The operational data were based on an FAA-supplied activity report (the Activity Report) on operations in the SFRA from May 1, 1997, to April 30, 1998. The Activity Report contains data on every operation reported by air tour operators during this 1-year period. These data, presented by aircraft type, tail number, routes, and time of operation, are the most accurate and current operational information available.

This analysis modeled the air tours and transportation/repositioning flights in support of those air tours, as well as most flights with FAA permission to deviate from those air tour routes. In addition, based on available data, FAA modeled flights with FAA permission to deviate from those routes that connected to other air tour routes. This analysis did not model routes designated as weather routes. These routes are only used during adverse weather conditions. Use of the routes require commercial air tour operators to file reports of deviation from the established air tour route structure. The FAA estimates that these weather routes are used less than five percent of the time. Therefore, there would be minimal environmental impacts.

Total operations for future years are based on an FAA-projected annual 3.3 percent compound growth rate applied to the 1997-1998 operational levels. The summary of the types of operations for each of the study years is given in **Table 4.2** for the No Action Alternative and in **Table 4.3** for the three commercial air tour route Proposed Alternatives. The INM categorizes each operation as an arrival, a departure, a circuit, or an overflight. Detailed operations data is provided in **Appendix E.**

Arrivals are flights that land at Grand Canyon National Park Airport (GCN) after having passed through some portion of the SFRA. Departures are flights which takeoff from GCN, enter the SFRA, and do not return to GCN. Circuits are flights which takeoff from GCN, enter the SFRA, and return to land at GCN. Overflights are flights that pass through some portion of the SFRA, but never land or takeoff at GCN.

It should be noted that the number of arrivals and departures at GCN, although close, are not equal. This is because operations to and from the airport that do not enter the SFRA are not counted. For example, consider a flight which departs Las Vegas, enters the SFRA, lands at GCN, then departs GCN and heads directly south to Valle airport (due south of GCN). This departure from GCN is not counted in the present study since this leg of the flight is conducted entirely outside of the SFRA.

The INM's method of categorizing flights differs from both the way operations are typically counted by Air Traffic Control (ATC) at GCN and from the way operations are counted in the Activity Report.[38]

Table 4.2

Summary of SFAR Operational Activities as a Function of Type of Operation, No Action Alternative

Type of Operation[1] (Annual Average Day)	Year 1998	2000	2003	2008
Approaches[2]	80.13	85.51	94.25	110.87
Departures[3]	70.35	75.07	82.75	97.33
Circuits[4]	110.10	117.49	129.51	152.33
Overflights[5]	61.20	65.31	71.99	84.67
Total	321.78	343.37	378.50	445.21

Table 4.3

Summary of SFAR Operational Activities as a Function of Type of Operation, Proposed Alternatives with Commercial Air Tour Limitations and Continued Growth

Type of Operation[1] (Annual Average Day)	Year 1998	2000 Commercial Air Tour Limitations	2000 Growth	2003 Commercial Air Tour Limitations	2003 Growth	2008 Commercial Air Tour Limitations	2008 Growth
Approaches[2]	80.11	80.11	85.48	80.11	94.23	80.11	110.84
Departures[3]	70.28	70.28	75.00	70.28	82.67	70.28	97.24
Circuits[4]	111.44	111.44	118.92	111.44	131.08	111.44	154.19
Overflights[5]	59.95	59.95	63.97	59.95	70.52	59.95	82.95
Total	321.78	321.78	343.37	321.78	378.50	321.78	445.21

Notes for Tables 4.2 and 4.3:

1 The average annual-day operations as a function of type of operation are calculated from the 1997-1998 Activity Report.
2 An approach is defined as an activity in which an aircraft that is in flight enters into the terminal airspace from an origin outside the GCNP study area, e.g., Las Vegas, NV, approaches, and lands at GCN.
3 A departure is an activity in which an aircraft departs from GCN, leaves the terminal airspace, and continues on in flight to a destination outside of the GCNP study area.
4 A circuit is an activity in which an aircraft departs from GCN, continues on in flight with various changes in performance and spatial position, approaches, and lands at GCN.
5 An overflight is an activity in which an aircraft that is already in flight continues on in flight, and does not approach and land at GCN.

Supplemental Analysis

As part of this study, four supplemental analyses were conducted. These supplemental analyses examine the projected noise environment at the Grand Canyon in four special cases. These cases include typical days for the summer and shoulder seasons as well as a peak day for the summer season and the peak hour for the typical summer day. These supplemental analyses are discussed in **Appendix F**.

Flight Track Assignments

Each of the Proposed Alternatives has fewer flight tracks than the No Action (existing) Alternative. Operations on flight tracks in the No Action that do not exist in the Proposed Alternatives have been moved to similar tracks in the Proposed Alternatives. Tracks that no longer exist in the Proposed Alternatives are referred to as 'terminated' tracks. Fixed wing and helicopter operations on terminated tracks originating and ending at GCN, except those which pass through the middle of the Canyon, have been moved to either the new Black 1 or the new Green 1, respectively. Operations on terminated tracks passing through the middle of the Canyon, primarily the old Blue 1, have been moved to both the new Blue Direct or Blue Direct North (37 percent) and the new Blue Direct South (63 percent). These percentages are based on information supplied by operators and are consistent with current business practices. Operations on terminated tracks over the west end of GCNP have been moved to either the new Blue 2 or the new Green 4.

An additional element of this study was the modeling of operations at the four helipads in the Inner Canyon near the Grand Canyon West airport. The ground segment for each operation at these pads is modeled as a 5-minute INM "run-up" operation at climb power. Flight operations are modeled as standard arrivals and departures from the existing and proposed Green 4 routes.

Profiles and Performance Data

In developing the airspace for the No Action and the Proposed Alternatives, air traffic and operator data were used to assign altitudes for each unique flight track. On Blue Direct/Blue Direct North for the Proposed Alternatives, 85 percent of twin engine aircraft operations were assigned to the higher altitude, and the remaining 15 percent were assigned to the lower altitude. All single engine aircraft were assigned to the lower altitude on Blue Direct/Blue Direct North. For Proposed Alternative 4, all aircraft use the 85/15 percent altitude assignment on both Blue Direct North and Blue Direct South. These assignments are based on operator inputs.

INM standard takeoff and approach procedures were assumed for all departure, approach, and circuit operations at GCN. Once aloft, changing-altitude flight profiles were developed using the INM profile generator,[40] with the specific altitudes at the start and end of a flight-path segment as input. The generator was, in turn, used to compute performance and position information for each segment, including distance from start of profile, altitude, speed, and thrust. Similarly, performance and position information associated with level flight-track segments was also computed using the INM profile generator.[41]

4.1.4 Model Output

All modeling was performed for the No Action, Proposed Action, and two other alternatives described in Chapter Two. Two types of analyses were performed with the INM, a contour analysis and a representative location analysis.

Contours

For the purposes of INM, a set of contours consists of lines of constant noise or time exposure that tend to decrease with increasing distance from an airport or flight track. For the current study area analysis, both L_{Aeq12h} and $\%TA_{12h}$ contours were computed for the study area.

In determining areas encompassed by specific sound level contours, two types of analyses were performed, a wide-area analysis and a GCNP boundary analysis. The wide-area analysis included the entire case analysis window in computing area values encompassed by specific contour levels, a 13,510 square statute mile area. The GCNP boundary analysis included only the area encompassed by the GCNP boundary, a 1,886.79 square statute mile area.

L_{Aeq12h} contours were computed for levels ranging from 20 to 60 dB. $\%TA_{12h}$ contours were computed for 25 percent. These $\%TA_{12h}$ contours were used in the evaluation of the NPS goal for restoration of natural quiet.

Representative Locations

A total of 72 individual points were considered in the analysis as representative of noise sensitive areas within the study area (e.g., attraction sites and sensitive resources). Both L_{Aeq12h} and $\%TA_{12h}$ were computed for each representative location. The representative locations are presented in **Tables 4.4 through 4.7**. These tables provide a descriptive name, a 6-character identifier, a latitude, a longitude, and an elevation above mean sea level (MSL). The four Tables present the location points in quadrants of the study area. The quadrants are defined as east or west of GCN and north or south of the Colorado River.

Figure 4-2 displays the individual point locations. These point locations are overlaid on the study area map.

4.1.5 Noise Modeling Results

Traditional FAA noise analyses focus on the effects of a particular action on L_{dn} contours, in particular the 65 dB L_{dn} contour. As stated previously, the current analysis has focused on L_{Aeq12h} instead of L_{dn} because of the limited hours of aircraft operations and the typical period of daytime visitor activity at GCNP. **Tables 4.8 and 4.9** present a comparison of areas covered by the L_{Aeq12h} contours (20 to 60 dB) for the year 2003. Although multiple years were analyzed, the year 2003 results are presented in this section to provide interim results. Detailed results for 1998, 2000 and 2008 are provided in Appendix A. **Figure 4-3** depicts the L_{Aeq12h} contours (20 to 60 dB) for the 1998 No Action condition. **Figure 4-4** depicts the L_{Aeq12h} contours (20 to 60 dB) for the 2003 No Action condition. **Figure 4-5** illustrates the three alternatives considered for the year 2003 with an commercial air tour limitations implemented compared to the 2003 No Action alternative. **Figure 4-6** illustrates the three alternatives considered for the year 2003 with continued growth compared to the 2003 No Action alternative.

Tables 4.10 and 11 presents the percentage of GCNP restored to natural quiet, as defined in Section 4.1.1. **Tables 4.12 and 4.13** present a comparison of areas covered by the 25 percent TA_{12h} contours for the year 2003. Additional years are detailed in

Table 4.4

Representative Point Locations in the Grand Canyon Vicinity
North of Colorado River, West of GCNP Airport

	Location	Latitude	Longitude	Elevation (ft MSL)
1	NPS Admin Site (ADMIN)	36-08-00.000N	113-31-30.000W	6102
2	Andrus Canyon (ANDRUS)	35-13-00.000N	113-25-00.000W	4204
3	Bass Camp (BASCMP)	36-14-14.091N	112-20-39.845W	2201
4	Bat Cave (BATCAV)	36-02-52.800N	113-48-10.200W	2314
5	Burnt Springs Canyon (BRNTSP)	35-57-58.379N	113-44-38.955W	1359
6	Castle Peak (CASTLE)	36-11-00.000N	113-34-00.000W	6397
7	Kanab Point (KANAPT)	36-24-15.875N	112-39-04.927W	5449
8	Kelly Point (KELLPT)	35-50-06.186N	113-28-10.443W	6000
9	Mt. Dellenbaugh (MTDELL)	36-06-31.800N	113-32-24.000W	6750
10	Point Sublime (PTSUBL)	36-11-54.012N	112-14-59.113W	7187
11	Sanup (SANUP)	36-07-17.065N	113-49-15.706W	4390
12	Separation Canyon at Colorado River (SCCORV)	35-50-00.000N	113-34-00.000W	2165
13	Separation Canyon (SEPARC)	35-49-24.232N	113-34-12.258W	1401
14	Shivwitz Fire Camp SHWZFC	36-07-00.00N	113-32-30.000W	6479
15	Stone Creek (STONCK)	36-20-47.881N	112-27-13.878W	2008
16	Suicide Point (SUIPNT)	36-00-15.000N	113-32-09.600W	5979
17	Toroweap Overlook (TOROWP)	36-12-48.603N	113-03-29.722W	4140
18	Tower of Ra (TOWER)	36-08-28.200N	112-12-10.200W	6269
19	Twin Point (TWINPT)	35-59-49.800N	113-37-40.200W	6052
20	Upper Deer Creek (UPDRCK)	36-23-37.457N	112-30-21.754W	2406
21	West End (WESEND)	36-07-00.000N	113-58-27.000W	1014

Table 4.5

Representative Point Locations in the Grand Canyon Vicinity South of Colorado River, West of GCNP Airport

	Location	Latitude	Longitude	Elevation (ft MSL)
22	Coyote Canyon (COYCAN)	36-12-42.000N	112-46-09.000W	4677
23	Diamond Creek (DIACRK)	35-45-57.000N	113-22-16.800W	1601
24	The Dome (DOME)	36-13-00.000N	112-50-00.000W	5797
25	Granite Gorge (GRAGOR)	36-02-00.000N	113-52-00.000W	2076
26	Grand Canyon West (GCWEST)	35-59-18.600N	113-48-35.400W	4748
27	Granite Park (GRNTPK)	35-57-53.400N	113-19-00.000W	1603
28	Dr. Tommy's Mountain (DRTOM or DTMTN)	36-00-36.000N	113-17-40.200W	6697
29	Havasu Point (HAVAPT)	36-18-33.059N	112-45-44.203W	1809
30	Havatagvitch Canyon (HAVCAN)	36-08-01.800N	112-34-18.000W	4199
31	Hermit Basin (HBASIN)	36-03-21.827N	112-13-22.679W	5175
32	Horse Flat Canyon (HFCAN)	35-51-41.400N	113-46-31.200W	2934
33	Meriwhitca (MERIWH)	35-46-31.800N	113-42-00.000W	4028
34	Mohawk Canyon (MOHAWK)	36-08-00.000N	112-59-00.000W	3999
35	Mohawk Canyon (MOHCAN)	36-09-52.800N	112-59-00.000W	3398
36	Mount Sinyala (MTSINY)	36-18-00.000N	112-42-19.800W	5007
37	National Canyon (NATCAN)	36-09-59.400N	112-54-21.600W	4388
38	Jackson Canyon (JCKCAN/NONAME)	35-52-00.000N	113-43-00.000W	2060
39	Parashant Wash (PARWAS)	36-05-40.200N	113-19-19.800W	1703
40	Pumpkin Springs (PMPKIN)	35-53-42.000N	113-19-00.000W	1801
41	Prospect Canyon (PROCAN)	36-09-52.800N	113-05-00.000W	4074
42	Prospect Canyon (PRSPCT)	36-07-00.000N	113-05-00.000W	4622
43	Peach Spring Canyon North (PSCNNO)	35-45-00.000N	113-20-00.000W	3343
44	Peach Spring Canyon South (PSCNSO)	35-37-00.000N	113-25-00.000W	3802
45	Quartermaster Point (QMPNT)	35-56-30.000N	113-47-30.000W	2201
46	The Ranch (RANCH)	36-01-27.000N	112-17-54.000W	6200
47	Spencer/Meriwhitica Canyons (SCMCIG)	35-47-00.000N	113-34-00.000W	4504
48	South Supai Canyon (SOSUPC)	36-00-19.200N	112-31-16.200W	4403
49	Spencer Canyon (SPENCA)	35-47-15.000N	113-38-45.000W	2790
50	Supai Village (SUPVIL)	36-14-12.338N	112-41-18.816W	3210
51	Three Springs Rapids (THRSPR)	35-52-30.000N	113-1-36.000W	1968
52	Whitmore Rapids (WHTRAP)	36-08-20.357N	113-12-11.219W	1680
53	96 Mile Camp (96MILE)	36-06-27.645N	112-13-30.800W	2401

Table 4.6

Representative Point Locations in the Grand Canyon Vicinity
North of Colorado River, East of GCNP Airport

	Location	Latitude	Longitude	Elevation (ft MSL)
54	The Basin (BASIN)	36-15-42.203N	112-06-10.941W	8198
55	Bright Angel Point (BRTANG)	36-11-53.011N	112-03-06.380W	8151
56	Cape Royal (CAPROY)	36-07-23.034N	111-56-54.549W	7621
57	Cliff Dwellers Lodge (CLDWEL)	36-44-38.400N	111-45-19.800W	4214
58	Marble Canyon Dam Site (MARBDM)	36-24-31.388N	111-52-21.588W	3007
59	Nankoweap Mesa (NANMES)	36-16-00.000N	111-51-28.800W	5391
60	North Canyon (NOCANY)	36-37-00.000N	111-46-30.000W	4457
61	Point Imperial (PTIMPL)	36-16-44.711N	111-58-39.584W	7425
62	Saddle Mountain (SADMTN)	36-18-43.800N	111-56-57.600W	7171
63	South Canyon (SOCAN)	36-30-20.000N	111-51-50.000W	5196
64	Temple Butte (TEMBUT)	36-10-01.200N	111-49-28.200W	3749

Table 4.7

Representative Point Locations in the Grand Canyon Vicinity
South of Colorado River, East of GCNP Airport

	Location	Latitude	Longitude	Elevation (ft MSL)
65	Cedar Ridge (CEDRIG)	36-03-50.889N	112-05-19.856W	6013
66	Lipan Point (LIPAN)	36-01-55.919N	111-51-12.981W	7063
67	Little Colorado (LITCOL)	36-11-25.200N	111-43-36.000W	5306
68	Little Colorado River (LTCORV)	36-11-45.230N	111-48-01.162W	2915
69	Nankoweap at river (NANRIV)	36-18-26.819N	111-51-27.960W	3254
70	Ten X Meadow (TENMED)	35-56-03.000N	112-03-36.000W	6906
71	Zuni Alpha (ZUNALF)	35-58-19.800N	111-53-21.000W	6859
72	Zuni Charlie (ZUNCHR)	36-07-30.000N	111-47-35.000W	5337

Table 4.8

Square Mile Area Covered by L_{Aeq12h} Contours (20-60) Considering Commercial Air Tour Limitations 2003

Analysis	Contour Level (dB)	No Action	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
	20	4723.79	3722.39	-21.20	3881.38	-17.83	4319.63	-8.56
W	30	2169.59	1632.01	-24.78	1690.95	-22.06	1773.45	-18.26
I	40	604.24	455.40	-24.63	436.64	-27.74	439.22	-27.31
D	50	33.01	28.82	-12.69	28.89	-12.48	28.82	-12.69
E	60	3.65	3.52	-3.56	3.58	-1.92	3.49	-4.38
	20	1619.78	1110.72	-31.43	1111.20	-31.40	1198.62	-26.00
G	30	701.92	558.02	-20.50	523.81	-25.37	560.90	-20.09
C	40	159.72	120.53	-24.54	107.65	-32.60	128.86	-19.32
N	50	5.54	2.44	-55.96	2.44	-55.96	2.52	-54.51
P	60	0.05	0.00	-100.00	0.00	-100.00	0.00	-100.00

Table 4.9

Square Mile Area Covered by L_{Aeq12h} Contours (20-60) Considering Continued Growth 2003

Analysis	Contour Level (dB)	No Action	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
	20	4723.79	3930.39	-16.8	4085.98	-13.5	4565.45	-3.35
W	30	2169.59	1732.37	-20.15	1811.57	-16.5	1901.8	-12.34
I	40	604.24	525.74	-12.99	511.83	-15.29	513.11	-15.08
D	50	33.01	33.74	2.21	33.78	2.33	33.78	2.33
E	60	3.65	3.98	9.04	4.05	10.96	3.94	7.95
	20	1619.78	1144.92	-29.32	1145.26	-29.3	1237.43	-23.61
G	30	701.92	590.98	-15.81	563.17	-19.77	600.63	-14.43
C	40	159.72	142.54	-10.76	125.42	-21.48	150.4	-5.84
N	50	5.54	3.59	-35.2	3.58	-35.38	3.7	-33.21
P	60	0.05	0	-100	0	-100	0	-100

Table 4.10

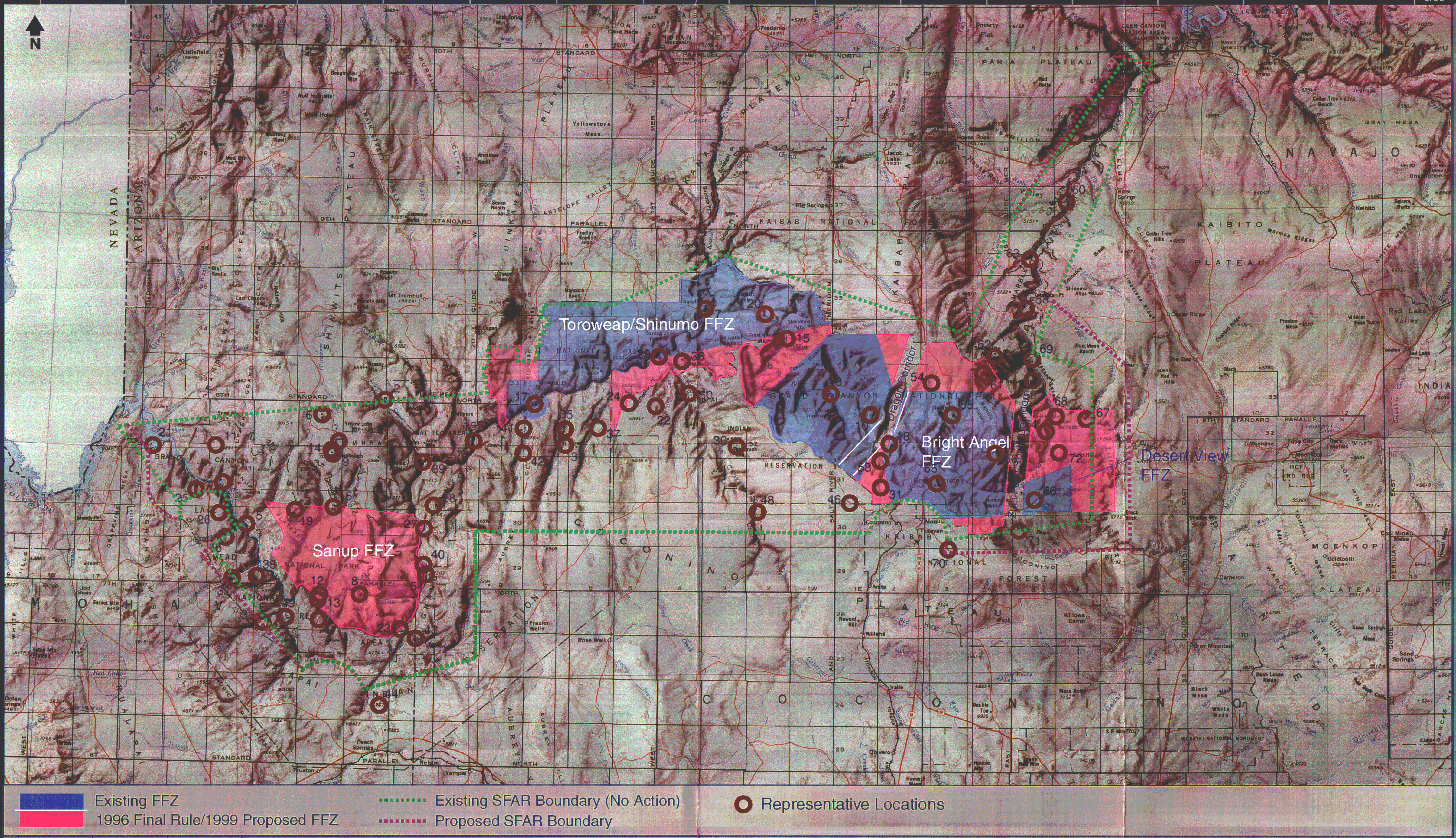
Percentage of Park Restored to Natural Quiet Considering Commercial Air Tour Limitations

Year	No Action	Alternative 2	Alternative 3	Alternative 4
1998	32.0	41.3	41.7	41.5
2000	30.6	41.3	41.7	41.5
2003	28.5	41.3	41.7	41.5
2008	25.3	41.3	41.7	41.5

Representative Locations

FIGURE 4-2

6/99



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Table 4.11

Percentage of Park Restored to Natural Quiet Considering Continued Growth

Year	No Action	Alternative 2	Alternative 3	Alternative 4
1998	32.0	41.3	41.7	41.5
2000	30.6	39.1	39.4	38.8
2003	28.5	35.3	35.4	33.9
2008	25.3	28.9	28.0	25.8

Table 4.12

Square Mile Area Where %TA_{12h} is Greater Than 25% Considering Commercial Air Tour Limitations 2003

	No Action	Alternative 2		Alternative 3		Alternative 4	
Analysis	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	3164.92	2568.46	-18.85	2638.8	-16.62	2447.31	-22.67
GCNP	1348.97	1107.11	-17.93	1100.56	-18.41	1103.4	-18.20

Table 4.13

Square Mile Area Where %TA_{12h} is Greater Than 25% Considering Continued Growth 2003

	No Action	Alternative 2		Alternative 3		Alternative 4	
Analysis	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	3164.92	2848.73	-9.99	2958.04	-6.54	2864.08	-9.51
GCNP	1348.97	1220.70	-9.51	1219.54	-9.59	1247.41	-7.53

Appendix A. These tables compare contour areas in square statue miles for the No Action and the three Proposed Alternatives. The comparisons are presented in terms of both a wide-area analysis and an analysis restricted to the GCNP boundary. **Figure 4-7** depicts the TA_{12h} contour for the 1998 No Action condition. **Figure 4-8** depicts the TA_{12h} for the 2003 No Action condition. **Figure 4-9** illustrates the TA_{12h} contours for the three alternatives considered for the year 2003 with an commercial air tour limitations implemented compared to the 2003 No Action alternative.

Figure 4-10 illustrates the TA_{12h} contours for the three alternatives considered for the year 2003 with continued growth compared to the 2003 No Action alternative.

L_{Aeq12h} Analysis

For the three Proposed Alternatives, with a commercial air tour limitations or with continued growth, there are no regions in the study area which have an L_{Aeq12h} equal to or greater than 65 dB. Therefore, none of the Proposed Alternatives compared to the No Action Alternative show a significant impact based on the criteria found in FAA Order 1050.1D.

TA_{12h} (25 %) Analysis

Each of the Proposed Alternatives, with or without an commercial air tour limitations, will reduce the time in which aircraft are audible for the general study area compared to the No Action Alternative. Each of the Proposed Alternatives substantially reduce the time in which aircraft are audible within the GCNP boundary. Although the Proposed Alternatives reduce the time in which aircraft are audible in GCNP, natural quiet is not substantially restored with any of the Proposed Alternatives or with the No Action Alternative.

For example, analysis of the three Proposed Alternatives indicates that modifications to the airspace will restore natural quiet to a level of approximately 42 percent of the GCNP in 1998. By contrast, the No Action Alternative results in approximately 32 percent natural quiet in the GCNP.

The benefits of all of the Proposed Alternatives erode over time if commercial air tours increase at the 3.3 percent expected rate. Operational growth through the year 2008 for the No Action Alternative reduces the level of natural quiet to approximately 25 percent of the GCNP. A similar effect in 2008 is shown for the commercial air tour route Alternatives, where the level of natural quiet falls to between 26 and 29 percent of the GCNP. Appendix A provides detailed information for the year 2008.

The benefits of the commercial air tour Proposed Alternatives are primarily due to the elimination of aircraft operations near the mid-canyon region of the GCNP. In the No Action Alternative, aircraft operations on Blue 1 heavily influence the mid-canyon noise environment. In all the Proposed Alternatives, operations on Blue 1 were replaced by operations on both Blue Direct/Blue Direct North and Blue Direct South. For this study, 37 percent of the existing Blue 1 operations were assigned to Blue Direct/Blue Direct North, 63 percent to Blue Direct South. Moving these operations from the mid-canyon to the south increased the areas of GCNP where natural quiet has been restored.

The high number of operations during the peak day and the peak hour may make the $\%TA_{12h}$ projections less accurate than projections for analytic periods having less activity. This reduced accuracy is because the INM calculates the %TA metric for each event independently and then sums the time for all events. During periods of high activity, events may overlap in time. The net effect is that this calculation of $\%TA_{12h}$ will always be equal or greater than a $\%TA_{12h}$ metric that accounts for overlapping operations.

Representative Location Analysis

For each of the study years and the Proposed Alternatives, the 72 representative locations all have L_{Aeq12h} levels less than 68 dB. Therefore, none of the representative locations show a significant impact based on the criteria found in FAA Order 1050.1D.

For the majority of the representative locations, each of the Proposed Alternatives results in a decrease in both the L_{Aeq12h} and the $\%TA_{12h}$ levels with an commercial air tour limitations or continued growth. **Tables 4.14 and 4.15** present summaries of improvements for each of the Proposed Alternatives by year.

Table 4.14

Improvements in Percent Time Audible Considering Commercial Air Tour Limitations

	Percent Time Audible (%TA_{12h})							
	Percent of Sites Improved				Overall Average Improvement (minutes)			
Year	1998	2000	2003	2008	1998	2000	2003	2008
Alternative 2[(1)]	75.0	79.2	83.3	88.9	22.9	33.5	50.6	80.7
Alternative 3[(1)]	75.0	79.2	88.9	95.8	23.4	34.0	51.1	81.1
Alternative 4[(1)]	61.1	66.7	73.6	80.6	18.2	28.7	45.8	75.9

(1) Improvements are all relative to the No Action Alternative (Alternative 1).

Table 4.15

Improvements in Percent Time Audible Considering Continued Growth

	Percent Time Audible (%TA_{12h})							
	Percent of Sites Improved				Overall Average Improvement (minutes)			
Year	1998	2000	2003	2008	1998	2000	2003	2008
Alternative 2[(1)]	75.0	75.0	73.6	75.0	22.9	23.7	26.2	31.3
Alternative 3[(1)]	75.0	75.0	73.6	76.4	23.4	24.1	26.8	32.0
Alternative 4[(1)]	61.1	61.1	59.7	61.1	18.2	18.6	20.4	24.2

(1) Improvements are all relative to the No Action Alternative (Alternative 1).

The summary of the %TA_{12h} improvements is shown in Tables 4.14 and 4.15. The L_{Aeq12h} improvements are shown in **Tables 4.16 and 4.17**. The left side of the Tables present the percentage of sites where the noise levels either decrease or remain the same going from the No Action Alternative to the particular alternative. The right side represents the arithmetic average of the differences, taking into account all sites, between the No Action Alternative and each of the Proposed Alternatives.

For example, in the year 2000, Alternative 2 would provide an improvement or no change in %TA_{12h} at 54 of the 72 sites (75 percent) and an improvement or no change in L_{Aeq12h} at 53 of the 72 sites (73.6 percent) considering continued growth. The average increase in time when aircraft are *not* audible, taking into account all sites, is 23.7 minutes considering continued growth. For this example, the L_{Aeq12h} noise level improves an average of 6.0 dB at the 72 sites considering continued growth.

Appendix A contains the complete %TA_{12h} and L_{Aeq12h} data for each of the 72 representative locations. The tables in this appendix present the data for the particular metric at each representative location for each Proposed Alternative and also compares the Proposed Alternatives with the No Action Alternative. Examination of these data shows that the majority of the sites that exhibit the largest increase in noise levels are under the proposed Blue Direct South route alternative regardless of continued growth or commercial air tour limitations alternatives (e.g., TWINPT, SUIPNT, GRAGOR), while those sites which exhibit a decrease in noise tend to be mid-Canyon sites (MTSINY, SUPVIL, UPDRCRK). This is expected since one of

Table 4.16

Improvements in Equivalent Sound Level Considering Commercial Air Tour Limitations

	Equivalent Sound Level (L_{Aeq12h})							
	Percent of Sites Improved				Overall Average Improvement (dB)			
Year	**1998**	**2000**	**2003**	**2008**	**1998**	**2000**	**2003**	**2008**
Alternative 2(1)	73.6	76.4	79.2	84.7	6.0	6.3	6.7	7.4
Alternative 3(1)	73.6	73.6	79.2	81.9	5.8	6.1	6.5	7.2
Alternative 4(1)	70.8	70.8	76.4	79.2	5.0	5.3	5.7	6.4

(1) Improvements are all relative to the No Action Alternative (Alternative 1).

Table 4.17

Improvements in Equivalent Sound Level Considering Continued Growth

	Equivalent Sound Level (L_{Aeq12h})							
	Percent of Sites Improved				Overall Average Improvement (dB)			
Year	**1998**	**2000**	**2003**	**2008**	**1998**	**2000**	**2003**	**2008**
Alternative 1(1)	73.6	73.6	73.6	73.6	6.0	6.0	6.0	6.0
Alternative 2(1)	73.6	73.6	73.6	73.6	5.8	5.8	5.8	5.8
Alternative 3(1)	70.8	70.8	69.4	69.4	5.0	5.0	5.0	5.0

(1) Improvements are all relative to the No Action Alternative (Alternative 1).

the major changes in the airspace is the elimination of the Blue 1 route (through the mid-Canyon), and the switch of the majority of these operations to Blue Direct South. Note that the site with the largest increase in noise is RANCH. This is due to the addition of the 'dogleg' in Black 1, Green 1 and Green 2. This dogleg increases the amount of time aircraft fly adjacent to RANCH when arriving at GCN.

Potential impacts to locations outside of the park were considered relative to standard residential noise level criteria as described in FAR Part 150 Table 1, unless TCPs were identified through consultation with individual Native American Tribes. Impacts on TCPs have been evaluated for all Tribes except the Hualapai Tribe and FAA has found that the Proposed Action (Preferred Alternative) will have No Adverse Effect on any TCPs identified by those Tribes.

4.1.6 Conclusions

The analysis presented here indicates that within the study area, as shown in Figure 3-1, the noise environment as a whole is improved by the implementation of Proposed Action with any of the Proposed Alternatives, with or without a commercial air tour limitations or continued growth. The expected overall improvement is not just limited to the immediate vicinity of GCNP, but extends beyond the boundaries of GCNP to include the entire study area. Both the L_{Aeq12h} and the TA_{12h} contours support these conclusions.

Although the three Proposed Alternatives do not restore natural quiet to GCNP, they represent a substantial improvement over the No Action Alternative.

4.2 HISTORIC, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

The National Historic Preservation Act (NHPA) of 1966, as amended, establishes measures to coordinate Federal actions affecting properties included in or eligible for the National Register of Historic Places. The Archaeological and Historic Preservation Act of 1974 provides for the survey and preservation of significant cultural resources that may be lost due to a Federal project.

Sec. 110 of the NHPA requires Federal agencies to consult with State Historic Preservation Officers. Tribal Historic Preservation Officers, tribes, and interested parties concerning proposed Federal actions that may affect properties included in or eligible for the National Register of Historic Places, including National Historic Landmarks, World Heritage Sites and Traditional Cultural Properties. Section 110 requires agencies to comply with Section 106, which governs consultation. The regulations governing consultation are 36 CFR 800.

The Archaeological and Historic Preservation Act of 1974 provides for the survey and preservation of significant cultural resources that may be lost due to a Federal project. NEPA also requires consideration of impacts on natural and cultural resources. These resources may include, e.g., National Natural Landmarks as well as National Historic Landmarks both of which are established under the Historic Sites Act of 1935.

Pursuant to the NHPA, an initial review of properties in or eligible for inclusion in the National Register of Historic Places which are within the area of potential effect (APE) of the undertaking was conducted (see Sections 3.6.3 and 3.6.4). This review indicated that the area in the vicinity of the GCNP contains a great volume and variety of historic resources that are distributed throughout the area.

Four GCNP areas containing substantial historic resources would be positively affected by the increased size of the flight free zones. Aircraft flights will be farther from the Grand Canyon Village Historic District, North Rim Historic District, and the Desert View Watchtower and Hermits Rest areas (both part of the Mary Jane Colter Historic District). This is as a result of the larger Bright Angel and Desert View FFZs.

Additionally, expansion of the Desert View FFZ helps to protect TCPs sacred to the Navajo Nation, and Hopi and Zuni Tribes. Relocation of routes has mitigated some effects of overflights on TCPs identified by Native American Tribes.

The Final EA and this Supplemental EA focus on areas in and around the Grand Canyon that could potentially be impacted by the new flight regulations and route structure. In developing the proposed commercial air tour route structure and airspace configuration, the FAA considered sites that have been identified by Native American communities as TCPs.

As noted in Section 4.1 the study area is characterized by low noise levels. Except as noted below, given the noise levels under consideration, no adverse effects to historic, cultural, or archaeological resources would result from implementation of any of the alternatives. Therefore the FAA has determined that there will be no adverse effect to the areas of concern for the Kaibab Pauite, the Paiute of Utah, the San Juan

Southern Paiute, the Hopi, the Pueblo of Zuni, the Havasupai Tribes, and the Navajo Nation with any of the proposed alternatives. The FAA has forwarded the finding letters to the Arizona State Historic Preservation Officer (with copies to the appropriate Tribes) and the Navajo Nation Historic Preservation Officer.

The FAA recognized the concern for privacy expressed by Native Americans with regard to these sites. Therefore, TCPs have not been specifically identified in this document.

Regarding the Hualapai Tribe, the FAA and the Tribe entered into a statement of work To Identify Traditional Cultural Properties within the Area of Potential Effect Related to Proposed FAA Actions Over the Hualapai Indian Reservation. This study had the express purpose of identifying TCP's within the APE of the proposed air tour route structure. The study is to be completed in three phases. Phase One, completed in March 1999, focused on those canyons identified by the Tribe as areas of significance. Phase Two will address those canyons within the APE not studied as part of Phase One. Phase Three is to be completed as part of the comprehensive noise management plan for the GCNP.

The FAA and the Tribe have agreed to develop a programmatic agreement (PA) in accordance with 36 CFR part 800.. The FAA expects to have the PA for the Hualapai Tribe as part of the Final Supplemental EA. Additionally, the FAA expects to complete the Section 106 consultation for cultural resources.

4.3 DOT SECTION 4(f)

Section 4(f) of the Department of Transportation (DOT) Act, 49 U.S.C. Section 303, requires that the Secretary of Transportation consider certain environmental consequences to public lands or assets if any proposed program or project requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national State, or local significance, or; land of a historic site or national, State, or local significance as determined by the officials having jurisdiction thereof, then the Secretary can approve the proposed program or project base only upon a showing that there is no feasible and prudent alternative to the use of such land and such program or project includes all possible planning to minimize harm.

Actions which render Section 4(f) properties unsuitable for the uses occurring at these sites may constitute a "constructive use" of such properties even if no physical taking of property is involved. Noise levels which substantially interfere with the use and value of such properties or preclude the activities normally occurring at such properties would therefore constitute a constructive use of property.

GCNP and adjoining lands are largely public lands protected under Section 4(f). The Congress stated in Pub. L. 100-91 that noise associated with aircraft overflights at GCNP was causing "a significant adverse effect on the natural quiet and experience of the park...."[42]

The Proposed Action is an effort to address the Congressional concern by reducing the effects of aircraft noise. To the extent that the proposed project reduces aircraft noise effects, it does not cause a use (actual or constructive) under DOT Section 4(f) within the impact analysis area.

None of the alternatives considered require the physical use of any lands protected under Section 4(f). The analysis in Section 4.1 indicates that increases in noise under the Proposed Alternatives would range from 0 dB to 11.7 dBA, at levels between 16 to 50 dB, at the representative locations provided in Appendix A. Accepted thresholds of significant noise impact for traditional recreational activities would not be exceeded at any of these representative locations. In addition, noise levels associated with any of the Proposed Alternatives are well below any accepted threshold of significance for residential land uses at all points in the SFAR area with the exception of Grand Canyon National Park Airport itself. Historic properties are not used within the meaning of Section 4(f) when FAA issues a No Effect Determination or a No Adverse Effect Determination under Section 106 of the NHPA. Section 4(f) does not apply to archeological resources that have value chiefly for data recovery and which are not important for preservation in place. Accordingly, based upon Section 106 consultation to date and actions taken by FAA to avoid and minimize impacts to TCPs and identification of other cultural resources in the APE for the Proposed Action for any of the Proposed Alternatives considered, it does not appear that constructive use of Section 4 (f) properties would occur.

4.4 WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act (Pub. L. 90-542, as amended) describes those river areas eligible to be included in a system afforded protection under the Act as free flowing and possessing "...outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values." As described in Section 3.6.5, the NPS reports that the Colorado River within the GCNP and Hualapai tribal lands, as well many of its major tributaries meet the criteria for designation as a wild and scenic river, and so is treated in accordance with the requirements of the Wild and Scenic Rivers Act.

The Proposed Alternatives considered adding flight free zones over large sections of the Colorado River and portions of the Little Colorado River. Within the impact analysis area, the Colorado River and Little Colorado River receives additional protection from the Toroweap/Shinumo and Desert View FFZs. Based on review of Figures 4-9 and 4-10, parts of the river including the intersection of the Colorado and Little Colorado Rivers under the expanded Toroweap/Shinumo and Desert View FFZs will experience reduced noise levels when compared to the No Action Alternatives.

4.5 VISUAL IMPACTS

This impact category is normally related to considerations of the aesthetic integrity of an area in relation to proposed development in residential areas, disruption of scenic vistas, impairment of experience at historic sites, and interference with privacy during ceremonies at Native American sacred sites. None of the Proposed alternatives considered involve physical development or construction.

The visual impact of air traffic across the scenic vistas of Grand Canyon is a matter of potential concern. The U.S. Forest Service report, National Forest Landscape Management, Volume 2, indicates the difficulty of establishing acceptable levels of visible activity. The report finds that individuals reaction to visible elements in the environment is dependent upon their personal expectations and images of the area. Accordingly, persons expecting a pristine environment may be concerned by the visible presence of any aircraft. Others with different expectations might not be concerned by any amount of aircraft activity.

As stated in the Final EA, the visual impact of air traffic across the scenic vistas of GCNP is a potential concern. The Proposed Action, considering any of the Proposed Alternatives, reduces the area of the GCNP that is subject to low level overflights relative to the No Action Alternative. There will be increases in density of aircraft in specific areas due to the revised commercial air tour routing but such increases are not likely to change the visual character of these areas for the same reasons visual character was not changed for the Final EA Proposed Action.

4.6 SOCIAL/ SOCIOECONOMIC IMPACTS

This impact category addresses the physical disruption or division of communities, relocation of residences or businesses, altered surface transportation systems, shifts in population movement or growth, changes in public service demands and business or economic activity. Of these, the only impact that the proposed action may have relates to business activity.

The Hualapai Tribe expressed concern over the potential detrimental economic impact of the Proposed Rule evaluated in the Final EA. The Proposed Action, with any of the proposed commercial air tour routes, analyzed in this Supplemental EA does not alter the Hualapai's unrestricted access to the airport on the Hualapai Reservation. Additionally, the FAA is still committed to working with the Hualapai, whenever necessary, to support future development at Grand Canyon West Airport.

As with the proposed action in the Final EA, the Proposed Action in this Supplemental EA does not involve ground traffic and associated impacts.

4.7 ENVIRONMENTAL JUSTICE

DOT issued DOT order 5610.2, Environmental Justice in Low-Income Populations and Minority Populations (62 FR 18377, April 15, 1997) to implement in part E.O. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations (59 FR 7629, February 16, 1994) and the accompanying Presidential Memorandum, and the DOT Strategy (60 FR 33896, June 29, 1995). The Proposed Action does not cause a disproportionately high or adverse effect on covered populations. The Proposed Action has eliminated existing air tour routes in the vicinity of Supai Village and over the Hualapai Reservation except in the vicinity of Grand Canyon West Airport. The Supplemental EA indicates that the Proposed Action would not result in significant noise or other environmental impacts on minority or low income populations in the study area.

Environmental justice (EJ) is concerned with whether or not adverse impacts to the environment and public health of minority populations and low income populations of

Federal actions are disproportionate. E.O. 12898 requires an examination of whether these impacts, including impacts to Native American subsistence hunting and gathering, are disproportionately high and adverse. The accompanying Presidential Memorandum encourages consideration of EJ in EAs especially to determine whether a significant impact may occur.

The population of the Grand Canyon region is small and thus Census tracts are large. The population within Census tracts is not uniformly distributed. Population groups tend to be dispersed or transient.

Native American populations are defined as minority populations and are presumed to be low-income or disadvantaged. Federally recognized tribes, including the tribes in the vicinity of the Grand Canyon (see 1994 Federally Recognized Indian Tribe List Act), also enjoy a political relationship with the U.S. government based on the U.S. Constitution, treaties, specific statutes and executive orders, and court decisions. These populations tend to be concentrated in widely dispersed settlements. Their activities, such as ceremonies at traditional cultural sites, or subsistence hunting and gathering are also dispersed.

Similarly, the population at or near the GCNP tends to be seasonal and concentrated in dispersed sites. Visitor activity occurs throughout the year but peaks during the summer. Ranches and dispersed villages in the vicinity of the GCNP may have a high proportion of Hispanic people, many of whom are also low-income, and non-Hispanics who are low-income.

The GCNP and, to a lesser extent, surrounding public lands and tribal lands receive large numbers of visitors, especially during the summer, who may stay a few hours to several days or weeks. Many visitors concentrate their activities at highly developed sites, such as the South Rim, while many others engage in dispersed recreation, such as wilderness camping.

Impacts to Native Americans. Because Census tract data do not fully capture the nature of these populations and their activities, FAA qualitatively analyzed the impacts and benefits following the procedures in DOT Order 5610.2. In working toward substantially restoring natural quiet, in the context of increasing visitor activity, including air tour activity, in GCNP, the FAA has worked with Native American tribes adjacent to or with aboriginal interests in the Grand Canyon to reduce or avoid adverse impacts, especially from noise, by adjusting proposed routes and allowing for Notice to Airmen (NOTAMs) on specific occasions in limited areas.

Impacts to Native American Subsistence Hunting and Gathering. In accordance with Sec. 5 of E.O. 12898, concerning impacts to subsistence hunting, fishing, and gathering by Native Americans, FAA analyzed effects of the alternative air tour and airspace structure and procedures on these activities. The Paiute commented on air pollution and intrusion during subsistence gathering activities in the context of Sec. 106 consultation but have tentatively concurred with a No Effect Determination under Sec. 106 by FAA. The Hualapai commented on potential impacts to subsistence hunting but noted that subsistence hunting has been curtailed due to commercial hunting pressure authorized by the tribe. The Navajo commented on potential impacts to subsistence sheep herding activities during the Sec. 106 consultation as a traditional cultural practice. In this latter situation, FAA through its

Flight Standard District Office is training tribal members in procedures for requesting temporary NOTAMs and reporting low-flying aircraft.

Impacts to Non-Native American Minority or Low-Income Populations. FAA has issued public notice and requested comments through Federal Register notices and numerous public hearings at the Grand Canyon, in Phoenix, Las Vegas, St. George, and elsewhere. No comments were received from other potentially affected EJ populations. The route structure outside of the SFRA that might impact EJ populations, other than Native American populations, is similar to the historic route structure. No significant impacts to non-Native American or other minority or low-income populations have been identified.

4.8 NATIVE AMERICAN COMMUNITIES

Section 3.3 provides a brief description of the .Native American Communities that inhabit and have ties to the areas around GCNP. The Proposed Action or any of the Proposed Alternatives, with an commercial air tour limitations or with continued growth, reduce noise levels over the majority of Native American areas with the exception of a few locations, most notably, Dr. Tommy's Mountain (formerly known as Gus' Plateau). Improvements made by commercial air tour route alternatives are eroded with continued growth. For the No Action Alternative and the Proposed Alternatives considered, noise levels associated with aircraft activity in and around the GCNP are substantially below any established threshold of significant impact. In addition, the analysis in Section 4.1 indicates that aircraft noise levels generally would not interfere with normal outdoor speech communication.

The FAA has made progress toward protecting Native American resources. This is evidenced by refining commercial air tour routes over Supai Village as requested by the Havasupai Tribe and expanding the Desert View FFZ as requested by the Navajo Nation, the Hopi, and the Pueblo of Zuni Tribes to avoid sites of importance to these Tribes.

A record of consultation with Native American Tribes and Nations is provided in Appendix H.

4.9 ENDANGERED SPECIES

As discussed in Section 3.7, three endangered plants and nine endangered animal species are found in the Grand Canyon and the Hualapai Reservation. With the exception of the American peregrine falcon and the California condor, all of these species are ground living and so are unlikely to be affected by aircraft operations and associated noise at the relatively low levels projected. Although the Desert bighorn sheep is not listed in Arizona as a federally threatened species, it is a species of special concern to the Hualapai Tribe. The Hualapai Tribe have expressed concerns about single event noise impacts as well as long term exposures and lower level noise events on the sheep.

The likelihood of adverse effects to the avian endangered species is remote given that, with any of the Proposed Alternatives with the exception of the Blue South Direct (Alternative 4 see Figure 2-4), aircraft will not be introduced into new areas. The effect of the Proposed Action will be to decrease air traffic in some areas with proportional increases in other airspace that is currently in use. The proposed actions would therefore reduce the potential for bird strikes in much of the GCNP and its surrounds.

Literature on flight altitudes for condors and peregrines is limited; however, discussions with raptor observers indicate that peregrines may soar at 3,000 feet or higher when hunting.[43] Although condors and falcons have the ability to climb as high as 10,000 to 20,000 feet and sometimes as high as 25,000 feet, observers find that these species are typically not flocking by nature and often migrate at altitudes lower than 3,000 feet.

Research completed for the FAA on potential bird hazards found that approximately 98 percent of bird strikes involving raptors occurred at less than 500 feet above ground.[44] It should be noted that the FAR Part 91 prohibits all aircraft from operating within 500 feet of any terrain or structure. Since flights below the rim of the Grand Canyon are not permitted, the altitude of aircraft above the canyon floor would be substantially higher. However, recent peregrine falcon (including their eyries) monitoring conducted by the NPS suggest significant disturbance to peregrines such that they have abandoned eyries in flight corridors.

Impact from any of the Proposed Alternatives on the California Condor is less likely than for the American peregrine falcon. The California Condor was re-introduced in Coconino County, Arizona on October 29, 1996, on top of the Vermilion Cliffs on land managed by the Bureau of Land Management. The area is approximately 30 miles north of the GCNP. NPS monitoring of the California Condor is in the early stages. As the birds have matured on the Vermilion Cliffs, they have been spending more time in the GCNP and its surrounds.

FAA has initiated consultation with U.S. Fish and Wildlife to determine any potential impacts associated with the Proposed Action (Alternative 2). Consultation with the Hualapai Natural Resources Department has been initiated to determine any potential impacts on Desert bighorn sheep and other species of concern listed in Sections 3.7.1 and 3.7.2.

4.10 AIR QUALITY

The thresholds of significant impacts to air quality relate to conformity of the proposed action with the State Implementation Plan (SIP), and to the potential for the proposed action or any of the Proposed Alternatives to exceed National Ambient Air Quality Standards (NAAQS) for any criteria pollutant. The GCNP is an attainment area for all criteria pollutants.

The Proposed Action, which includes an commercial air tour limitation, is projected to maintain total aviation activity at 1997 levels relative to the No Action Alternative. Accordingly, the Proposed Action would not increase emissions due to aircraft operations when compared to the No Action Alternative. This outcome would clearly be in conformance with the SIP. Emissions under the No Action Alternative would be no worse than with any of the alternatives.

The EPA, in issuing the Final Rule on Determining Conformity of General Federal Actions to State or Federal Implementation Plans under Section 176(c) of the Clean Air Act, identified "de minimus" emissions levels which do not require a conformity determination. The EPA also identified

Federal actions which are de minimus in nature. In the preamble to that Final Rule, the EPA stated that air traffic control activities and adopting approach, departure, and en route procedures for air operations are de minimus actions, exempt from conformity determinations requirements.

4.11 CUMULATIVE IMPACTS

CEQ 1508.7 states that cumulative impact is the effect on the environment which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. In this way, the cumulative impacts which result from individually minor but collectively significant actions occurring over a period of time may be examined.

Paragraph 26 of FAA Order 5050.4A, Airport Environmental Handbook, states that the cumulative impacts of the following types of actions should be considered in the preparation of an environmental assessment:

1. Actions which are closely related and should be discussed in the same NEPA document. Actions are connected if they meet one or more of the following criteria:

    - Actions which automatically trigger other actions which may require the preparation of an environmental impact statement.

    - Actions which can not or will not proceed unless other actions are taken previously, or simultaneously.

    - Actions which are interdependent parts of a larger action and depend on the larger actions for their justification.

2. Cumulative actions, when considered with other proposed actions, have cumulatively significantly impacts and should therefore be discussed in the same NEPA document.

3. Similar actions which are similarities, such as timing or location, with other reasonably foreseeable or Proposed Actions that provide a basis for evaluating their environmental impacts in the same NEPA document.

The previous analyses indicate that there is very little potential for adverse impact, given the relatively low noise levels in the study area. The potential for cumulative impacts is limited to local areas which would experience increased noise levels as a result of implementation of the Final Rule with the Proposed Alternative.

A Notice of Proposed Rulemaking for the establishment of noise limitations for aircraft operations in the vicinity of the GCNP (transition to quiet technology), was issued in December 1996 accompanied by a Draft EA. A quiet technology rulemaking has not been finalized but is expected to provide a net benefit impact upon implementation. The Noise Limitations/ Quiet Technology Final Rule will be analyzed in an EA, which will consider the cumulative impacts of the air tour routes, final SFAR boundary, FFZs, implementation of the 1996 curfew and aircraft cap and the proposal to implement an commercial air tour limitation.

Grand Canyon West Airport is located in the vicinity of the Proposed Action and Alternatives. Although air tour operators may be authorized to land at the airport without using the tour routes, some operators do so. Based upon the current low level of airport operations, potentially significant cumulative noise or other environmental impacts are not anticipated.

The FAA is aware that the Hualapai Tribe have plans to develop Grand Canyon West. However, these plans are conceptual in nature. The plans are described as follows:

> **Grand Canyon West Airport**: The Hualapai Tribe plans to expand the development at Grand Canyon West, including moving the airstrip back from the rim. Most of the air tours on Green 4 land at Grand Canyon West, or on Hualapai lands near the Colorado River below Grand Canyon West.

The development is contemplated, but not yet proposed. As such, the development is too uncertain and far in the future for its impacts to be reasonably foreseen and analyzed along with the Proposed Action and Alternatives. The Proposed Action, which will proceed independently, is not related to future development of Grand Canyon West.

Any proposal to relocate and expand Grand Canyon West, including potential cumulative impacts of airport operations along with air tour operations and the potential for expansion of the airport to increase use of the tour routes, will be subject to environmental review by the Hualapai Tribe. FAA will also participate or conduct appropriate environmental review if a grant of federal funds is contemplated.

4.12 OTHER IMPACT CATEGORIES

The Environmental Consequences "section forms the scientific and analytic basis for the comparisons" in the alternatives section.[45] FAA Order 1050.1D advises, in essence, that specific environmental impact areas should be discussed "as much as is necessary to support the comparisons [of alternatives]."[46] Accordingly, an early review of the potential environmental impacts was conducted to guide the development of the environmental consequences section. This review indicated that most impact categories typically evaluated in an environmental assessment would not be affected by any of the alternatives. Scoping comments confirmed that this review was reasonable. Therefore, the following impact categories were not analyzed in detail:

- Coastal Zone
- Water Quality
- Wetlands
- Coastal Barriers
- Compatible Land Use
- Biotic Communities
- Light Emissions
- Floodplains
- Farmland
- Solid Waste
- Bird Hazard
- Energy/Natural Resources
- Construction

4.13 MITIGATION

As discussed in Section 4.2, the FAA shall continue to consult and work with Native American Tribes and Nations during further development of the air tour routes to address any additional requests to minimize noise increases over traditional cultural properties as part of the continuing Section 106 process, this includes areas potentially affected by traffic and commercial air tour routes outside the Flight Free Zones.

The FAA has and will continue to protect any confidentiality requested by the Tribes to limit public access and preserve the character and integrity of sacred sites. The FAA will complete Section 106 consultation before it finalizes and permanently implements the commercial air tour routes and adopt all measures necessary to support a determination of no adverse effect.

1998 Leq_{12h} No Action Contours

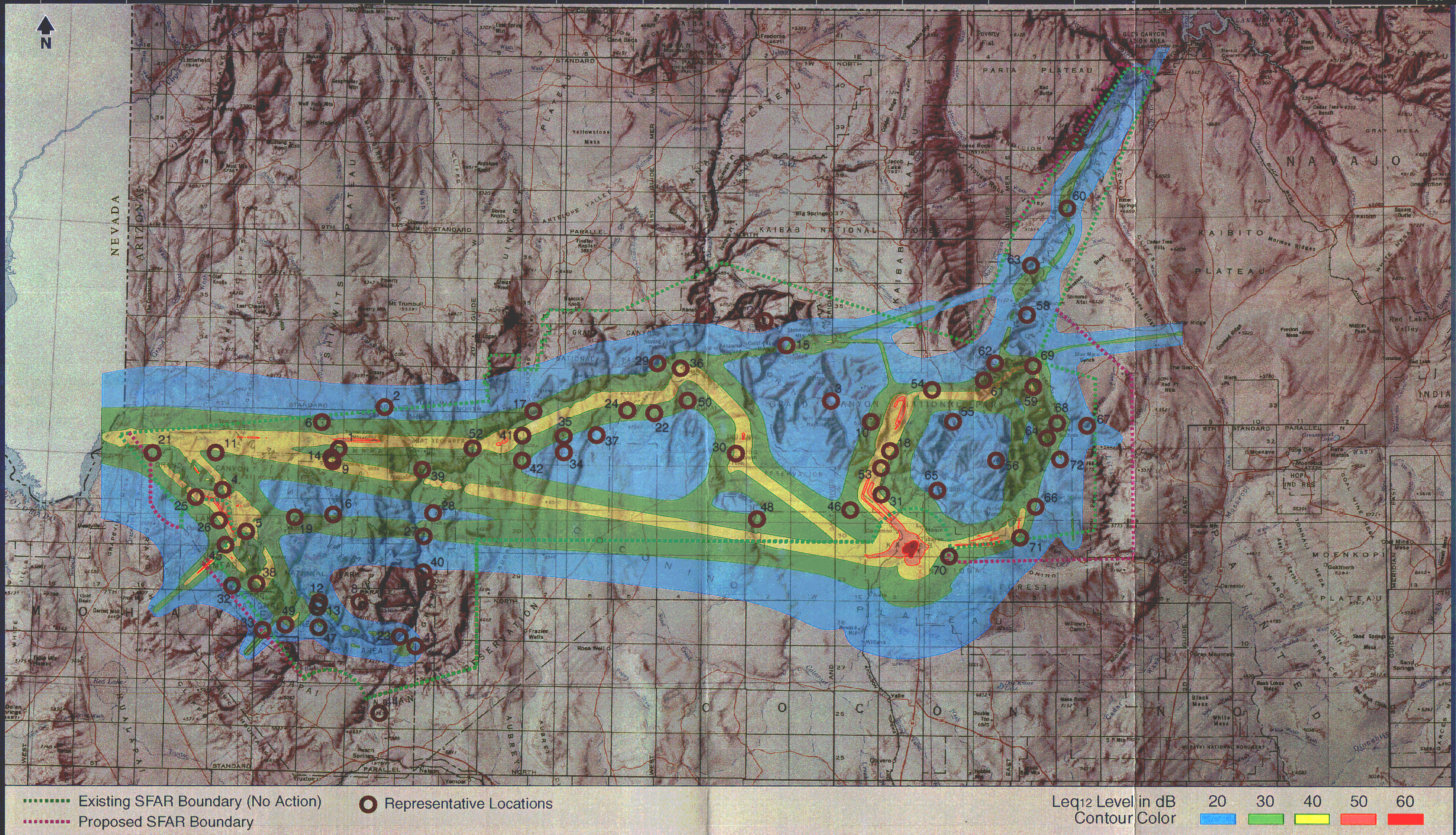
FIGURE 4-3

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

2003 Leq_{12h} No Action Contours

FIGURE 4-4

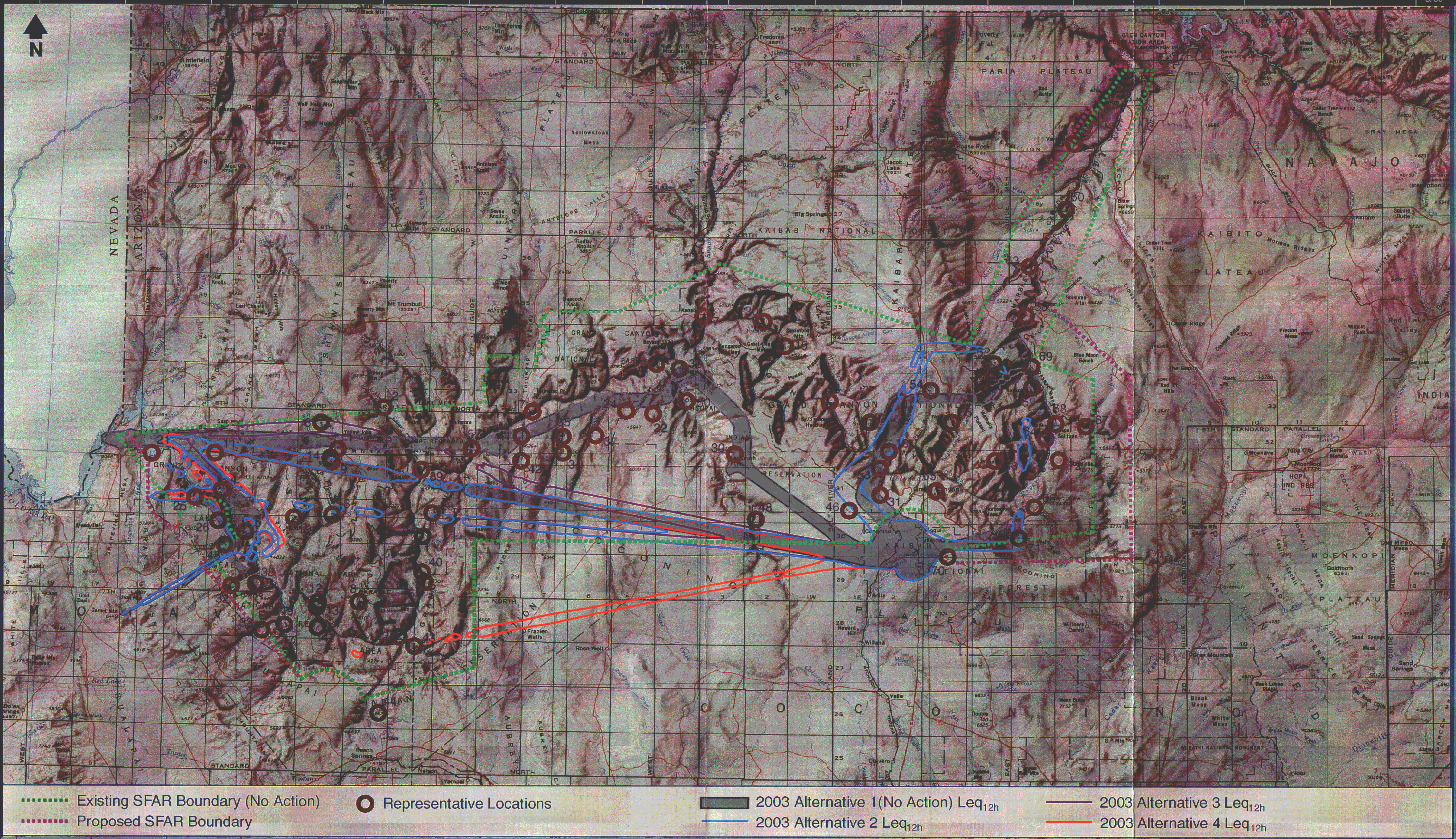


PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Supplemental Environmental Assessment

2003 Alternatives With Commercial Air Tour Limitations Compared to the 2003 No Action Leq_{12h} 40 Contours

FIGURE 4-5

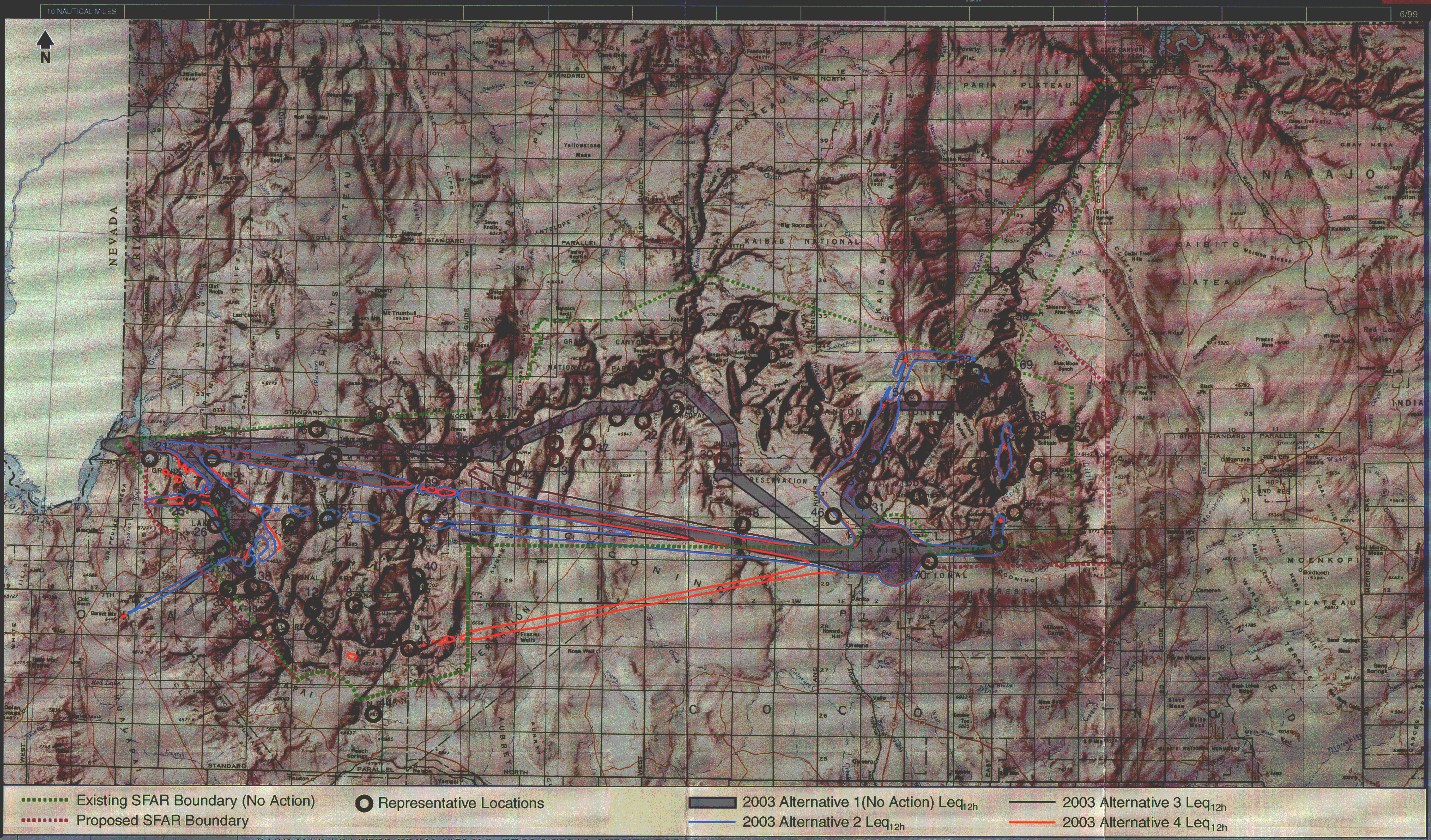


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

FIGURE 4-6

Alternatives With Continued Growth Compared to the 2003 No Action Leq_{12h} 40 Contours

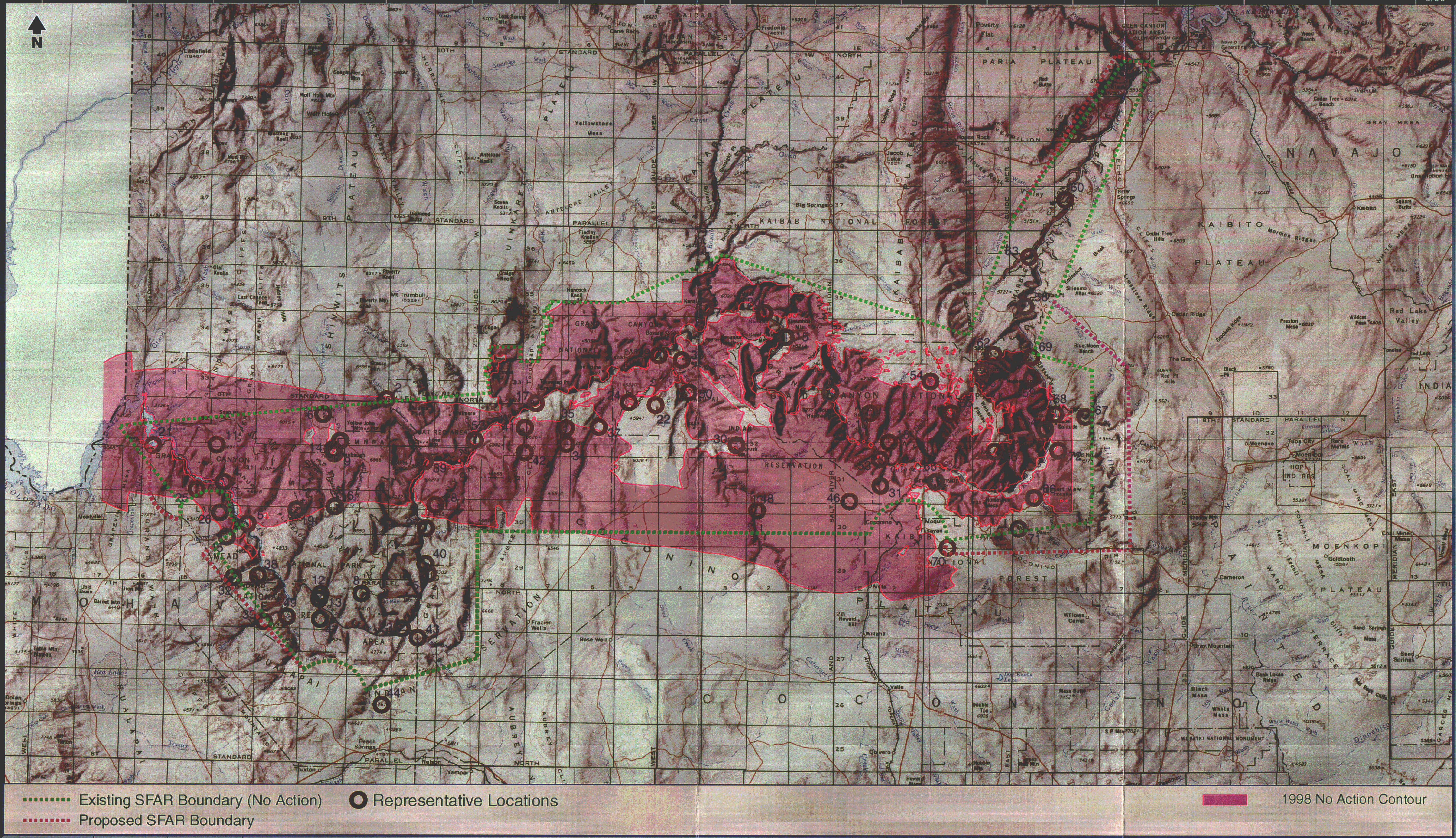


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

1998 Aircraft Audible More Than 25% of Time
No Action Contour

FIGURE 4-7

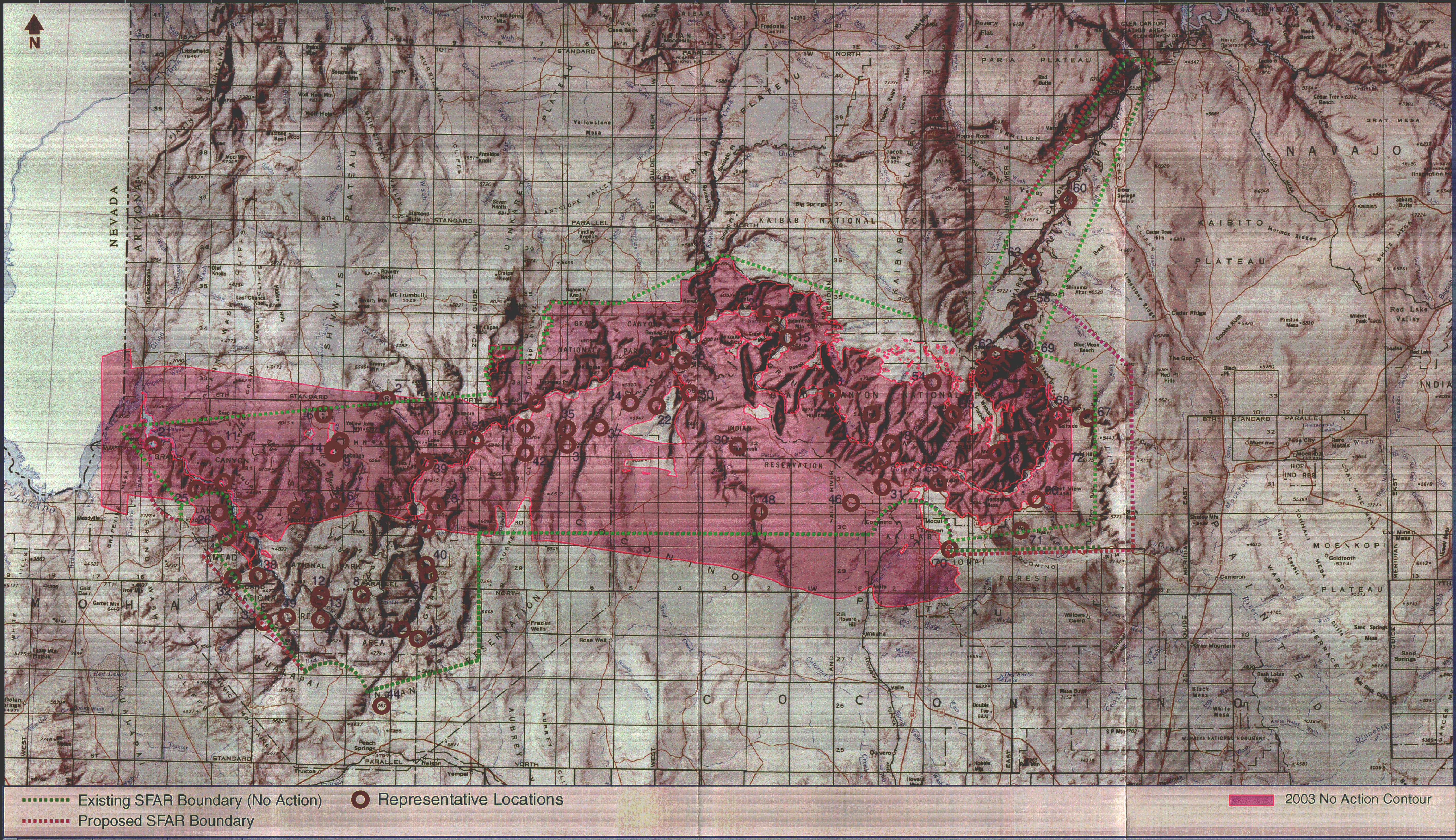
6/99



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

2003 Aircraft Audible More Than 25% of Time
No Action Contour

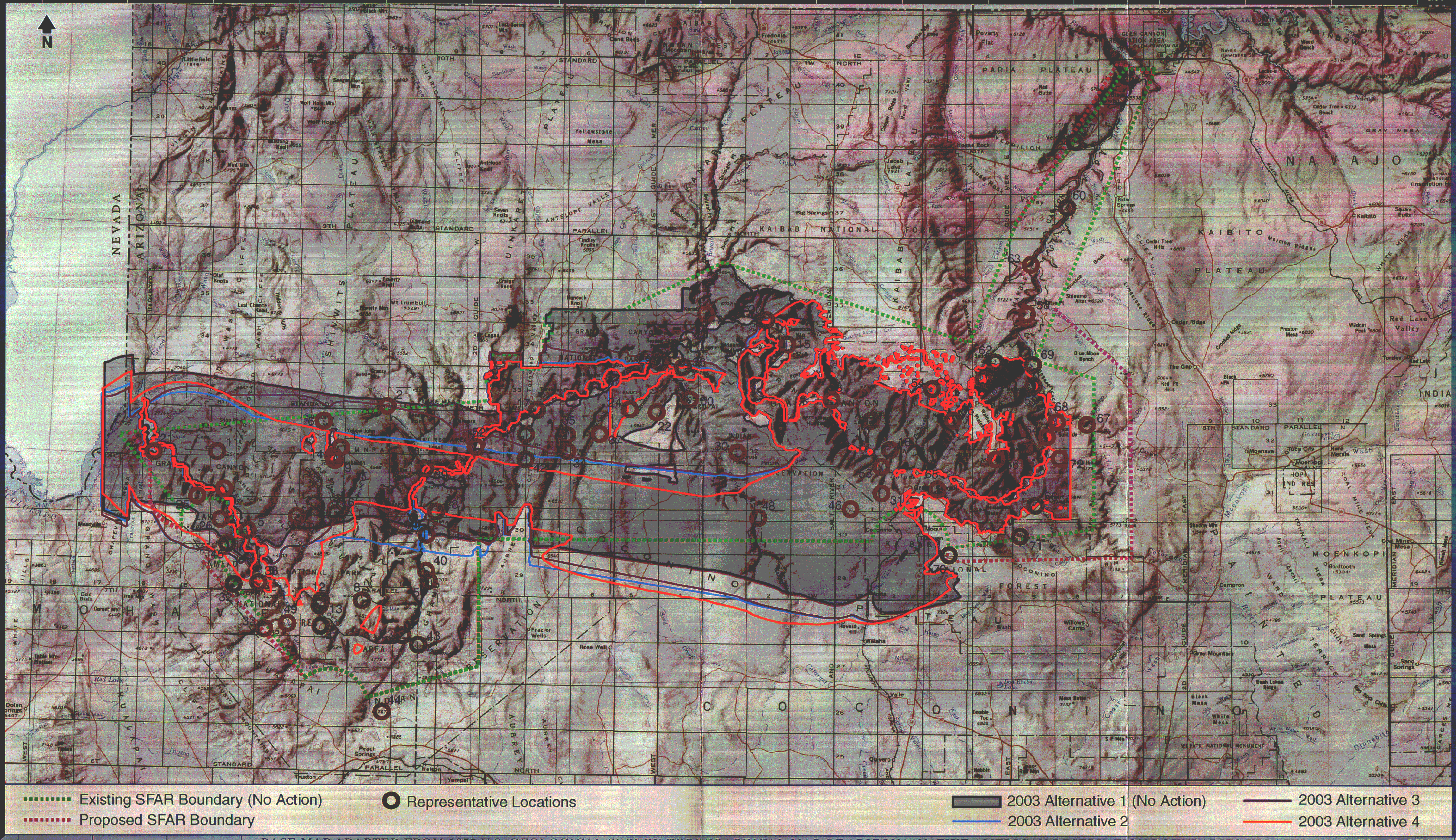
6/99



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

FIGURE 4-9

Alternatives With Commercial Air Tour Limitations Compared to the 2003 No Action Aircraft Audible More Than 25% of Time Contours



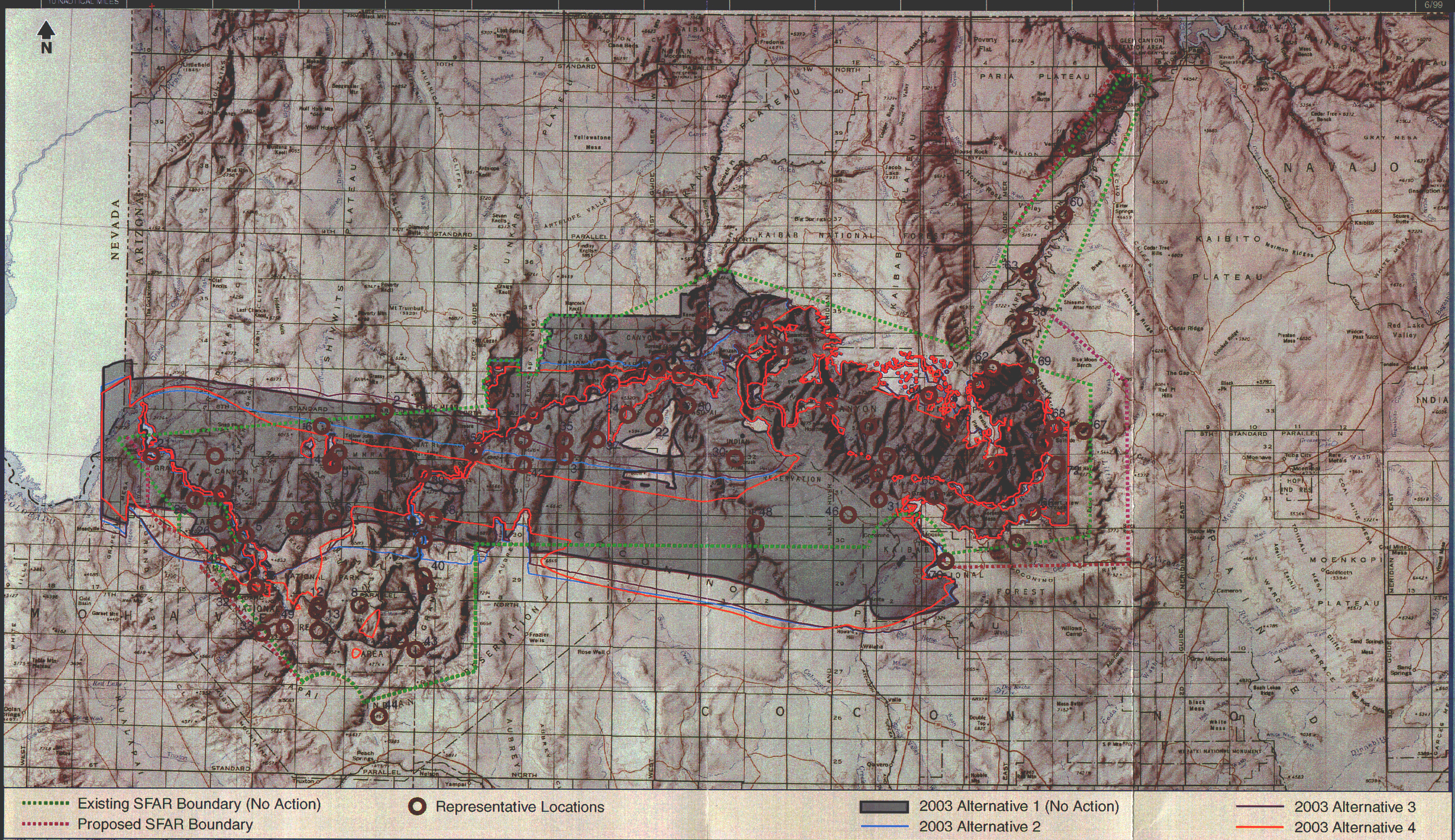
BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Alternatives With Continued Growth Freeze Compared to the 2003 No Action Aircraft Audible More Than 25% of Time Contours

FIGURE 4-10

6/99



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Chapter Five
LIST OF PREPARERS

Listed below are employees of the Federal Aviation Administration (FAA) who are responsible for the preparation of the Draft Supplemental Environmental Assessment (EA). Supporting the FAA, DOI NPS and Native American Tribes and Nations in this effort are individuals from VOLPE National Transportation Systems Center, PRC, Inc., and HNTB Corporation.

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Mylinda H. Green

B.A., English, Mary Washington College, 1994. Technical Editor, HNTB Corp. Eight years of editorial experience. Responsible for technical editing of the document.

Notes

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[1] NPS Report to Congress on the Effects of Aircraft Overflights on the National Park System, July 1995, p. 182.

[2] FAA Order 1050.1D, Par 64.

[3] Ibid.

[4] National Park Service General Management Plan DEIS, p.155; Note that a GMP Final EIS was completed and a Record of Decision (ROD) issued in August 1995.

[5] National Park Service General Management Plan, pp. 141-145 and comments provided by the Hualapai in memorandum dated May 19, and June 1, 1999.

[6] National Park Service General Management Plan DEIS, p. 157.

[7] National Park Service General Management Plan DEIS, Management Zones map, p. 15.

[8] National Park Service General Management Plan DEIS, p. 4.

[9] Ibid., p. 48.

[10] Ibid., p. 6.

[11] Ibid., p. 154.

[12] Grand Canyon West, Economic Development Concept Presentation, December 1998.

[13] National Park Service General Management Plan DEIS, pg. 146.

[14] Ibid.

[15] Ibid., p. 148.

[16] Ibid.

[17] Ibid., p. 140.

[18] Ibid.

[19] Ibid., p. 141.

[20] Ibid.

[21] Ibid.

[22] Ibid.

[23] Ibid.

[24] Ibid., p. 4.

[25] Phillips et al, 1987.

[26] National Park Service General Management Plan DEIS, p. 4.

[27] Sender (GRCA_Wildlife_Biologist@nps.gov) (1999, April 29). Endangered Species List. E-mail to Fred Bankert (Bankert_Fred@prc.com); USDOI Fish and Wildlife Service Arizona Ecological Services Field Office letter, dated November 13, 1996, and National Park Service General Management Plan DEIS, pg. 135.

[28] FAA Order 1050.1D, par. 65(b).

[29] National Park Service Report To Congress, Figure 9-4, p. 191.

[30] Ibid., Figure 9-3, p. 190.

[31] Ibid., p. 175.

[32] National Park Service General Management Plan, pp. 157-158.

[33] National Park Service General Management Plan, pp. 157-158.

[34] Previous sections discuss this objective and note that it is the primary motivation for the rule.

[35] "Actively listening" means the sole task of the observer is to listen for the presence of aircraft.

[36] Note that the noise heard on the ground is a function of both the source noise and the propagation path from the source to the receiver, so specifying source noise is not equivalent to specifying the noise a listener hears.

[37] Note that the noise heard on the ground is a function of both the source noise and the propagation path from the source to the receiver, so specifying source noise is not equivalent to specifying the noise a listener hears.

[38] ATC does not count overflights as operations. On the other hand, ATC counts circuits as two operations (each circuit has a departure and an arrival). The Activity Report counts the number of commercial air tour routes flown, not the number of takeoff and landings. For example, an air tour which enters the SFRA on Black 2, overflies Cape Solitude and Nankoweap Rapids on Black 1, and exits the SFRA on Black 3 counts as 3 operations in the Activity Report, as one operation (an overflight) in the INM, and is not counted at all by Air Traffic Control at GCN.

[39] ATC does not count overflights as operations. On the other hand, ATC counts circuits as two operations (each circuit has a departure and an arrival). The Activity Report counts the number of commercial air tour routes flown, not the number of takeoff and landings. For example, an air tour which enters the SFRA on Black 2, overflies Cape Solitude and Nankoweap Rapids on Black 1, and exits the SFRA on Black 3 counts as 3 operations in the Activity Report, as one operation (an overflight) in the INM, and is not counted at all by Air Traffic Control at GCN.

[40] The INM profile generator was used for all aircraft except the three helicopter types and the DHC-6, as explained above.

[41] The INM profile generator is based on recommendations found in the Society of Automotive Engineers' Aerospace Information Report 1845 (SAE AIR 1845). It presents an empirical method for computing aircraft position and performance, using a set of aerodynamic and engine coefficients unique to each aircraft model. These coefficients, along with the standard procedure for each aircraft exist in INM as an automated profile generation utility.

[42] NPRM, p. 5.

[43] Expanded East Coast Plan FEIS, USDOT FAA, 1995, p. 5-67.

[44] Harrison, Michael J., Assessment of Potential Bird Hazards Houston Westside Airport, Table 6, April 3, 1989.

[45] Council on Environmental Quality (CEQ) Regulations sec. 1502.16.

[46] FAA Order 1050.1D, par. 66, p. 38.

APPENDIX A

NOISE RESULTS

This appendix presents noise results summarized in Section 4.1.

Table A.1

Comparison of L_{Aeq12h} at Representative Locations in GCNP North of Colorado River, West of GC Airport 1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	37.5	31.9	-5.6	31.1	-6.4	31.7	-5.8
2	Andrus Canyon (ANDRUS)	24.5	18.5	-6.0	26.4	1.9	18.0	-6.5
3	Bass Camp (BASCMP)	21.4	22.2	0.8	22.2	0.8	22.1	0.7
4	Bat Cave (BATCAV)	39.4	42.0	2.6	41.9	2.5	41.9	2.5
5	Bumt Springs Canyon (BRNTSP)	39.5	42.6	3.1	42.6	3.1	42.6	3.1
6	Castle Peak (CASTLE)	31.0	23.5	-7.5	42.9	11.9	23.3	-7.7
7	Kanab Point (KANAPT)	17.3	9.7	-7.6	9.8	-7.5	9.4	-7.9
8	Kelly Point (KELLPT)	16.1	15.1	-1.0	14.6	-1.5	25.4	9.3
9	Mt. Dellenbaugh (MTDELL)	42.8	41.7	-1.1	26.5	-16.3	41.7	-1.1
10	Point Sublime (PTSUBL)	30.9	31.8	0.9	31.8	0.9	31.8	0.9
11	Sanup (SANUP)	38.5	38.7	0.2	32.8	-5.7	39.2	0.7
12	Separation Canyon at Colorado River (SCCORV)	27.0	16.6	-10.4	16.2	-10.8	34.1	7.1
13	Separation Canyon (SEPARC)	25.2	16.2	-9.0	15.9	-9.3	32.2	7.0
14	Shivwitz Fire Camp (SHWZFC)	38.5	38.0	-0.5	27.5	-11.0	38.0	-0.5
15	Stone Creek (STONCK)	28.7	14.5	-14.2	14.6	-14.1	14.4	-14.3
16	Suicide Point (SUIPNT)	29.2	38.6	9.4	38.5	9.3	23.2	-6.0
17	Toroweap Overlook (TOROWP)	32.5	15.9	-16.6	17.7	-14.8	15.0	-17.5
18	Tower of Ra (TOWER)	45.9	41.8	-4.1	41.8	-4.1	41.8	-4.1
19	Twin Point (TWINPT)	32.5	34.2	1.7	34.1	1.6	28.6	-3.9
20	Upper Deer Creek (UPDRCK)	17.3	12.2	-5.1	12.3	-5.0	12.1	-5.2
21	West End (WESEND)	37.3	34.4	-2.9	34.4	-2.9	35.0	-2.3

Table A.2

Comparison of L_{Aeq12h} at Representative Locations in GCNP
South of Colorado River, West of GC Airport
1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	32.3	14.8	-17.5	15.3	-17.0	14.1	-18.2
23	Diamond Creek (DIACRK)	26.4	12.6	-13.8	12.1	-14.3	32.7	6.3
24	The Dome (DOME)	34.7	14.5	-20.2	15.1	-19.6	13.7	-21.0
25	Granite Gorge (GRAGOR)	42.1	39.7	-2.4	39.7	-2.4	37.6	-4.5
26	Grand Canyon West (GCWEST)	40.3	39.1	-1.2	39.1	-1.2	38.9	-1.4
27	Granite Park (GRNTPK)	29.1	29.4	0.3	29.1	0.0	21.0	-8.1
28	Dr. Tommy's Mountain (DRTOMM)	27.7	39.6	11.9	39.4	11.7	26.4	-1.3
29	Havasu Point (HAVAPT)	28.5	11.9	-16.6	12.2	-16.3	11.4	-17.1
30	Havatagvitch Canyon (HAVCAN)	40.5	19.0	-21.5	19.3	-21.2	18.4	-22.1
31	Hermit Basin (HBASIN)	39.8	33.9	-5.9	33.9	-5.9	33.9	-5.9
32	Horse Flat Canyon (HFCAN)	27.0	23.8	-3.2	23.7	-3.3	24.1	-2.9
33	Meriwhitca (MERIWH)	28.2	15.1	-13.1	15.0	-13.2	18.0	-10.2
34	Mohawk Canyon (MOHAWK)	25.5	21.3	-4.2	23.4	-2.1	20.5	-5.0
35	Mohawk Canyon (MOHCAN)	30.2	18.7	-11.5	20.3	-9.9	17.8	-12.4
36	Mount Sinyala (MTSINY)	45.6	12.0	-33.6	12.2	-33.4	11.5	-34.1
37	National Canyon (NATCAN)	26.0	17.8	-8.2	19.0	-7.0	17.0	-9.0
38	Jackson Canyon (JCKCAN/NONAME)	38.5	24.7	-13.8	24.7	-13.8	25.8	-12.7
39	Parashant Wash (PARWAS)	34.4	34.3	-0.1	29.4	-5.0	34.1	-0.3
40	Pumpkin Springs (PMPKIN)	18.8	20.0	1.2	19.4	0.6	18.8	0.0
41	Prospect Canyon (PROCAN)	42.4	19.5	-22.9	22.5	-19.9	18.7	-23.7
42	Prospect Canyon (PRSPCT)	30.8	24.6	-6.2	29.5	-1.3	24.0	-6.8
43	Peach Spring Canyon North (PSCNNO)	27.0	11.8	-15.2	11.3	-15.7	37.4	10.4
44	Peach Spring Canyon South (PSCNSO)	7.9	7.8	-0.1	7.5	-0.4	16.0	8.1
45	Quartermaster Point (QMPNT)	39.4	36.4	-3.0	36.3	-3.1	36.4	-3.0
46	The Ranch (RANCH)	31.8	38.1	6.3	38.1	6.3	38.1	6.3
47	Spencer/Meriwhitica Canyons (SCMCIG)	27.8	13.8	-14.0	13.4	-14.4	29.3	1.5
48	South Supai Canyon (SOSUPC)	30.9	32.6	1.7	34.0	3.1	31.8	0.9
49	Spencer Canyon (SPENCA)	29.4	15.2	-14.2	15.0	-14.4	21.0	-8.4
50	Supai Village (SUPVIL)	31.7	14.3	-17.4	14.5	-17.2	13.7	-18.0
51	Three Springs Rapids (THRSPR)	17.2	18.4	1.2	17.8	0.6	19.4	2.2
52	Whitmore Rapids (WHTRAP)	38.7	23.8	-14.9	33.2	-5.5	23.2	-15.5
53	96 Mile Camp (96MILE)	40.7	35.9	-4.8	35.9	-4.8	35.9	-4.8

Table A.3

Comparison of L_{Aeq12h} at Representative Locations in GCNP North of Colorado River, East of GC Airport 1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	36.5	27.3	-9.2	27.3	-9.2	27.3	-9.2
55	Bright Angel Point (BRTANG)	25.1	23.3	-1.8	23.4	-1.7	23.3	-1.8
56	Cape Royal (CAPROY)	23.2	25.9	2.7	25.9	2.7	25.9	2.7
57	Cliff Dwellers Lodge (CLDWEL)	15.2	19.4	4.2	19.4	4.2	19.4	4.2
58	Marble Canyon Dam Site (MARBDM)	21.1	17.8	-3.3	17.8	-3.3	17.8	-3.3
59	Nankoweap Mesa (NANMES)	41.2	27.3	-13.9	27.3	-13.9	27.3	-13.9
60	North Canyon (NOCANY)	29.7	21.9	-7.8	21.9	-7.8	21.9	-7.8
61	Point Imperial (PTIMPL)	34.8	25.5	-9.3	25.5	-9.3	25.5	-9.3
62	Saddle Mountain (SADMTN)	28.3	37.7	9.4	37.7	9.4	37.7	9.4
63	South Canyon (SOCAN)	25.8	16.7	-9.1	16.7	-9.1	16.7	-9.1
64	Temple Butte (TEMBUT)	37.5	28.5	-9.0	28.5	-9.0	28.5	-9.0

Table A.4

Comparison of L_{Aeq12h} at Representative Locations in GCNP South of Colorado River, East of GC Airport 1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	27.6	28.2	0.6	28.2	0.6	28.2	0.6
66	Lipan Point (LIPAN)	30.2	28.5	-1.7	28.5	-1.7	28.5	-1.7
67	Little Colorado (LITCOL)	24.8	17.1	-7.7	17.1	-7.7	17.1	-7.7
68	Little Colorado River (LTCORV)	36.8	24.1	-12.7	24.1	-12.7	24.1	-12.7
69	Nankoweap at river (NANRIV)	35.8	23.3	-12.5	23.3	-12.5	23.3	-12.5
70	Ten X Meadow (TENMED)	35.8	36.4	0.6	36.4	0.6	36.3	0.5
71	Zuni Alpha (ZUNALF)	34.6	39.9	5.3	39.9	5.3	39.9	5.3
72	Zuni Charlie (ZUNCHR)	27.6	22.9	-4.7	22.9	-4.7	22.9	-4.7

Table A.5

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, West of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	37.8	31.9	-5.9	31.1	-6.7	31.7	-6.1
2	Andrus Canyon (ANDRUS)	24.8	18.5	-6.3	26.4	1.6	18	-6.8
3	Bass Camp (BASCMP)	21.7	22.2	0.5	22.2	0.5	22.1	0.4
4	Bat Cave (BATCAV)	39.7	42	2.3	41.9	2.2	41.9	2.2
5	Burnt Springs Canyon (BRNTSP)	39.8	42.6	2.8	42.6	2.8	42.6	2.8
6	Castle Peak (CASTLE)	31.3	23.5	-7.8	42.9	11.6	23.3	-8
7	Kanab Point (KANAPT)	17.6	9.7	-7.9	9.8	-7.8	9.4	-8.2
8	Kelly Point (KELLPT)	16.4	15.1	-1.3	14.6	-1.8	25.4	9
9	Mt. Dellenbaugh (MTDELL)	43.0	41.7	-1.3	26.5	-16.5	41.7	-1.3
10	Point Sublime (PTSUBL)	31.2	31.8	0.6	31.8	0.6	31.8	0.6
11	Sanup (SANUP)	38.8	38.7	-0.1	32.8	-6	39.2	0.4
12	Separation Canyon at Colorado River (SCCORV)	27.3	16.6	-10.7	16.2	-11.1	34.1	6.8
13	Separation Canyon (SEPARC)	25.5	16.2	-9.3	15.9	-9.6	32.2	6.7
14	Shivwitz Fire Camp (SHWZFC)	38.8	38	-0.8	27.5	-11.3	38	-0.8
15	Stone Creek (STONCK)	29.0	14.5	-14.5	14.6	-14.4	14.4	-14.6
16	Suicide Point (SUIPNT)	29.5	38.6	9.1	38.5	9	23.2	-6.3
17	Toroweap Overlook (TOROWP)	32.8	15.9	-16.9	17.7	-15.1	15	-17.8
18	Tower of Ra (TOWER)	46.2	41.8	-4.4	41.8	-4.4	41.8	-4.4
19	Twin Point (TWINPT)	32.8	34.2	1.4	34.1	1.3	28.6	-4.2
20	Upper Deer Creek (UPDRCK)	17.6	12.2	-5.4	12.3	-5.3	12.1	-5.5
21	West End (WESEND)	37.6	34.4	-3.2	34.4	-3.2	35	-2.6

Table A.6

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, West of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	32.6	14.8	-17.8	15.3	-17.3	14.1	-18.5
23	Diamond Creek (DIACRK)	26.7	12.6	-14.1	12.1	-14.6	32.7	6
24	The Dome (DOME)	35	14.5	-20.5	15.1	-19.9	13.7	-21.3
25	Granite Gorge (GRAGOR)	42.4	39.7	-2.7	39.7	-2.7	37.6	-4.8
26	Grand Canyon West (GCWEST)	40.5	39.1	-1.4	39.1	-1.4	38.9	-1.6
27	Granite Park (GRNTPK)	29.4	29.4	0	29.1	-0.3	21	-8.4
28	Dr. Tommy's Mountain (DRTOMM)	28	39.6	11.6	39.4	11.4	26.4	-1.6
29	Havasu Point (HAVAPT)	28.8	11.9	-16.9	12.2	-16.6	11.4	-17.4
30	Havatagvitch Canyon (HAVCAN)	40.8	19	-21.8	19.3	-21.5	18.4	-22.4
31	Hermit Basin (HBASIN)	40.1	33.9	-6.2	33.9	-6.2	33.9	-6.2
32	Horse Flat Canyon (HFCAN)	27.3	23.8	-3.5	23.7	-3.6	24.1	-3.2
33	Meriwhitca (MERIWH)	28.5	15.1	-13.4	15	-13.5	18	-10.5
34	Mohawk Canyon (MOHAWK)	25.8	21.3	-4.5	23.4	-2.4	20.5	-5.3
35	Mohawk Canyon (MOHCAN)	30.5	18.7	-11.8	20.3	-10.2	17.8	-12.7
36	Mount Sinyala (MTSINY)	45.9	12	-33.9	12.2	-33.7	11.5	-34.4
37	National Canyon (NATCAN)	26.2	17.8	-8.4	19	-7.2	17	-9.2
38	Jackson Canyon (JCKCAN/NONAME)	38.8	24.7	-14.1	24.7	-14.1	25.8	-13
39	Parashant Wash (PARWAS)	34.7	34.3	-0.4	29.4	-5.3	34.1	-0.6
40	Pumpkin Springs (PMPKIN)	19.1	20	0.9	19.4	0.3	18.8	-0.3
41	Prospect Canyon (PROCAN)	42.6	19.5	-23.1	22.5	-20.1	18.7	-23.9
42	Prospect Canyon (PRSPCT)	31.1	24.6	-6.5	29.5	-1.6	24	-7.1
43	Peach Spring Canyon North (PSCNNO)	27.3	11.8	-15.5	11.3	-16	37.4	10.1
44	Peach Spring Canyon South (PSCNSO)	8.2	7.8	-0.4	7.5	-0.7	16	7.8
45	Quartermaster Point (QMPNT)	39.7	36.4	-3.3	36.3	-3.4	36.4	-3.3
46	The Ranch (RANCH)	32	38.1	6.1	38.1	6.1	38.1	6.1
47	Spencer/Meriwhitica Canyons (SCMCIG)	28.1	13.8	-14.3	13.4	-14.7	29.3	1.2
48	South Supai Canyon (SOSUPC)	31.2	32.6	1.4	34	2.8	31.8	0.6
49	Spencer Canyon (SPENCA)	29.7	15.2	-14.5	15	-14.7	21	-8.7
50	Supai Village (SUPVIL)	31.9	14.3	-17.6	14.5	-17.4	13.7	-18.2
51	Three Springs Rapids (THRSPR)	17.5	18.4	0.9	17.8	0.3	19.4	1.9
52	Whitmore Rapids (WHTRAP)	39	23.8	-15.2	33.2	-5.8	23.2	-15.8
53	96 Mile Camp (96MILE)	41	35.9	-5.1	35.9	-5.1	35.9	-5.1

Table A.7

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	36.8	27.3	-9.5	27.3	-9.5	27.3	-9.5
55	Bright Angel Point (BRTANG)	25.4	23.3	-2.1	23.4	-2	23.3	-2.1
56	Cape Royal (CAPROY)	23.4	25.9	2.5	25.9	2.5	25.9	2.5
57	Cliff Dwellers Lodge (CLDWEL)	15.5	19.4	3.9	19.4	3.9	19.4	3.9
58	Marble Canyon Dam Site (MARBDM)	21.4	17.8	-3.6	17.8	-3.6	17.8	-3.6
59	Nankoweap Mesa (NANMES)	41.4	27.3	-14.1	27.3	-14.1	27.3	-14.1
60	North Canyon (NOCANY)	29.9	21.9	-8	21.9	-8	21.9	-8
61	Point Imperial (PTIMPL)	35	25.5	-9.5	25.5	-9.5	25.5	-9.5
62	Saddle Mountain (SADMTN)	28.6	37.7	9.1	37.7	9.1	37.7	9.1
63	South Canyon (SOCAN)	26.1	16.7	-9.4	16.7	-9.4	16.7	-9.4
64	Temple Butte (TEMBUT)	37.8	28.5	-9.3	28.5	-9.3	28.5	-9.3

Table A.8

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	27.9	28.2	0.3	28.2	0.3	28.2	0.3
66	Lipan Point (LIPAN)	30.5	28.5	-2.0	28.5	-2.0	28.5	-2.0
67	Little Colorado (LITCOL)	25.1	17.1	-8.0	17.1	-8.0	17.1	-8.0
68	Little Colorado River (LTCORV)	37.1	24.1	-13.0	24.1	-13.0	24.1	-13.0
69	Nankoweap at river (NANRIV)	36.1	23.3	-12.8	23.3	-12.8	23.3	-12.8
70	Ten X Meadow (TENMED)	36.1	36.4	0.3	36.4	0.3	36.3	0.2
71	Zuni Alpha (ZUNALF)	34.9	39.9	5.0	39.9	5.0	39.9	5.0
72	Zuni Charlie (ZUNCHR)	27.9	22.9	-5.0	22.9	-5.0	22.9	-5.0

Table A.9

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, West of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	37.8	32.2	-5.6	31.4	-6.4	32.1	-5.7
2	Andrus Canyon (ANDRUS)	24.8	18.9	-5.9	26.7	1.9	18.4	-6.4
3	Bass Camp (BASCMP)	21.7	22.5	0.8	22.5	0.8	22.4	0.7
4	Bat Cave (BATCAV)	39.7	42.2	2.5	42.2	2.5	42.2	2.5
5	Bumt Springs Canyon (BRNTSP)	39.8	42.8	3.0	42.8	3.0	42.9	3.1
6	Castle Peak (CASTLE)	31.3	23.8	-7.5	43.3	12.0	23.6	-7.7
7	Kanab Point (KANAPT)	17.6	10.0	-7.6	10.1	-7.5	9.7	-7.9
8	Kelly Point (KELLPT)	16.4	15.4	-1.0	14.8	-1.6	25.6	9.2
9	Mt. Dellenbaugh (MTDELL)	43.0	42.1	-0.9	26.8	-16.2	42.0	-1.0
10	Point Sublime (PTSUBL)	31.2	32.1	0.9	32.1	0.9	32.1	0.9
11	Sanup (SANUP)	38.8	39.0	0.2	33.1	-5.7	39.5	0.7
12	Separation Canyon at Colorado River (SCCORV)	27.3	16.9	-10.4	16.5	-10.8	34.4	7.1
13	Separation Canyon (SEPARC)	25.5	16.5	-9.0	16.1	-9.4	32.5	7.0
14	Shivwitz Fire Camp (SHWZFC)	38.8	38.4	-0.4	27.8	-11.0	38.3	-0.5
15	Stone Creek (STONCK)	29.0	14.8	-14.2	14.9	-14.1	14.7	-14.3
16	Suicide Point (SUIPNT)	29.5	38.9	9.4	38.8	9.3	23.5	-6.0
17	Toroweap Overlook (TOROWP)	32.8	16.2	-16.6	18.1	-14.7	15.4	-17.4
18	Tower of Ra (TOWER)	46.2	42.1	-4.1	42.1	-4.1	42.1	-4.1
19	Twin Point (TWINPT)	32.8	34.5	1.7	34.4	1.6	28.9	-3.9
20	Upper Deer Creek (UPDRCK)	17.6	12.5	-5.1	12.6	-5.0	12.4	-5.2
21	West End (WESEND)	37.6	34.7	-2.9	34.7	-2.9	35.3	-2.3

Table A.10

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, West of GC Airport
2000

		No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Location	L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	32.6	15.2	-17.4	15.6	-17.0	14.4	-18.2
23	Diamond Creek (DIACRK)	26.7	13.0	-13.7	12.4	-14.3	33.0	6.3
24	The Dome (DOME)	35.0	14.8	-20.2	15.5	-19.5	14.0	-21.0
25	Granite Gorge (GRAGOR)	42.4	40.0	-2.4	40.0	-2.4	37.9	-4.5
26	Grand Canyon West (GCWEST)	40.5	39.3	-1.2	39.3	-1.2	39.0	-1.5
27	Granite Park (GRNTPK)	29.4	29.7	0.3	29.4	0.0	21.3	-8.1
28	Dr. Tommy's Mountain (DRTOMM)	28.0	39.9	11.9	39.7	11.7	26.8	-1.2
29	Havasu Point (HAVAPT)	28.8	12.3	-16.5	12.6	-16.2	11.7	-17.1
30	Havatagvitch Canyon (HAVCAN)	40.8	19.3	-21.5	19.6	-21.2	18.7	-22.1
31	Hermit Basin (HBASIN)	40.1	34.2	-5.9	34.2	-5.9	34.1	-6.0
32	Horse Flat Canyon (HFCAN)	27.3	24.0	-3.3	24.0	-3.3	24.4	-2.9
33	Meriwhitca (MERIWH)	28.5	15.4	-13.1	15.2	-13.3	18.2	-10.3
34	Mohawk Canyon (MOHAWK)	25.8	21.6	-4.2	23.7	-2.1	20.9	-4.9
35	Mohawk Canyon (MOHCAN)	30.5	19.0	-11.5	20.6	-9.9	18.2	-12.3
36	Mount Sinyala (MTSINY)	45.9	12.3	-33.6	12.5	-33.4	11.8	-34.1
37	National Canyon (NATCAN)	26.2	18.2	-8.0	19.3	-6.9	17.3	-8.9
38	Jackson Canyon (JCKCAN/NONAME)	38.8	25.0	-13.8	24.9	-13.9	26.0	-12.8
39	Parashant Wash (PARWAS)	34.7	34.6	-0.1	29.7	-5.0	34.4	-0.3
40	Pumpkin Springs (PMPKIN)	19.1	20.3	1.2	19.7	0.6	19.1	0.0
41	Prospect Canyon (PROCAN)	42.6	19.8	-22.8	22.8	-19.8	19.1	-23.5
42	Prospect Canyon (PRSPCT)	31.1	24.9	-6.2	29.8	-1.3	24.4	-6.7
43	Peach Spring Canyon North (PSCNNO)	27.3	12.1	-15.2	11.6	-15.7	37.7	10.4
44	Peach Spring Canyon South (PSCNSO)	8.2	8.1	-0.1	7.8	-0.4	16.2	8.0
45	Quartermaster Point (QMPNT)	39.7	36.6	-3.1	36.6	-3.1	36.6	-3.1
46	The Ranch (RANCH)	32.0	38.4	6.4	38.4	6.4	38.4	6.4
47	Spencer/Meriwhitica Canyons (SCMCIG)	28.1	14.0	-14.1	13.7	-14.4	29.6	1.5
48	South Supai Canyon (SOSUPC)	31.2	32.9	1.7	34.3	3.1	32.1	0.9
49	Spencer Canyon (SPENCA)	29.7	15.5	-14.2	15.3	-14.4	21.3	-8.4
50	Supai Village (SUPVIL)	31.9	14.6	-17.3	14.9	-17.0	14.0	-17.9
51	Three Springs Rapids (THRSPR)	17.5	18.7	1.2	18.1	0.6	19.7	2.2
52	Whitmore Rapids (WHTRAP)	39.0	24.1	-14.9	33.6	-5.4	23.6	-15.4
53	96 Mile Camp (96MILE)	41.0	36.2	-4.8	36.2	-4.8	36.2	-4.8

Table A.11

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	36.8	27.6	-9.2	27.6	-9.2	27.6	-9.2
55	Bright Angel Point (BRTANG)	25.4	23.6	-1.8	23.6	-1.8	23.6	-1.8
56	Cape Royal (CAPROY)	23.4	26.2	2.8	26.2	2.8	26.1	2.7
57	Cliff Dwellers Lodge (CLDWEL)	15.5	19.7	4.2	19.7	4.2	19.7	4.2
58	Marble Canyon Dam Site (MARBDM)	21.4	18.1	-3.3	18.1	-3.3	18.1	-3.3
59	Nankoweap Mesa (NANMES)	41.4	27.6	-13.8	27.6	-13.8	27.6	-13.8
60	North Canyon (NOCANY)	29.9	22.1	-7.8	22.1	-7.8	22.1	-7.8
61	Point Imperial (PTIMPL)	35.0	25.8	-9.2	25.8	-9.2	25.8	-9.2
62	Saddle Mountain (SADMTN)	28.6	38.0	9.4	38.0	9.4	38.0	9.4
63	South Canyon (SOCAN)	26.1	17.0	-9.1	17.0	-9.1	17.0	-9.1
64	Temple Butte (TEMBUT)	37.8	28.8	-9.0	28.8	-9.0	28.8	-9.0

Table A.12

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	27.9	28.5	0.6	28.5	0.6	28.4	0.5
66	Lipan Point (LIPAN)	30.5	28.8	-1.7	28.8	-1.7	28.8	-1.7
67	Little Colorado (LITCOL)	25.1	17.4	-7.7	17.4	-7.7	17.4	-7.7
68	Little Colorado River (LTCORV)	37.1	24.4	-12.7	24.4	-12.7	24.3	-12.8
69	Nankoweap at river (NANRIV)	36.1	23.6	-12.5	23.6	-12.5	23.6	-12.5
70	Ten X Meadow (TENMED)	36.1	36.7	0.6	36.7	0.6	36.6	0.5
71	Zuni Alpha (ZUNALF)	34.9	40.2	5.3	40.2	5.3	40.2	5.3
72	Zuni Charlie (ZUNCHR)	27.9	23.2	-4.7	23.2	-4.7	23.2	-4.7

Table A.13

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, West of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	38.2	31.9	-6.3	31.1	-7.1	31.7	-6.5
2	Andrus Canyon (ANDRUS)	25.2	18.5	-6.7	26.4	1.2	18	-7.2
3	Bass Camp (BASCMP)	22.1	22.2	0.1	22.2	0.1	22.1	0.0
4	Bat Cave (BATCAV)	40.1	42	1.9	41.9	1.8	41.9	1.8
5	Bumt Springs Canyon (BRNTSP)	40.2	42.6	2.4	42.6	2.4	42.6	2.4
6	Castle Peak (CASTLE)	31.7	23.5	-8.2	42.9	11.2	23.3	-8.4
7	Kanab Point (KANAPT)	18.0	9.7	-8.3	9.8	-8.2	9.4	-8.6
8	Kelly Point (KELLPT)	16.8	15.1	-1.7	14.6	-2.2	25.4	8.6
9	Mt. Dellenbaugh (MTDELL)	43.5	41.7	-1.8	26.5	-17.0	41.7	-1.8
10	Point Sublime (PTSUBL)	31.7	31.8	0.1	31.8	0.1	31.8	0.1
11	Sanup (SANUP)	39.2	38.7	-0.5	32.8	-6.4	39.2	0.0
12	Separation Canyon at Colorado River (SCCORV)	27.7	16.6	-11.1	16.2	-11.5	34.1	6.4
13	Separation Canyon (SEPARC)	25.9	16.2	-9.7	15.9	-10.0	32.2	6.3
14	Shivwitz Fire Camp (SHWZFC)	39.2	38	-1.2	27.5	-11.7	38	-1.2
15	Stone Creek (STONCK)	29.4	14.5	-14.9	14.6	-14.8	14.4	-15.0
16	Suicide Point (SUIPNT)	29.9	38.6	8.7	38.5	8.6	23.2	-6.7
17	Toroweap Overlook (TOROWP)	33.2	15.9	-17.3	17.7	-15.5	15	-18.2
18	Tower of Ra (TOWER)	46.6	41.8	-4.8	41.8	-4.8	41.8	-4.8
19	Twin Point (TWINPT)	33.2	34.2	1.0	34.1	0.9	28.6	-4.6
20	Upper Deer Creek (UPDRCK)	18.1	12.2	-5.9	12.3	-5.8	12.1	-6.0
21	West End (WESEND)	38.0	34.4	-3.6	34.4	-3.6	35	-3.0

Table A.14

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, West of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	33	14.8	-18.2	15.3	-17.7	14.1	-18.9
23	Diamond Creek (DIACRK)	27.1	12.6	-14.5	12.1	-15.0	32.7	5.6
24	The Dome (DOME)	35.4	14.5	-20.9	15.1	-20.3	13.7	-21.7
25	Granite Gorge (GRAGOR)	42.8	39.7	-3.1	39.7	-3.1	37.6	-5.2
26	Grand Canyon West (GCWEST)	40.9	39.1	-1.8	39.1	-1.8	38.9	-2.0
27	Granite Park (GRNTPK)	29.8	29.4	-0.4	29.1	-0.7	21	-8.8
28	Dr. Tommy's Mountain (DRTOMM)	28.4	39.6	11.2	39.4	11.0	26.4	-2.0
29	Havasu Point (HAVAPT)	29.2	11.9	-17.3	12.2	-17.0	11.4	-17.8
30	Havatagvitch Canyon (HAVCAN)	41.2	19	-22.2	19.3	-21.9	18.4	-22.8
31	Hermit Basin (HBASIN)	40.5	33.9	-6.6	33.9	-6.6	33.9	-6.6
32	Horse Flat Canyon (HFCAN)	27.7	23.8	-3.9	23.7	-4.0	24.1	-3.6
33	Meriwhitca (MERIWH)	29	15.1	-13.9	15	-14.0	18	-11.0
34	Mohawk Canyon (MOHAWK)	26.2	21.3	-4.9	23.4	-2.8	20.5	-5.7
35	Mohawk Canyon (MOHCAN)	30.9	18.7	-12.2	20.3	-10.6	17.8	-13.1
36	Mount Sinyala (MTSINY)	46.3	12	-34.3	12.2	-34.1	11.5	-34.8
37	National Canyon (NATCAN)	26.7	17.8	-8.9	19	-7.7	17	-9.7
38	Jackson Canyon (JCKCAN/NONAME)	39.3	24.7	-14.6	24.7	-14.6	25.8	-13.5
39	Parashant Wash (PARWAS)	35.1	34.3	-0.8	29.4	-5.7	34.1	-1.0
40	Pumpkin Springs (PMPKIN)	19.5	20	0.5	19.4	-0.1	18.8	-0.7
41	Prospect Canyon (PROCAN)	43.1	19.5	-23.6	22.5	-20.6	18.7	-24.4
42	Prospect Canyon (PRSPCT)	31.5	24.6	-6.9	29.5	-2.0	24	-7.5
43	Peach Spring Canyon North (PSCNNO)	27.7	11.8	-15.9	11.3	-16.4	37.4	9.7
44	Peach Spring Canyon South (PSCNSO)	8.6	7.8	-0.8	7.5	-1.1	16	7.4
45	Quartermaster Point (QMPNT)	40.1	36.4	-3.7	36.3	-3.8	36.4	-3.7
46	The Ranch (RANCH)	32.5	38.1	5.6	38.1	5.6	38.1	5.6
47	Spencer/Meriwhitica Canyons (SCMCIG)	28.5	13.8	-14.7	13.4	-15.1	29.3	0.8
48	South Supai Canyon (SOSUPC)	31.6	32.6	1.0	34	2.4	31.8	0.2
49	Spencer Canyon (SPENCA)	30.1	15.2	-14.9	15	-15.1	21	-9.1
50	Supai Village (SUPVIL)	32.4	14.3	-18.1	14.5	-17.9	13.7	-18.7
51	Three Springs Rapids (THRSPR)	17.9	18.4	0.5	17.8	-0.1	19.4	1.5
52	Whitmore Rapids (WHTRAP)	39.4	23.8	-15.6	33.2	-6.2	23.2	-16.2
53	96 Mile Camp (96MILE)	41.4	35.9	-5.5	35.9	-5.5	35.9	-5.5

Table A.15

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, East of GC Airport
2003

		No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Location	L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	37.2	27.3	-9.9	27.3	-9.9	27.3	-9.9
55	Bright Angel Point (BRTANG)	25.9	23.3	-2.6	23.4	-2.5	23.3	-2.6
56	Cape Royal (CAPROY)	23.9	25.9	2.0	25.9	2.0	25.9	2.0
57	Cliff Dwellers Lodge (CLDWEL)	15.9	19.4	3.5	19.4	3.5	19.4	3.5
58	Marble Canyon Dam Site (MARBDM)	21.8	17.8	-4.0	17.8	-4.0	17.8	-4.0
59	Nankoweap Mesa (NANMES)	41.9	27.3	-14.6	27.3	-14.6	27.3	-14.6
60	North Canyon (NOCANY)	30.4	21.9	-8.5	21.9	-8.5	21.9	-8.5
61	Point Imperial (PTIMPL)	35.5	25.5	-10.0	25.5	-10.0	25.5	-10.0
62	Saddle Mountain (SADMTN)	29	37.7	8.7	37.7	8.7	37.7	8.7
63	South Canyon (SOCAN)	26.5	16.7	-9.8	16.7	-9.8	16.7	-9.8
64	Temple Butte (TEMBUT)	38.2	28.5	-9.7	28.5	-9.7	28.5	-9.7

Table A.16

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, East of GC Airport
2003

		No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Location	L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	28.3	28.2	-0.1	28.2	-0.1	28.2	-0.1
66	Lipan Point (LIPAN)	30.9	28.5	-2.4	28.5	-2.4	28.5	-2.4
67	Little Colorado (LITCOL)	25.5	17.1	-8.4	17.1	-8.4	17.1	-8.4
68	Little Colorado River (LTCORV)	37.5	24.1	-13.4	24.1	-13.4	24.1	-13.4
69	Nankoweap at river (NANRIV)	36.5	23.3	-13.2	23.3	-13.2	23.3	-13.2
70	Ten X Meadow (TENMED)	36.5	36.4	-0.1	36.4	-0.1	36.3	-0.2
71	Zuni Alpha (ZUNALF)	35.3	39.9	4.6	39.9	4.6	39.9	4.6
72	Zuni Charlie (ZUNCHR)	28.3	22.9	-5.4	22.9	-5.4	22.9	-5.4

Table A.17

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, West of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	38.2	32.6	-5.6	31.8	-6.4	32.5	-5.7
2	Andrus Canyon (ANDRUS)	25.2	19.3	-5.9	27.1	1.9	18.8	-6.4
3	Bass Camp (BASCMP)	22.1	22.9	0.8	22.9	0.8	22.8	0.7
4	Bat Cave (BATCAV)	40.1	42.7	2.6	42.6	2.5	42.6	2.5
5	Burnt Springs Canyon (BRNTSP)	40.2	43.2	3.0	43.2	3.0	43.3	3.1
6	Castle Peak (CASTLE)	31.7	24.2	-7.5	43.7	12.0	24.0	-7.7
7	Kanab Point (KANAPT)	18.0	10.4	-7.6	10.5	-7.5	10.1	-7.9
8	Kelly Point (KELLPT)	16.8	15.8	-1.0	15.2	-1.6	26.1	9.3
9	Mt. Dellenbaugh (MTDELL)	43.5	42.5	-1.0	27.2	-16.3	42.4	-1.1
10	Point Sublime (PTSUBL)	31.7	32.5	0.8	32.5	0.8	32.5	0.8
11	Sanup (SANUP)	39.2	39.4	0.2	33.5	-5.7	39.9	0.7
12	Separation Canyon at Colorado River (SCCORV)	27.7	17.2	-10.5	16.9	-10.8	34.8	7.1
13	Separation Canyon (SEPARC)	25.9	16.9	-9.0	16.5	-9.4	32.9	7.0
14	Shivwitz Fire Camp (SHWZFC)	39.2	38.8	-0.4	28.2	-11.0	38.7	-0.5
15	Stone Creek (STONCK)	29.4	15.3	-14.1	15.3	-14.1	15.1	-14.3
16	Suicide Point (SUIPNT)	29.9	39.3	9.4	39.2	9.3	23.9	-6.0
17	Toroweap Overlook (TOROWP)	33.2	16.7	-16.5	18.5	-14.7	15.8	-17.4
18	Tower of Ra (TOWER)	46.6	42.5	-4.1	42.5	-4.1	42.5	-4.1
19	Twin Point (TWINPT)	33.2	34.9	1.7	34.8	1.6	29.3	-3.9
20	Upper Deer Creek (UPDRCK)	18.1	13.0	-5.1	13.0	-5.1	12.8	-5.3
21	West End (WESEND)	38.0	35.1	-2.9	35.1	-2.9	35.7	-2.3

Table A.18

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, West of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	33.0	15.6	-17.4	16.1	-16.9	14.8	-18.2
23	Diamond Creek (DIACRK)	27.1	13.4	-13.7	12.8	-14.3	33.4	6.3
24	The Dome (DOME)	35.4	15.3	-20.1	15.9	-19.5	14.5	-20.9
25	Granite Gorge (GRAGOR)	42.8	40.4	-2.4	40.4	-2.4	38.3	-4.5
26	Grand Canyon West (GCWEST)	40.9	39.5	-1.4	39.5	-1.4	39.3	-1.6
27	Granite Park (GRNTPK)	29.8	30.2	0.4	29.8	0.0	21.8	-8.0
28	Dr. Tommy's Mountain (DRTOMM)	28.4	40.3	11.9	40.1	11.7	27.2	-1.2
29	Havasu Point (HAVAPT)	29.2	12.7	-16.5	13.0	-16.2	12.2	-17.0
30	Havatagvitch Canyon (HAVCAN)	41.2	19.7	-21.5	20.0	-21.2	19.1	-22.1
31	Hermit Basin (HBASIN)	40.5	34.6	-5.9	34.6	-5.9	34.6	-5.9
32	Horse Flat Canyon (HFCAN)	27.7	24.4	-3.3	24.4	-3.3	24.8	-2.9
33	Meriwhitca (MERIWH)	29.0	15.8	-13.2	15.6	-13.4	18.6	-10.4
34	Mohawk Canyon (MOHAWK)	26.2	22.1	-4.1	24.1	-2.1	21.3	-4.9
35	Mohawk Canyon (MOHCAN)	30.9	19.5	-11.4	21.0	-9.9	18.6	-12.3
36	Mount Sinyala (MTSINY)	46.3	12.7	-33.6	12.9	-33.4	12.2	-34.1
37	National Canyon (NATCAN)	26.7	18.6	-8.1	19.7	-7.0	17.7	-9.0
38	Jackson Canyon (JCKCAN/NONAME)	39.3	25.4	-13.9	25.3	-14.0	26.4	-12.9
39	Parashant Wash (PARWAS)	35.1	35.0	-0.1	30.1	-5.0	34.9	-0.2
40	Pumpkin Springs (PMPKIN)	19.5	20.7	1.2	20.1	0.6	19.6	0.1
41	Prospect Canyon (PROCAN)	43.1	20.3	-22.8	23.2	-19.9	19.5	-23.6
42	Prospect Canyon (PRSPCT)	31.5	25.4	-6.1	30.2	-1.3	24.8	-6.7
43	Peach Spring Canyon North (PSCNNO)	27.7	12.5	-15.2	12.0	-15.7	38.1	10.4
44	Peach Spring Canyon South (PSCNSO)	8.6	8.5	-0.1	8.2	-0.4	16.7	8.1
45	Quartermaster Point (QMPNT)	40.1	37.0	-3.1	37.0	-3.1	37.0	-3.1
46	The Ranch (RANCH)	32.5	38.8	6.3	38.8	6.3	38.8	6.3
47	Spencer/Meriwhitica Canyons (SCMCIG)	28.5	14.4	-14.1	14.1	-14.4	30.0	1.5
48	South Supai Canyon (SOSUPC)	31.6	33.3	1.7	34.8	3.2	32.5	0.9
49	Spencer Canyon (SPENCA)	30.1	15.9	-14.2	15.7	-14.4	21.7	-8.4
50	Supai Village (SUPVIL)	32.4	15.0	-17.4	15.3	-17.1	14.4	-18.0
51	Three Springs Rapids (THRSPR)	17.9	19.2	1.3	18.5	0.6	20.2	2.3
52	Whitmore Rapids (WHTRAP)	39.4	24.6	-14.8	34.0	-5.4	24.0	-15.4
53	96 Mile Camp (96MILE)	41.4	36.7	-4.7	36.7	-4.7	36.6	-4.8

Table A.19

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, East of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	37.2	28.0	-9.2	28.0	-9.2	28.0	-9.2
55	Bright Angel Point (BRTANG)	25.9	24.1	-1.8	24.1	-1.8	24.0	-1.9
56	Cape Royal (CAPROY)	23.9	26.6	2.7	26.6	2.7	26.6	2.7
57	Cliff Dwellers Lodge (CLDWEL)	15.9	20.1	4.2	20.1	4.2	20.1	4.2
58	Marble Canyon Dam Site (MARBDM)	21.8	18.5	-3.3	18.5	-3.3	18.5	-3.3
59	Nankoweap Mesa (NANMES)	41.9	28.0	-13.9	28.0	-13.9	28.0	-13.9
60	North Canyon (NOCANY)	30.4	22.5	-7.9	22.5	-7.9	22.5	-7.9
61	Point Imperial (PTIMPL)	35.5	26.2	-9.3	26.2	-9.3	26.2	-9.3
62	Saddle Mountain (SADMTN)	29.0	38.4	9.4	38.4	9.4	38.4	9.4
63	South Canyon (SOCAN)	26.5	17.4	-9.1	17.4	-9.1	17.4	-9.1
64	Temple Butte (TEMBUT)	38.2	29.2	-9.0	29.2	-9.0	29.2	-9.0

Table A.20

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, East of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	28.3	28.9	0.6	28.9	0.6	28.9	0.6
66	Lipan Point (LIPAN)	30.9	29.2	-1.7	29.2	-1.7	29.2	-1.7
67	Little Colorado (LITCOL)	25.5	17.8	-7.7	17.9	-7.6	17.8	-7.7
68	Little Colorado River (LTCORV)	37.5	24.8	-12.7	24.8	-12.7	24.8	-12.7
69	Nankoweap at river (NANRIV)	36.5	24.0	-12.5	24.0	-12.5	24.0	-12.5
70	Ten X Meadow (TENMED)	36.5	37.1	0.6	37.1	0.6	37.0	0.5
71	Zuni Alpha (ZUNALF)	35.3	40.6	5.3	40.6	5.3	40.6	5.3
72	Zuni Charlie (ZUNCHR)	28.3	23.6	-4.7	23.6	-4.7	23.6	-4.7

Table A.21

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, West of GC Airport
2008

	Location	No Action (Alt.1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	38.9	31.9	-7.0	31.1	-7.8	31.7	-7.2
2	Andrus Canyon (ANDRUS)	25.9	18.5	-7.4	26.4	0.5	18	-7.9
3	Bass Camp (BASCMP)	22.8	22.2	-0.6	22.2	-0.6	22.1	-0.7
4	Bat Cave (BATCAV)	40.8	42	1.2	41.9	1.1	41.9	1.1
5	Burnt Springs Canyon (BRNTSP)	40.8	42.6	1.8	42.6	1.8	42.6	1.8
6	Castle Peak (CASTLE)	32.4	23.5	-8.9	42.9	10.5	23.3	-9.1
7	Kanab Point (KANAPT)	18.7	9.7	-9.0	9.8	-8.9	9.4	-9.3
8	Kelly Point (KELLPT)	17.5	15.1	-2.4	14.6	-2.9	25.4	7.9
9	Mt. Dellenbaugh (MTDELL)	44.2	41.7	-2.5	26.5	-17.7	41.7	-2.5
10	Point Sublime (PTSUBL)	32.4	31.8	-0.6	31.8	-0.6	31.8	-0.6
11	Sanup (SANUP)	39.9	38.7	-1.2	32.8	-7.1	39.2	-0.7
12	Separation Canyon at Colorado River (SCCORV)	28.4	16.6	-11.8	16.2	-12.2	34.1	5.7
13	Separation Canyon (SEPARC)	26.6	16.2	-10.4	15.9	-10.7	32.2	5.6
14	Shivwitz Fire Camp (SHWZFC)	39.9	38	-1.9	27.5	-12.4	38	-1.9
15	Stone Creek (STONCK)	30.1	14.5	-15.6	14.6	-15.5	14.4	-15.7
16	Suicide Point (SUIPNT)	30.6	38.6	8.0	38.5	7.9	23.2	-7.4
17	Toroweap Overlook (TOROWP)	33.9	15.9	-18.0	17.7	-16.2	15	-18.9
18	Tower of Ra (TOWER)	47.3	41.8	-5.5	41.8	-5.5	41.8	-5.5
19	Twin Point (TWINPT)	33.9	34.2	0.3	34.1	0.2	28.6	-5.3
20	Upper Deer Creek (UPDRCK)	18.8	12.2	-6.6	12.3	-6.5	12.1	-6.7
21	West End (WESEND)	38.7	34.4	-4.3	34.4	-4.3	35	-3.7

Table A.22

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, West of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	33.7	14.8	-18.9	15.3	-18.4	14.1	-19.6
23	Diamond Creek (DIACRK)	27.8	12.6	-15.2	12.1	-15.7	32.7	4.9
24	The Dome (DOME)	36.1	14.5	-21.6	15.1	-21.0	13.7	-22.4
25	Granite Gorge (GRAGOR)	43.5	39.7	-3.8	39.7	-3.8	37.6	-5.9
26	Grand Canyon West (GCWEST)	41.4	39.1	-2.3	39.1	-2.3	38.9	-2.5
27	Granite Park (GRNTPK)	30.5	29.4	-1.1	29.1	-1.4	21	-9.5
28	Dr. Tommy's Mountain (DRTOMM)	29.2	39.6	10.4	39.4	10.2	26.4	-2.8
29	Havasu Point (HAVAPT)	29.9	11.9	-18.0	12.2	-17.7	11.4	-18.5
30	Havatagvitch Canyon (HAVCAN)	41.9	19	-22.9	19.3	-22.6	18.4	-23.5
31	Hermit Basin (HBASIN)	41.2	33.9	-7.3	33.9	-7.3	33.9	-7.3
32	Horse Flat Canyon (HFCAN)	28.4	23.8	-4.6	23.7	-4.7	24.1	-4.3
33	Meriwhitca (MERIWH)	29.7	15.1	-14.6	15	-14.7	18	-11.7
34	Mohawk Canyon (MOHAWK)	26.9	21.3	-5.6	23.4	-3.5	20.5	-6.4
35	Mohawk Canyon (MOHCAN)	31.6	18.7	-12.9	20.3	-11.3	17.8	-13.8
36	Mount Sinyala (MTSINY)	47.0	12	-35.0	12.2	-34.8	11.5	-35.5
37	National Canyon (NATCAN)	27.4	17.8	-9.6	19	-8.4	17	-10.4
38	Jackson Canyon (JCKCAN/NONAME)	40.0	24.7	-15.3	24.7	-15.3	25.8	-14.2
39	Parashant Wash (PARWAS)	35.8	34.3	-1.5	29.4	-6.4	34.1	-1.7
40	Pumpkin Springs (PMPKIN)	20.2	20	-0.2	19.4	-0.8	18.8	-1.4
41	Prospect Canyon (PROCAN)	43.8	19.5	-24.3	22.5	-21.3	18.7	-25.1
42	Prospect Canyon (PRSPCT)	32.2	24.6	-7.6	29.5	-2.7	24	-8.2
43	Peach Spring Canyon North (PSCNNO)	28.4	11.8	-16.6	11.3	-17.1	37.4	9.0
44	Peach Spring Canyon South (PSCNSO)	9.3	7.8	-1.5	7.5	-1.8	16	6.7
45	Quartermaster Point (QMPNT)	40.8	36.4	-4.4	36.3	-4.5	36.4	-4.4
46	The Ranch (RANCH)	33.2	38.1	4.9	38.1	4.9	38.1	4.9
47	Spencer/Meriwhitica Canyons (SCMCIG)	29.2	13.8	-15.4	13.4	-15.8	29.3	0.1
48	South Supai Canyon (SOSUPC)	32.3	32.6	0.3	34	1.7	31.8	-0.5
49	Spencer Canyon (SPENCA)	30.9	15.2	-15.7	15	-15.9	21	-9.9
50	Supai Village (SUPVIL)	33.1	14.3	-18.8	14.5	-18.6	13.7	-19.4
51	Three Springs Rapids (THRSPR)	18.6	18.4	-0.2	17.8	-0.8	19.4	0.8
52	Whitmore Rapids (WHTRAP)	40.1	23.8	-16.3	33.2	-6.9	23.2	-16.9
53	96 Mile Camp (96MILE)	42.1	35.9	-6.2	35.9	-6.2	35.9	-6.2

Table A.23

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	37.9	27.3	-10.6	27.3	-10.6	27.3	-10.6
55	Bright Angel Point (BRTANG)	26.6	23.3	-3.3	23.4	-3.2	23.3	-3.3
56	Cape Royal (CAPROY)	24.6	25.9	1.3	25.9	1.3	25.9	1.3
57	Cliff Dwellers Lodge (CLDWEL)	16.6	19.4	2.8	19.4	2.8	19.4	2.8
58	Marble Canyon Dam Site (MARBDM)	22.5	17.8	-4.7	17.8	-4.7	17.8	-4.7
59	Nankoweap Mesa (NANMES)	42.6	27.3	-15.3	27.3	-15.3	27.3	-15.3
60	North Canyon (NOCANY)	31.1	21.9	-9.2	21.9	-9.2	21.9	-9.2
61	Point Imperial (PTIMPL)	36.2	25.5	-10.7	25.5	-10.7	25.5	-10.7
62	Saddle Mountain (SADMTN)	29.7	37.7	8.0	37.7	8.0	37.7	8.0
63	South Canyon (SOCAN)	27.2	16.7	-10.5	16.7	-10.5	16.7	-10.5
64	Temple Butte (TEMBUT)	38.9	28.5	-10.4	28.5	-10.4	28.5	-10.4

Table A.24

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	29.0	28.2	-0.8	28.2	-0.8	28.2	-0.8
66	`Lipan Point (LIPAN)	31.6	28.5	-3.1	28.5	-3.1	28.5	-3.1
67	Little Colorado (LITCOL)	26.2	17.1	-9.1	17.1	-9.1	17.1	-9.1
68	Little Colorado River (LTCORV)	38.2	24.1	-14.1	24.1	-14.1	24.1	-14.1
69	Nankoweap at river (NANRIV)	37.2	23.3	-13.9	23.3	-13.9	23.3	-13.9
70	Ten X Meadow (TENMED)	37.2	36.4	-0.8	36.4	-0.8	36.3	-0.9
71	Zuni Alpha (ZUNALF)	36.0	39.9	3.9	39.9	3.9	39.9	3.9
72	Zuni Charlie (ZUNCHR)	29.0	22.9	-6.1	22.9	-6.1	22.9	-6.1

Table A.25

Comparison of L_{Aeq12h} at Representative Locations in GCNP Considering Continued Growth North of Colorado River, West of GC Airport 2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
1	NPS Admin Site (ADMIN)	38.9	33.3	-5.6	32.5	-6.4	33.2	-5.7
2	Andrus Canyon (ANDRUS)	25.9	20.0	-5.9	27.8	1.9	19.5	-6.4
3	Bass Camp (BASCMP)	22.8	23.6	0.8	23.6	0.8	23.5	0.7
4	Bat Cave (BATCAV)	40.8	43.4	2.6	43.3	2.5	43.3	2.5
5	Burnt Springs Canyon (BRNTSP)	40.8	43.9	3.1	43.9	3.1	44.0	3.2
6	Castle Peak (CASTLE)	32.4	24.9	-7.5	44.4	12.0	24.7	-7.7
7	Kanab Point (KANAPT)	18.7	11.1	-7.6	11.2	-7.5	10.8	-7.9
8	Kelly Point (KELLPT)	17.5	16.5	-1.0	15.9	-1.6	26.8	9.3
9	Mt. Dellenbaugh (MTDELL)	44.2	43.2	-1.0	27.9	-16.3	43.1	-1.1
10	Point Sublime (PTSUBL)	32.4	33.2	0.8	33.2	0.8	33.2	0.8
11	Sanup (SANUP)	39.9	40.1	0.2	34.2	-5.7	40.6	0.7
12	Separation Canyon at Colorado River (SCCORV)	28.4	17.9	-10.5	17.5	-10.9	35.5	7.1
13	Separation Canyon (SEPARC)	26.6	17.6	-9.0	17.2	-9.4	33.6	7.0
14	Shivwitz Fire Camp (SHWZFC)	39.9	39.5	-0.4	28.9	-11.0	39.4	-0.5
15	Stone Creek (STONCK)	30.1	16.0	-14.1	16.0	-14.1	15.8	-14.3
16	Suicide Point (SUIPNT)	30.6	40.0	9.4	40.0	9.4	24.6	-6.0
17	Toroweap Overlook (TOROWP)	33.9	17.4	-16.5	19.2	-14.7	16.5	-17.4
18	Tower of Ra (TOWER)	47.3	43.2	-4.1	43.2	-4.1	43.2	-4.1
19	Twin Point (TWINPT)	33.9	35.6	1.7	35.5	1.6	30.0	-3.9
20	Upper Deer Creek (UPDRCK)	18.8	13.7	-5.1	13.7	-5.1	13.5	-5.3
21	West End (WESEND)	38.7	35.8	-2.9	35.8	-2.9	36.4	-2.3

Table A.26

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, West of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
22	Coyote Canyon (COYCAN)	33.7	16.3	-17.4	16.8	-16.9	15.5	-18.2
23	Diamond Creek (DIACRK)	27.8	14.0	-13.8	13.5	-14.3	34.1	6.3
24	The Dome (DOME)	36.1	16.0	-20.1	16.6	-19.5	15.2	-20.9
25	Granite Gorge (GRAGOR)	43.5	41.1	-2.4	41.1	-2.4	39.0	-4.5
26	Grand Canyon West (GCWEST)	41.4	40.0	-1.4	40.0	-1.4	39.7	-1.7
27	Granite Park (GRNTPK)	30.5	30.9	0.4	30.5	0.0	22.5	-8.0
28	Dr. Tommy's Mountain (DRTOMM)	29.2	41.0	11.8	40.8	11.6	27.9	-1.3
29	Havasu Point (HAVAPT)	29.9	13.4	-16.5	13.7	-16.2	12.9	-17.0
30	Havatagvitch Canyon (HAVCAN)	41.9	20.4	-21.5	20.7	-21.2	19.8	-22.1
31	Hermit Basin (HBASIN)	41.2	35.3	-5.9	35.3	-5.9	35.3	-5.9
32	Horse Flat Canyon (HFCAN)	28.4	25.1	-3.3	25.0	-3.4	25.5	-2.9
33	Meriwhitca (MERIWH)	29.7	16.4	-13.3	16.2	-13.5	19.3	-10.4
34	Mohawk Canyon (MOHAWK)	26.9	22.8	-4.1	24.8	-2.1	22.0	-4.9
35	Mohawk Canyon (MOHCAN)	31.6	20.2	-11.4	21.7	-9.9	19.3	-12.3
36	Mount Sinyala (MTSINY)	47.0	13.4	-33.6	13.6	-33.4	12.9	-34.1
37	National Canyon (NATCAN)	27.4	19.3	-8.1	20.4	-7.0	18.4	-9.0
38	Jackson Canyon (JCKCAN/NONAME)	40.0	26.1	-13.9	26.0	-14.0	27.1	-12.9
39	Parashant Wash (PARWAS)	35.8	35.7	-0.1	30.8	-5.0	35.6	-0.2
40	Pumpkin Springs (PMPKIN)	20.2	21.5	1.3	20.8	0.6	20.3	0.1
41	Prospect Canyon (PROCAN)	43.8	21.0	-22.8	24.0	-19.8	20.2	-23.6
42	Prospect Canyon (PRSPCT)	32.2	26.1	-6.1	30.9	-1.3	25.5	-6.7
43	Peach Spring Canyon North (PSCNNO)	28.4	13.2	-15.2	12.7	-15.7	38.8	10.4
44	Peach Spring Canyon South (PSCNSO)	9.3	9.2	-0.1	8.8	-0.5	17.4	8.1
45	Quartermaster Point (QMPNT)	40.8	37.6	-3.2	37.6	-3.2	37.6	-3.2
46	The Ranch (RANCH)	33.2	39.5	6.3	39.5	6.3	39.5	6.3
47	Spencer/Meriwhitica Canyons (SCMCIG)	29.2	15.1	-14.1	14.7	-14.5	30.7	1.5
48	South Supai Canyon (SOSUPC)	32.3	34.0	1.7	35.5	3.2	33.2	0.9
49	Spencer Canyon (SPENCA)	30.9	16.5	-14.4	16.3	-14.6	22.4	-8.5
50	Supai Village (SUPVIL)	33.1	15.7	-17.4	16.0	-17.1	15.1	-18.0
51	Three Springs Rapids (THRSPR)	18.6	19.9	1.3	19.2	0.6	20.9	2.3
52	Whitmore Rapids (WHTRAP)	40.1	25.3	-14.8	34.7	-5.4	24.7	-15.4
53	96 Mile Camp (96MILE)	42.1	37.4	-4.7	37.4	-4.7	37.3	-4.8

Table A.27

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
54	The Basin (BASIN)	37.9	28.8	-9.1	28.8	-9.1	28.7	-9.2
55	Bright Angel Point (BRTANG)	26.6	24.8	-1.8	24.8	-1.8	24.7	-1.9
56	Cape Royal (CAPROY)	24.6	27.3	2.7	27.3	2.7	27.3	2.7
57	Cliff Dwellers Lodge (CLDWEL)	16.6	20.8	4.2	20.8	4.2	20.8	4.2
58	Marble Canyon Dam Site (MARBDM)	22.5	19.3	-3.2	19.3	-3.2	19.2	-3.3
59	Nankoweap Mesa (NANMES)	42.6	28.7	-13.9	28.7	-13.9	28.7	-13.9
60	North Canyon (NOCANY)	31.1	23.3	-7.8	23.3	-7.8	23.3	-7.8
61	Point Imperial (PTIMPL)	36.2	26.9	-9.3	26.9	-9.3	26.9	-9.3
62	Saddle Mountain (SADMTN)	29.7	39.1	9.4	39.1	9.4	39.1	9.4
63	South Canyon (SOCAN)	27.2	18.1	-9.1	18.1	-9.1	18.1	-9.1
64	Temple Butte (TEMBUT)	38.9	29.9	-9.0	29.9	-9.0	29.9	-9.0

Table A.28

Comparison of L_{Aeq12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		L_{Aeq12h}	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference	L_{Aeq12h}	Difference
65	Cedar Ridge (CEDRIG)	29.0	29.6	0.6	29.6	0.6	29.6	0.6
66	`Lipan Point (LIPAN)	31.6	29.9	-1.7	29.9	-1.7	29.9	-1.7
67	Little Colorado (LITCOL)	26.2	18.6	-7.6	18.6	-7.6	18.5	-7.7
68	Little Colorado River (LTCORV)	38.2	25.5	-12.7	25.5	-12.7	25.5	-12.7
69	Nankoweap at river (NANRIV)	37.2	24.7	-12.5	24.7	-12.5	24.7	-12.5
70	Ten X Meadow (TENMED)	37.2	37.8	0.6	37.8	0.6	37.8	0.6
71	Zuni Alpha (ZUNALF)	36.0	41.3	5.3	41.3	5.3	41.3	5.3
72	Zuni Charlie (ZUNCHR)	29.0	24.3	-4.7	24.3	-4.7	24.3	-4.7

Table A.29

Comparison of 25%TA_{12h} at Representative Locations in GCNP North of Colorado River, West of GC Airport 1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
1	NPS Admin Site (ADMIN)	39.8	37.9	-1.9	38.4	-1.4	28.5	-11.3
2	Andrus Canyon (ANDRUS)	26.5	10.6	-15.9	25.2	-1.3	10.6	-15.9
3	Bass Camp (BASCMP)	1.6	1.5	-0.1	1.5	-0.1	1.5	-0.1
4	Bat Cave (BATCAV)	27.1	43.1	16.0	33.1	6.0	43.9	16.8
5	Burnt Springs Canyon (BRNTSP)	11.4	8.2	-3.2	8.2	-3.2	12.5	1.1
6	Castle Peak (CASTLE)	32.8	22.6	-10.2	28.0	-4.8	22.5	-10.3
7	Kanab Point (KANAPT)	36.7	16.4	-20.3	16.8	-19.9	15.9	-20.8
8	Kelly Point (KELLPT)	1.6	0.2	-1.4	0.2	-1.4	20.0	18.4
9	Mt. Dellenbaugh (MTDELL)	17.6	14.8	-2.8	3.4	-14.2	14.7	-2.9
10	Point Sublime (PTSUBL)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
11	Sanup (SANUP)	62.0	60.8	-1.2	59.5	-2.5	67.3	5.3
12	Separation Canyon at Colorado River (SCCORV)	1.0	0.0	-1.0	0.0	-1.0	11.4	10.4
13	Separation Canyon (SEPARC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Shivwitz Fire Camp (SHWZFC)	33.7	33.8	0.1	31.7	-2.0	25.4	-8.3
15	Stone Creek (STONCK)	0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2
16	Suicide Point (SUIPNT)	23.5	42.9	19.4	23.4	-0.1	33.9	10.4
17	Toroweap Overlook (TOROWP)	82.4	65.3	-17.1	71.4	-11.0	44.8	-37.6
18	Tower of Ra (TOWER)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
19	Twin Point (TWINPT)	28.9	49.4	20.5	34.0	5.1	48.0	19.1
20	Upper Deer Creek (UPDRCK)	51.3	25.2	-26.1	25.4	-25.9	24.8	-26.5
21	West End (WESEND)	8.9	5.1	-3.8	5.1	-3.8	5.8	-3.1

Table A.30

Comparison of 25%TA_{12h} at Representative Locations in GCNP
South of Colorado River, West of GC Airport
1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
22	Coyote Canyon (COYCAN)	23.2	0.0	-23.2	0.0	-23.2	0.0	-23.2
23	Diamond Creek (DIACRK)	0.4	0.0	-0.4	0.0	-0.4	6.9	6.5
24	The Dome (DOME)	25.2	0.0	-25.2	0.0	-25.2	0.0	-25.2
25	Granite Gorge (GRAGOR)	42.3	60.2	17.9	55.1	12.8	57.9	15.6
26	Grand Canyon West (GCWEST)	37.9	46.1	8.2	42.3	4.4	45.7	7.8
27	Granite Park (GRNTPK)	1.8	1.3	-0.5	1.3	-0.5	0.0	-1.8
28	Dr. Tommy's Mountain (DRTOMM)	29.9	45.0	15.1	33.5	3.6	24.9	-5.0
29	Havasu Point (HAVAPT)	9.0	0.0	-9.0	0.0	-9.0	0.0	-9.0
30	Havatagvitch Canyon (HAVCAN)	27.7	2.5	-25.2	5.8	-21.9	2.1	-25.6
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	18.0	11.0	-7.0	11.0	-7.0	18.9	0.9
33	Meriwhitca (MERIWH)	5.2	3.1	-2.1	3.1	-2.1	7.4	2.2
34	Mohawk Canyon (MOHAWK)	33.8	18.6	-15.2	22.9	-10.9	18.4	-15.4
35	Mohawk Canyon (MOHCAN)	30.6	9.9	-20.7	17.1	-13.5	10.0	-20.6
36	Mount Sinyala (MTSINY)	63.3	25.7	-37.6	30.0	-33.3	24.6	-38.7
37	National Canyon (NATCAN)	23.5	3.3	-20.2	12.0	-11.5	3.3	-20.2
38	Jackson Canyon (JCKCAN/NONAME)	14.0	11.5	-2.5	11.5	-2.5	26.8	12.8
39	Parashant Wash (PARWAS)	23.9	18.0	-5.9	15.4	-8.5	17.9	-6.0
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	34.7	14.0	-20.7	21.8	-12.9	13.9	-20.8
42	Prospect Canyon (PRSPCT)	33.0	30.7	-2.3	35.6	2.6	23.2	-9.8
43	Peach Spring Canyon North (PSCNNO)	0.5	0.0	-0.5	0.0	-0.5	20.7	20.2
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	7.3	7.1
45	Quartermaster Point (QMPNT)	22.5	33.0	10.5	33.0	10.5	33.9	11.4
46	The Ranch (RANCH)	60.5	86.2	25.7	86.5	26.0	83.7	23.2
47	Spencer/Meriwhitica Canyons (SCMCIG)	3.2	0.6	-2.6	0.6	-2.6	20.9	17.7
48	South Supai Canyon (SOSUPC)	44.3	53.6	9.3	54.0	9.7	46.1	1.8
49	Spencer Canyon (SPENCA)	5.0	2.8	-2.2	2.8	-2.2	18.5	13.5
50	Supai Village (SUPVIL)	28.0	0.0	-28.0	0.0	-28.0	0.0	-28.0
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	9.4	0.0	-9.4	8.8	-0.6	0.0	-9.4
53	96 Mile Camp (96MILE)	41.2	45.6	4.4	45.6	4.4	45.4	4.2

Table A.31

Comparison of 25%TA_{12h} at Representative Locations in GCNP
North of Colorado River, East of GC Airport
1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
54	The Basin (BASIN)	52.8	46.2	-6.6	46.2	-6.6	46.1	-6.7
55	Bright Angel Point (BRTANG)	4.7	1.9	-2.8	1.9	-2.8	1.9	-2.8
56	Cape Royal (CAPROY)	28.8	29.6	0.8	29.7	0.9	29.5	0.7
57	Cliff Dwellers Lodge (CLDWEL)	1.1	0.8	-0.3	0.8	-0.3	0.8	-0.3
58	Marble Canyon Dam Site (MARBDM)	0.3	0.0	-0.3	0.0	-0.3	0.0	-0.3
59	Nankoweap Mesa (NANMES)	43.8	45.3	1.5	45.2	1.4	45.2	1.4
60	North Canyon (NOCANY)	1.3	1.3	0.0	1.3	0.0	1.3	0.0
61	Point Imperial (PTIMPL)	18.0	19.9	1.9	19.9	1.9	19.9	1.9
62	Saddle Mountain (SADMTN)	5.2	7.0	1.8	7.0	1.8	7.0	1.8
63	South Canyon (SOCAN)	1.9	1.4	-0.5	1.4	-0.5	1.4	-0.5
64	Temple Butte (TEMBUT)	45.5	45.1	-0.4	45.2	-0.3	45.0	-0.5

Table A.32

Comparison of 25%TA_{12h} at Representative Locations in GCNP
South of Colorado River, East of GC Airport
1998

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
65	Cedar Ridge (CEDRIG)	80.8	80.6	-0.2	80.9	0.1	79.7	-1.1
66	Lipan Point (LIPAN)	16.7	20.8	4.1	20.9	4.2	20.7	4.0
67	Little Colorado (LITCOL)	6.0	5.4	-0.6	5.4	-0.6	5.4	-0.6
68	Little Colorado River (LTCORV)	12.6	5.6	-7.0	5.6	-7.0	5.6	-7.0
69	Nankoweap at river (NANRIV)	4.9	1.1	-3.8	1.1	-3.8	1.1	-3.8
70	Ten X Meadow (TENMED)	17.8	19.3	1.5	19.6	1.8	19.2	1.4
71	Zuni Alpha (ZUNALF)	4.5	6.6	2.1	6.6	2.1	6.6	2.1
72	Zuni Charlie (ZUNCHR)	45.2	43.4	-1.8	43.4	-1.8	43.3	-1.9

Table A.33

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, West of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
1	NPS Admin Site (ADMIN)	42.5	37.9	-4.6	38.4	-4.1	28.5	-14.0
2	Andrus Canyon (ANDRUS)	28.3	10.6	-17.7	25.2	-3.1	10.6	-17.7
3	Bass Camp (BASCMP)	1.7	1.5	-0.2	1.5	-0.2	1.5	-0.2
4	Bat Cave (BATCAV)	29.0	43.1	14.1	33.1	4.1	43.9	14.9
5	Burnt Springs Canyon (BRNTSP)	12.2	8.2	-4.0	8.2	-4.0	12.5	0.3
6	Castle Peak (CASTLE)	35.0	22.6	-12.4	28	-7.0	22.5	-12.5
7	Kanab Point (KANAPT)	39.2	16.4	-22.8	16.8	-22.4	15.9	-23.3
8	Kelly Point (KELLPT)	1.7	0.2	-1.5	0.2	-1.5	20	18.3
9	Mt. Dellenbaugh (MTDELL)	18.8	14.8	-4.0	3.4	-15.4	14.7	-4.1
10	Point Sublime (PTSUBL)	100.0	100	0.0	100	0.0	100	0.0
11	Sanup (SANUP)	66.2	60.8	-5.4	59.5	-6.7	67.3	1.1
12	Separation Canyon at Colorado River (SCCORV)	1.0	0	-1.0	0	-1.0	11.4	10.4
13	Separation Canyon (SEPARC)	0.0	0	0.0	0	0.0	0	0.0
14	Shivwitz Fire Camp (SHWZFC)	36.0	33.8	-2.2	31.7	-4.3	25.4	-10.6
15	Stone Creek (STONCK)	0.2	0	-0.2	0	-0.2	0	-0.2
16	Suicide Point (SUIPNT)	25.1	42.9	17.8	23.4	-1.7	33.9	8.8
17	Toroweap Overlook (TOROWP)	87.9	65.3	-22.6	71.4	-16.5	44.8	-43.1
18	Tower of Ra (TOWER)	100.0	100	0.0	100	0.0	100	0.0
19	Twin Point (TWINPT)	30.8	49.4	18.6	34	3.2	48	17.2
20	Upper Deer Creek (UPDRCK)	54.8	25.2	-29.6	25.4	-29.4	24.8	-30.0
21	West End (WESEND)	9.5	5.1	-4.4	5.1	-4.4	5.8	-3.7

Table A.34

Comparison of $25\%TA_{12h}$ at Representative Locations in GCNP Considering Commercial Air Tour Limitations South of Colorado River, West of GC Airport 2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		$25\%TA_{12h}$	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference
22	Coyote Canyon (COYCAN)	24.8	0.0	-24.8	0.0	-24.8	0.0	-24.8
23	Diamond Creek (DIACRK)	0.4	0.0	-0.4	0.0	-0.4	6.9	6.5
24	The Dome (DOME)	26.9	0.0	-26.9	0.0	-26.9	0.0	-26.9
25	Granite Gorge (GRAGOR)	45.2	60.2	15.0	55.1	9.9	57.9	12.7
26	Grand Canyon West (GCWEST)	40.4	46.1	5.7	42.3	1.9	45.7	5.3
27	Granite Park (GRNTPK)	2.0	1.3	-0.7	1.3	-0.7	0.0	-2.0
28	Dr. Tommy's Mountain (DRTOMM)	31.9	45.0	13.1	33.5	1.6	24.9	-7.0
29	Havasu Point (HAVAPT)	9.6	0.0	-9.6	0.0	-9.6	0.0	-9.6
30	Havatagvitch Canyon (HAVCAN)	29.5	2.5	-27.0	5.8	-23.7	2.1	-27.4
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	19.2	11.0	-8.2	11.0	-8.2	18.9	-0.3
33	Meriwhitca (MERIWH)	5.6	3.1	-2.5	3.1	-2.5	7.4	1.8
34	Mohawk Canyon (MOHAWK)	36.1	18.6	-17.5	22.9	-13.2	18.4	-17.7
35	Mohawk Canyon (MOHCAN)	32.7	9.9	-22.8	17.1	-15.6	10.0	-22.7
36	Mount Sinyala (MTSINY)	67.5	25.7	-41.8	30.0	-37.5	24.6	-42.9
37	National Canyon (NATCAN)	25.0	3.3	-21.7	12.0	-13.0	3.3	-21.7
38	Jackson Canyon (JCKCAN/NONAME)	15.0	11.5	-3.5	11.5	-3.5	26.8	11.8
39	Parashant Wash (PARWAS)	25.5	18.0	-7.5	15.4	-10.1	17.9	-7.6
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	37.0	14.0	-23.0	21.8	-15.2	13.9	-23.1
42	Prospect Canyon (PRSPCT)	35.2	30.7	-4.5	35.6	0.4	23.2	-12.0
43	Peach Spring Canyon North (PSCNNO)	0.6	0.0	-0.6	0.0	-0.6	20.7	20.1
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	7.3	7.1
45	Quartermaster Point (QMPNT)	24.0	33.0	9.0	33.0	9.0	33.9	9.9
46	The Ranch (RANCH)	64.6	86.2	21.6	86.5	21.9	83.7	19.1
47	Spencer/Meriwhitica Canyons (SCMCIG)	3.4	0.6	-2.8	0.6	-2.8	20.9	17.5
48	South Supai Canyon (SOSUPC)	47.2	53.6	6.4	54.0	6.8	46.1	-1.1
49	Spencer Canyon (SPENCA)	5.3	2.8	-2.5	2.8	-2.5	18.5	13.2
50	Supai Village (SUPVIL)	29.9	0.0	-29.9	0.0	-29.9	0.0	-29.9
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	10.0	0.0	-10.0	8.8	-1.2	0.0	-10.0
53	96 Mile Camp (96MILE)	44.0	45.6	1.6	45.6	1.6	45.4	1.4

Table A.35

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
54	The Basin (BASIN)	56.4	46.2	-10.2	46.2	-10.2	46.1	-10.3
55	Bright Angel Point (BRTANG)	5.0	1.9	-3.1	1.9	-3.1	1.9	-3.1
56	Cape Royal (CAPROY)	30.7	29.6	-1.1	29.7	-1.0	29.5	-1.2
57	Cliff Dwellers Lodge (CLDWEL)	1.2	0.8	-0.4	0.8	-0.4	0.8	-0.4
58	Marble Canyon Dam Site (MARBDM)	0.3	0.0	-0.3	0.0	-0.3	0.0	-0.3
59	Nankoweap Mesa (NANMES)	46.8	45.3	-1.5	45.2	-1.6	45.2	-1.6
60	North Canyon (NOCANY)	1.4	1.3	-0.1	1.3	-0.1	1.3	-0.1
61	Point Imperial (PTIMPL)	19.2	19.9	0.7	19.9	0.7	19.9	0.7
62	Saddle Mountain (SADMTN)	5.6	7.0	1.4	7.0	1.4	7.0	1.4
63	South Canyon (SOCAN)	2.0	1.4	-0.6	1.4	-0.6	1.4	-0.6
64	Temple Butte (TEMBUT)	48.5	45.1	-3.4	45.2	-3.3	45.0	-3.5

Table A.36

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
65	Cedar Ridge (CEDRIG)	86.3	80.6	-5.7	80.9	-5.4	79.7	-6.6
66	Lipan Point (LIPAN)	17.8	20.8	3.0	20.9	3.1	20.7	2.9
67	Little Colorado (LITCOL)	6.4	5.4	-1.0	5.4	-1.0	5.4	-1.0
68	Little Colorado River (LTCORV)	13.5	5.6	-7.9	5.6	-7.9	5.6	-7.9
69	Nankoweap at river (NANRIV)	5.2	1.1	-4.1	1.1	-4.1	1.1	-4.1
70	Ten X Meadow (TENMED)	19.0	19.3	0.3	19.6	0.6	19.2	0.2
71	Zuni Alpha (ZUNALF)	4.8	6.6	1.8	6.6	1.8	6.6	1.8
72	Zuni Charlie (ZUNCHR)	48.3	43.4	-4.9	43.4	-4.9	43.3	-5.0

Table A.37

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, West of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
1	NPS Admin Site (ADMIN)	42.5	41.0	-1.5	41.6	-0.9	31.0	-11.5
2	Andrus Canyon (ANDRUS)	28.3	11.5	-16.8	27.4	-0.9	11.5	-16.8
3	Bass Camp (BASCMP)	1.7	1.6	-0.1	1.6	-0.1	1.6	-0.1
4	Bat Cave (BATCAV)	29.0	46.2	17.2	35.3	6.3	47.0	18.0
5	Burnt Springs Canyon (BRNTSP)	12.2	8.8	-3.4	8.8	-3.4	13.3	1.1
6	Castle Peak (CASTLE)	35.0	24.6	-10.4	30.4	-4.6	24.4	-10.6
7	Kanab Point (KANAPT)	39.2	17.5	-21.7	18.0	-21.2	17.0	-22.2
8	Kelly Point (KELLPT)	1.7	0.2	-1.5	0.2	-1.5	21.4	19.7
9	Mt. Dellenbaugh (MTDELL)	18.8	16.1	-2.7	3.6	-15.2	16.0	-2.8
10	Point Sublime (PTSUBL)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
11	Sanup (SANUP)	66.2	65.5	-0.7	64.1	-2.1	72.4	6.2
12	Separation Canyon at Colorado River (SCCORV)	1.0	0.0	-1.0	0.0	-1.0	12.1	11.1
13	Separation Canyon (SEPARC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Shivwitz Fire Camp (SHWZFC)	36.0	36.6	0.6	34.3	-1.7	27.6	-8.4
15	Stone Creek (STONCK)	0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2
16	Suicide Point (SUIPNT)	25.1	46.1	21.0	25.0	-0.1	36.6	11.5
17	Toroweap Overlook (TOROWP)	87.9	70.5	-17.4	77.2	-10.7	48.7	-39.2
18	Tower of Ra (TOWER)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
19	Twin Point (TWINPT)	30.8	53.1	22.3	36.3	5.5	51.5	20.7
20	Upper Deer Creek (UPDRCK)	54.8	26.9	-27.9	27.2	-27.6	26.5	-28.3
21	West End (WESEND)	9.5	5.4	-4.1	5.4	-4.1	6.2	-3.3

Table A.38

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, West of GC Airport
2000

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Diff3rence	25%TA_{12h}	Difference
22	Coyote Canyon (COYCAN)	24.8	0.0	-24.8	0.0	-24.8	0.0	-24.8
23	Diamond Creek (DIACRK)	0.4	0.0	-0.4	0.0	-0.4	7.4	7.0
24	The Dome (DOME)	26.9	0.0	-26.9	0.0	-26.9	0.0	-26.9
25	Granite Gorge (GRAGOR)	45.2	64.6	19.4	59.0	13.8	62.2	17.0
26	Grand Canyon West (GCWEST)	40.4	49.2	8.8	45.2	4.8	48.7	8.3
27	Granite Park (GRNTPK)	2.0	1.4	-0.6	1.4	-0.6	0.0	-2.0
28	Dr. Tommy's Mountain (DRTOMM)	31.9	48.5	16.6	36.0	4.1	27.1	-4.8
29	Havasu Point (HAVAPT)	9.6	0.0	-9.6	0.0	-9.6	0.0	-9.6
30	Havatagvitch Canyon (HAVCAN)	29.5	2.7	-26.8	6.2	-23.3	2.2	-27.3
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	19.2	11.8	-7.4	11.8	-7.4	20.2	1.0
33	Meriwhitca (MERIWH)	5.6	3.3	-2.3	3.3	-2.3	7.9	2.3
34	Mohawk Canyon (MOHAWK)	36.1	20.2	-15.9	24.9	-11.2	20.0	-16.1
35	Mohawk Canyon (MOHCAN)	32.7	10.8	-21.9	18.6	-14.1	10.8	-21.9
36	Mount Sinyala (MTSINY)	67.5	27.5	-40.0	32.3	-35.2	26.4	-41.1
37	National Canyon (NATCAN)	25.0	3.5	-21.5	13.0	-12.0	3.5	-21.5
38	Jackson Canyon (JCKCAN/NONAME)	15.0	12.2	-2.8	12.2	-2.8	28.6	13.6
39	Parashant Wash (PARWAS)	25.5	19.5	-6.0	16.8	-8.7	19.4	-6.1
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	37.0	15.2	-21.8	23.7	-13.3	15.2	-21.8
42	Prospect Canyon (PRSPCT)	35.2	33.2	-2.0	38.6	3.4	25.3	-9.9
43	Peach Spring Canyon North (PSCNNO)	0.6	0.0	-0.6	0.0	-0.6	22.1	21.5
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	7.8	7.6
45	Quartermaster Point (QMPNT)	24.0	35.2	11.2	35.2	11.2	36.2	12.2
46	The Ranch (RANCH)	64.6	92.4	27.8	92.7	28.1	89.6	25.0
47	Spencer/Meriwhitica Canyons (SCMCIG)	3.4	0.7	-2.7	0.7	-2.7	22.3	18.9
48	South Supai Canyon (SOSUPC)	47.2	57.8	10.6	58.2	11.0	49.7	2.5
49	Spencer Canyon (SPENCA)	5.3	3.0	-2.3	3.0	-2.3	19.7	14.4
50	Supai Village (SUPVIL)	29.9	0.0	-29.9	0.0	-29.9	0.0	-29.9
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	10.0	0.0	-10.0	9.6	-0.4	0.0	-10.0
53	96 Mile Camp (96MILE)	44.0	48.6	4.6	48.7	4.7	48.4	4.4

Table A.39

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1) 25%TA_{12h}	Alternative 2 25%TA_{12h}	Alternative 2 Difference	Alternative 3 25%TA_{12h}	Alternative 3 Difference	Alternative 4 25%TA_{12h}	Alternative 4 Difference
54	The Basin (BASIN)	56.4	49.3	-7.1	49.4	-7.0	49.2	-7.2
55	Bright Angel Point (BRTANG)	5.0	2.0	-3.0	2.0	-3.0	2.0	-3.0
56	Cape Royal (CAPROY)	30.7	31.6	0.9	31.7	1.0	31.5	0.8
57	Cliff Dwellers Lodge (CLDWEL)	1.2	0.8	-0.4	0.8	-0.4	0.8	-0.4
58	Marble Canyon Dam Site (MARBDM)	0.3	0.0	-0.3	0.0	-0.3	0.0	-0.3
59	Nankoweap Mesa (NANMES)	46.8	48.3	1.5	48.3	1.5	48.3	1.5
60	North Canyon (NOCANY)	1.4	1.4	0.0	1.4	0.0	1.4	0.0
61	Point Imperial (PTIMPL)	19.2	21.3	2.1	21.3	2.1	21.2	2.0
62	Saddle Mountain (SADMTN)	5.6	7.4	1.8	7.4	1.8	7.4	1.8
63	South Canyon (SOCAN)	2.0	1.5	-0.5	1.5	-0.5	1.5	-0.5
64	Temple Butte (TEMBUT)	48.5	48.2	-0.3	48.2	-0.3	48.0	-0.5

Table A.40

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, East of GC Airport
2000

	Location	No Action (Alt. 1) 25%TA_{12h}	Alternative 2 25%TA_{12h}	Alternative 2 Difference	Alternative 3 25%TA_{12h}	Alternative 3 Difference	Alternative 4 25%TA_{12h}	Alternative 4 Difference
65	Cedar Ridge (CEDRIG)	86.3	86.3	0.0	86.7	0.4	85.5	-0.8
66	Lipan Point (LIPAN)	17.8	22.2	4.4	22.3	4.5	22.1	4.3
67	Little Colorado (LITCOL)	6.4	5.8	-0.6	5.8	-0.6	5.8	-0.6
68	Little Colorado River (LTCORV)	13.5	6.0	-7.5	6.0	-7.5	6.0	-7.5
69	Nankoweap at river (NANRIV)	5.2	1.2	-4.0	1.2	-4.0	1.2	-4.0
70	Ten X Meadow (TENMED)	19.0	20.7	1.7	21.0	2.0	20.5	1.5
71	Zuni Alpha (ZUNALF)	4.8	7.0	2.2	7.0	2.2	7.0	2.2
72	Zuni Charlie (ZUNCHR)	48.3	46.3	-2.0	46.4	-1.9	46.2	-2.1

Table A.41

Comparison of 25%TA_{12h} at Representative Locations in GCNP Considering Commercial Air Tour Limitations North of Colorado River, West of GC Airport 2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
1	NPS Admin Site (ADMIN)	46.8	37.9	-8.9	38.4	-8.4	28.5	-18.3
2	Andrus Canyon (ANDRUS)	31.2	10.6	-20.6	25.2	-6.0	10.6	-20.6
3	Bass Camp (BASCMP)	1.8	1.5	-0.3	1.5	-0.3	1.5	-0.3
4	Bat Cave (BATCAV)	31.9	43.1	11.2	33.1	1.2	43.9	12.0
5	Burnt Springs Canyon (BRNTSP)	13.4	8.2	-5.2	8.2	-5.2	12.5	-0.9
6	Castle Peak (CASTLE)	38.6	22.6	-16.0	28.0	-10.6	22.5	-16.1
7	Kanab Point (KANAPT)	43.2	16.4	-26.8	16.8	-26.4	15.9	-27.3
8	Kelly Point (KELLPT)	1.8	0.2	-1.6	0.2	-1.6	20.0	18.2
9	Mt. Dellenbaugh (MTDELL)	20.7	14.8	-5.9	3.4	-17.3	14.7	-6.0
10	Point Sublime (PTSUBL)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
11	Sanup (SANUP)	72.9	60.8	-12.1	59.5	-13.4	67.3	-5.6
12	Separation Canyon at Colorado River (SCCORV)	1.1	0.0	-1.1	0.0	-1.1	11.4	10.3
13	Separation Canyon (SEPARC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Shivwitz Fire Camp (SHWZFC)	39.7	33.8	-5.9	31.7	-8.0	25.4	-14.3
15	Stone Creek (STONCK)	0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2
16	Suicide Point (SUIPNT)	27.6	42.9	15.3	23.4	-4.2	33.9	6.3
17	Toroweap Overlook (TOROWP)	96.9	65.3	-31.6	71.4	-25.5	44.8	-52.1
18	Tower of Ra (TOWER)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
19	Twin Point (TWINPT)	34.0	49.4	15.4	34.0	0.0	48.0	14.0
20	Upper Deer Creek (UPDRCK)	60.4	25.2	-35.2	25.4	-35.0	24.8	-35.6
21	West End (WESEND)	10.5	5.1	-5.4	5.1	-5.4	5.8	-4.7

Table A.42

Comparison of $25\%TA_{12h}$ at Representative Locations in GCNP Considering Commercial Air Tour Limitations South of Colorado River, West of GC Airport 2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		$25\%TA_{12h}$	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference
22	Coyote Canyon (COYCAN)	27.3	0.0	-27.3	0.0	-27.3	0.0	-27.3
23	Diamond Creek (DIACRK)	0.5	0.0	-0.5	0.0	-0.5	6.9	6.4
24	The Dome (DOME)	29.6	0.0	-29.6	0.0	-29.6	0.0	-29.6
25	Granite Gorge (GRAGOR)	49.8	60.2	10.4	55.1	5.3	57.9	8.1
26	Grand Canyon West (GCWEST)	44.6	46.1	1.5	42.3	-2.3	45.7	1.1
27	Granite Park (GRNTPK)	2.2	1.3	-0.9	1.3	-0.9	0.0	-2.2
28	Dr. Tommy's Mountain (DRTOMM)	35.1	45.0	9.9	33.5	-1.6	24.9	-10.2
29	Havasu Point (HAVAPT)	10.5	0.0	-10.5	0.0	-10.5	0.0	-10.5
30	Havatagvitch Canyon (HAVCAN)	32.5	2.5	-30.0	5.8	-26.7	2.1	-30.4
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	21.2	11.0	-10.2	11.0	-10.2	18.9	-2.3
33	Meriwhitca (MERIWH)	6.2	3.1	-3.1	3.1	-3.1	7.4	1.2
34	Mohawk Canyon (MOHAWK)	39.7	18.6	-21.1	22.9	-16.8	18.4	-21.3
35	Mohawk Canyon (MOHCAN)	36.0	9.9	-26.1	17.1	-18.9	10.0	-26.0
36	Mount Sinyala (MTSINY)	74.4	25.7	-48.7	30.0	-44.4	24.6	-49.8
37	National Canyon (NATCAN)	27.6	3.3	-24.3	12.0	-15.6	3.3	-24.3
38	Jackson Canyon (JCKCAN/NONAME)	16.5	11.5	-5.0	11.5	-5.0	26.8	10.3
39	Parashant Wash (PARWAS)	28.1	18.0	-10.1	15.4	-12.7	17.9	-10.2
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	40.8	14.0	-26.8	21.8	-19.0	13.9	-26.9
42	Prospect Canyon (PRSPCT)	38.8	30.7	-8.1	35.6	-3.2	23.2	-15.6
43	Peach Spring Canyon North (PSCNNO)	0.6	0.0	-0.6	0.0	-0.6	20.7	20.1
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	7.3	7.1
45	Quartermaster Point (QMPNT)	26.5	33.0	6.5	33.0	6.5	33.9	7.4
46	The Ranch (RANCH)	71.2	86.2	15.0	86.5	15.3	83.7	12.5
47	Spencer/Meriwhitica Canyons (SCMCIG)	3.7	0.6	-3.1	0.6	-3.1	20.9	17.2
48	South Supai Canyon (SOSUPC)	52.1	53.6	1.5	54.0	1.9	46.1	-6.0
49	Spencer Canyon (SPENCA)	5.8	2.8	-3.0	2.8	-3.0	18.5	12.7
50	Supai Village (SUPVIL)	32.9	0.0	-32.9	0.0	-32.9	0.0	-32.9
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	11.0	0.0	-11.0	8.8	-2.2	0.0	-11.0
53	96 Mile Camp (96MILE)	48.5	45.6	-2.9	45.6	-2.9	45.4	-3.1

Table A.43

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, East of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
54	The Basin (BASIN)	62.1	46.2	-15.9	46.2	-15.9	46.1	-16.0
55	Bright Angel Point (BRTANG)	5.5	1.9	-3.6	1.9	-3.6	1.9	-3.6
56	Cape Royal (CAPROY)	33.9	29.6	-4.3	29.7	-4.2	29.5	-4.4
57	Cliff Dwellers Lodge (CLDWEL)	1.3	0.8	-0.5	0.8	-0.5	0.8	-0.5
58	Marble Canyon Dam Site (MARBDM)	0.4	0.0	-0.4	0.0	-0.4	0.0	-0.4
59	Nankoweap Mesa (NANMES)	51.5	45.3	-6.2	45.2	-6.3	45.2	-6.3
60	North Canyon (NOCANY)	1.5	1.3	-0.2	1.3	-0.2	1.3	-0.2
61	Point Imperial (PTIMPL)	21.2	19.9	-1.3	19.9	-1.3	19.9	-1.3
62	Saddle Mountain (SADMTN)	6.2	7.0	0.8	7.0	0.8	7.0	0.8
63	South Canyon (SOCAN)	2.2	1.4	-0.8	1.4	-0.8	1.4	-0.8
64	Temple Butte (TEMBUT)	53.5	45.1	-8.4	45.2	-8.3	45.0	-8.5

Table A.44

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, East of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
65	Cedar Ridge (CEDRIG)	95.1	80.6	-14.5	80.9	-14.2	79.7	-15.4
66	Lipan Point (LIPAN)	19.6	20.8	1.2	20.9	1.3	20.7	1.1
67	Little Colorado (LITCOL)	7.1	5.4	-1.7	5.4	-1.7	5.4	-1.7
68	Little Colorado River (LTCORV)	14.8	5.6	-9.2	5.6	-9.2	5.6	-9.2
69	Nankoweap at river (NANRIV)	5.8	1.1	-4.7	1.1	-4.7	1.1	-4.7
70	Ten X Meadow (TENMED)	21.0	19.3	-1.7	19.6	-1.4	19.2	-1.8
71	Zuni Alpha (ZUNALF)	5.3	6.6	1.3	6.6	1.3	6.6	1.3
72	Zuni Charlie (ZUNCHR)	53.2	43.4	-9.8	43.4	-9.8	43.3	-9.9

Table A.45

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, West of GC Airport
2003

		No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Location	25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
1	NPS Admin Site (ADMIN)	46.8	45.1	-1.7	45.8	-1.0	34.2	-12.6
2	Andrus Canyon (ANDRUS)	31.2	12.7	-18.5	30.2	-1.0	12.6	-18.6
3	Bass Camp (BASCMP)	1.8	1.8	0.0	1.8	0.0	1.8	0.0
4	Bat Cave (BATCAV)	31.9	50.9	19.0	38.9	7.0	51.8	19.9
5	Burnt Springs Canyon (BRNTSP)	13.4	9.7	-3.7	9.7	-3.7	14.6	1.2
6	Castle Peak (CASTLE)	38.6	27.1	-11.5	33.6	-5.0	26.9	-11.7
7	Kanab Point (KANAPT)	43.2	19.3	-23.9	19.8	-23.4	18.7	-24.5
8	Kelly Point (KELLPT)	1.8	0.2	-1.6	0.2	-1.6	23.6	21.8
9	Mt. Dellenbaugh (MTDELL)	20.7	17.7	-3.0	4.0	-16.7	17.6	-3.1
10	Point Sublime (PTSUBL)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
11	Sanup (SANUP)	72.9	72.1	-0.8	70.6	-2.3	79.8	6.9
12	Separation Canyon at Colorado River (SCCORV)	1.1	0.0	-1.1	0.0	-1.1	13.4	12.3
13	Separation Canyon (SEPARC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Shivwitz Fire Camp (SHWZFC)	39.7	40.3	0.6	37.8	-1.9	30.5	-9.2
15	Stone Creek (STONCK)	0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2
16	Suicide Point (SUIPNT)	27.6	50.8	23.2	27.5	-0.1	40.3	12.7
17	Toroweap Overlook (TOROWP)	96.9	77.7	-19.2	85.0	-11.9	53.7	-43.2
18	Tower of Ra (TOWER)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
19	Twin Point (TWINPT)	34.0	58.5	24.5	40.0	6.0	56.8	22.8
20	Upper Deer Creek (UPDRCK)	60.4	29.7	-30.7	29.9	-30.5	29.2	-31.2
21	West End (WESEND)	10.5	6.0	-4.5	6.0	-4.5	6.9	-3.6

Table A.46

Comparison of 25%TA_{12h} at Representative Locations in GCNP Considering Continued Growth South of Colorado River, West of GC Airport 2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
22	Coyote Canyon (COYCAN)	27.3	0.0	-27.3	0.0	-27.3	0.0	-27.3
23	Diamond Creek (DIACRK)	0.5	0.0	-0.5	0.0	-0.5	8.2	7.7
24	The Dome (DOME)	29.6	0.0	-29.6	0.0	-29.6	0.0	-29.6
25	Granite Gorge (GRAGOR)	49.8	71.2	21.4	65.0	15.2	68.5	18.7
26	Grand Canyon West (GCWEST)	44.6	54.2	9.6	49.8	5.2	53.7	9.1
27	Granite Park (GRNTPK)	2.2	1.6	-0.6	1.6	-0.6	0.0	-2.2
28	Dr. Tommy's Mountain (DRTOMM)	35.1	53.5	18.4	39.6	4.5	29.8	-5.3
29	Havasu Point (HAVAPT)	10.5	0.0	-10.5	0.0	-10.5	0.0	-10.5
30	Havatagvitch Canyon (HAVCAN)	32.5	3.0	-29.5	6.8	-25.7	2.4	-30.1
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	21.2	13.0	-8.2	13.0	-8.2	22.2	1.0
33	Meriwhitca (MERIWH)	6.2	3.7	-2.5	3.7	-2.5	8.7	2.5
34	Mohawk Canyon (MOHAWK)	39.7	22.2	-17.5	27.5	-12.2	22.0	-17.7
35	Mohawk Canyon (MOHCAN)	36.0	11.9	-24.1	20.5	-15.5	11.9	-24.1
36	Mount Sinyala (MTSINY)	74.4	30.3	-44.1	35.6	-38.8	29.1	-45.3
37	National Canyon (NATCAN)	27.6	3.9	-23.7	14.4	-13.2	3.9	-23.7
38	Jackson Canyon (JCKCAN/NONAME)	16.5	13.5	-3.0	13.5	-3.0	31.5	15.0
39	Parashant Wash (PARWAS)	28.1	21.5	-6.6	18.5	-9.6	21.4	-6.7
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	40.8	16.7	-24.1	26.2	-14.6	16.7	-24.1
42	Prospect Canyon (PRSPCT)	38.8	36.6	-2.2	42.5	3.7	27.9	-10.9
43	Peach Spring Canyon North (PSCNNO)	0.6	0.0	-0.6	0.0	-0.6	24.3	23.7
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	8.5	8.3
45	Quartermaster Point (QMPNT)	26.5	38.8	12.3	38.8	12.3	39.9	13.4
46	The Ranch (RANCH)	71.2	100.0	28.8	100.0	28.8	98.8	27.6
47	Spencer/Meriwhitica Canyons (SCMCIG)	3.7	0.8	-2.9	0.8	-2.9	24.5	20.8
48	South Supai Canyon (SOSUPC)	52.1	63.7	11.6	64.2	12.1	54.8	2.7
49	Spencer Canyon (SPENCA)	5.8	3.3	-2.5	3.3	-2.5	21.7	15.9
50	Supai Village (SUPVIL)	32.9	0.0	-32.9	0.0	-32.9	0.0	-32.9
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	11.0	0.0	-11.0	10.6	-0.4	0.0	-11.0
53	96 Mile Camp (96MILE)	48.5	53.6	5.1	53.6	5.1	53.4	4.9

Table A.47

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, East of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
54	The Basin (BASIN)	62.1	54.4	-7.7	54.4	-7.7	54.2	-7.9
55	Bright Angel Point (BRTANG)	5.5	2.2	-3.3	2.2	-3.3	2.2	-3.3
56	Cape Royal (CAPROY)	33.9	34.8	0.9	34.9	1.0	34.7	0.8
57	Cliff Dwellers Lodge (CLDWEL)	1.3	0.9	-0.4	0.9	-0.4	0.9	-0.4
58	Marble Canyon Dam Site (MARBDM)	0.4	0.0	-0.4	0.0	-0.4	0.0	-0.4
59	Nankoweap Mesa (NANMES)	51.5	53.3	1.8	53.2	1.7	53.2	1.7
60	North Canyon (NOCANY)	1.5	1.6	0.1	1.6	0.1	1.6	0.1
61	Point Imperial (PTIMPL)	21.2	23.4	2.2	23.5	2.3	23.4	2.2
62	Saddle Mountain (SADMTN)	6.2	8.2	2.0	8.2	2.0	8.2	2.0
63	South Canyon (SOCAN)	2.2	1.7	-0.5	1.7	-0.5	1.7	-0.5
64	Temple Butte (TEMBUT)	53.5	53.1	-0.4	53.1	-0.4	52.9	-0.6

Table A.48

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, East of GC Airport
2003

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
65	Cedar Ridge (CEDRIG)	95.1	95.1	0.0	95.5	0.4	94.2	-0.9
66	Lipan Point (LIPAN)	19.6	24.5	4.9	24.5	4.9	24.4	4.8
67	Little Colorado (LITCOL)	7.1	6.4	-0.7	6.4	-0.7	6.4	-0.7
68	Little Colorado River (LTCORV)	14.8	6.6	-8.2	6.6	-8.2	6.6	-8.2
69	Nankoweap at river (NANRIV)	5.8	1.4	-4.4	1.4	-4.4	1.4	-4.4
70	Ten X Meadow (TENMED)	21.0	22.8	1.8	23.1	2.1	22.6	1.6
71	Zuni Alpha (ZUNALF)	5.3	7.7	2.4	7.7	2.4	7.7	2.4
72	Zuni Charlie (ZUNCHR)	53.2	51.0	-2.2	51.1	-2.1	50.9	-2.3

Table A.49

Comparison of 25%TA_{12h} at Representative Locations in GCNP Considering Commercial Air Tour Limitations North of Colorado River, West of GC Airport 2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
1	NPS Admin Site (ADMIN)	55.1	37.9	-17.2	38.4	-16.7	28.5	-26.6
2	Andrus Canyon (ANDRUS)	36.7	10.6	-26.1	25.2	-11.5	10.6	-26.1
3	Bass Camp (BASCMP)	2.2	1.5	-0.7	1.5	-0.7	1.5	-0.7
4	Bat Cave (BATCAV)	37.5	43.1	5.6	33.1	-4.4	43.9	6.4
5	Burnt Springs Canyon (BRNTSP)	15.8	8.2	-7.6	8.2	-7.6	12.5	-3.3
6	Castle Peak (CASTLE)	45.4	22.6	-22.8	28.0	-17.4	22.5	-22.9
7	Kanab Point (KANAPT)	50.8	16.4	-34.4	16.8	-34.0	15.9	-34.9
8	Kelly Point (KELLPT)	2.2	0.2	-2.0	0.2	-2.0	20.0	17.8
9	Mt. Dellenbaugh (MTDELL)	24.4	14.8	-9.6	3.4	-21.0	14.7	-9.7
10	Point Sublime (PTSUBL)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
11	Sanup (SANUP)	85.8	60.8	-25.0	59.5	-26.3	67.3	-18.5
12	Separation Canyon at Colorado River (SCCORV)	1.3	0.0	-1.3	0.0	-1.3	11.4	10.1
13	Separation Canyon (SEPARC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Shivwitz Fire Camp (SHWZFC)	46.7	33.8	-12.9	31.7	-15.0	25.4	-21.3
15	Stone Creek (STONCK)	0.3	0.0	-0.3	0.0	-0.3	0.0	-0.3
16	Suicide Point (SUIPNT)	32.5	42.9	10.4	23.4	-9.1	33.9	1.4
17	Toroweap Overlook (TOROWP)	100.0	65.3	-34.7	71.4	-28.6	44.8	-55.2
18	Tower of Ra (TOWER)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
19	Twin Point (TWINPT)	40.0	49.4	9.4	34.0	-6.0	48.0	8.0
20	Upper Deer Creek (UPDRCK)	71.0	25.2	-45.8	25.4	-45.6	24.8	-46.2
21	West End (WESEND)	12.3	5.1	-7.2	5.1	-7.2	5.8	-6.5

Table A.50

Comparison of $25\%TA_{12h}$ at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, West of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		$25\%TA_{12h}$	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference
22	Coyote Canyon (COYCAN)	32.1	0.0	-32.1	0.0	-32.1	0.0	-32.1
23	Diamond Creek (DIACRK)	0.6	0.0	-0.6	0.0	-0.6	6.9	6.3
24	The Dome (DOME)	34.8	0.0	-34.8	0.0	-34.8	0.0	-34.8
25	Granite Gorge (GRAGOR)	58.5	60.2	1.7	55.1	-3.4	57.9	-0.6
26	Grand Canyon West (GCWEST)	52.4	46.1	-6.3	42.3	-10.1	45.7	-6.7
27	Granite Park (GRNTPK)	2.6	1.3	-1.3	1.3	-1.3	0.0	-2.6
28	Dr. Tommy's Mountain (DRTOMM)	41.3	45.0	3.7	33.5	-7.8	24.9	-16.4
29	Havasu Point (HAVAPT)	12.4	0.0	-12.4	0.0	-12.4	0.0	-12.4
30	Havatagvitch Canyon (HAVCAN)	38.3	2.5	-35.8	5.8	-32.5	2.1	-36.2
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	24.9	11.0	-13.9	11.0	-13.9	18.9	-6.0
33	Meriwhitca (MERIWH)	7.2	3.1	-4.1	3.1	-4.1	7.4	0.2
34	Mohawk Canyon (MOHAWK)	46.8	18.6	-28.2	22.9	-23.9	18.4	-28.4
35	Mohawk Canyon (MOHCAN)	42.4	9.9	-32.5	17.1	-25.3	10.0	-32.4
36	Mount Sinyala (MTSINY)	87.5	25.7	-61.8	30.0	-57.5	24.6	-62.9
37	National Canyon (NATCAN)	32.5	3.3	-29.2	12.0	-20.5	3.3	-29.2
38	Jackson Canyon (JCKCAN/NONAME)	19.4	11.5	-7.9	11.5	-7.9	26.8	7.4
39	Parashant Wash (PARWAS)	33.1	18.0	-15.1	15.4	-17.7	17.9	-15.2
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	48.0	14.0	-34.0	21.8	-26.2	13.9	-34.1
42	Prospect Canyon (PRSPCT)	45.7	30.7	-15.0	35.6	-10.1	23.2	-22.5
43	Peach Spring Canyon North (PSCNNO)	0.7	0.0	-0.7	0.0	-0.7	20.7	20.0
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	7.3	7.1
45	Quartermaster Point (QMPNT)	31.2	33.0	1.8	33.0	1.8	33.9	2.7
46	The Ranch (RANCH)	83.7	86.2	2.5	86.5	2.8	83.7	0.0
47	Spencer/Meriwhitica Canyons (SCMCIG)	4.4	0.6	-3.8	0.6	-3.8	20.9	16.5
48	South Supai Canyon (SOSUPC)	61.2	53.6	-7.6	54.0	-7.2	46.1	-15.1
49	Spencer Canyon (SPENCA)	6.9	2.8	-4.1	2.8	-4.1	18.5	11.6
50	Supai Village (SUPVIL)	38.8	0.0	-38.8	0.0	-38.8	0.0	-38.8
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	13.0	0.0	-13.0	8.8	-4.2	0.0	-13.0
53	96 Mile Camp (96MILE)	57.1	45.6	-11.5	45.6	-11.5	45.4	-11.7

Table A.51

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
North of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
54	The Basin (BASIN)	73.1	46.2	-26.9	46.2	-26.9	46.1	-27.0
55	Bright Angel Point (BRTANG)	6.5	1.9	-4.6	1.9	-4.6	1.9	-4.6
56	Cape Royal (CAPROY)	39.9	29.6	-10.3	29.7	-10.2	29.5	-10.4
57	Cliff Dwellers Lodge (CLDWEL)	1.6	0.8	-0.8	0.8	-0.8	0.8	-0.8
58	Marble Canyon Dam Site (MARBDM)	0.4	0.0	-0.4	0.0	-0.4	0.0	-0.4
59	Nankoweap Mesa (NANMES)	60.6	45.3	-15.3	45.2	-15.4	45.2	-15.4
60	North Canyon (NOCANY)	1.8	1.3	-0.5	1.3	-0.5	1.3	-0.5
61	Point Imperial (PTIMPL)	24.9	19.9	-5.0	19.9	-5.0	19.9	-5.0
62	Saddle Mountain (SADMTN)	7.2	7.0	-0.2	7.0	-0.2	7.0	-0.2
63	South Canyon (SOCAN)	2.6	1.4	-1.2	1.4	-1.2	1.4	-1.2
64	Temple Butte (TEMBUT)	62.9	45.1	-17.8	45.2	-17.7	45.0	-17.9

Table A.52

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Commercial Air Tour Limitations
South of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
65	Cedar Ridge (CEDRIG)	100.0	80.6	-19.4	80.9	-19.1	79.7	-20.3
66	Lipan Point (LIPAN)	23.1	20.8	-2.3	20.9	-2.2	20.7	-2.4
67	Little Colorado (LITCOL)	8.3	5.4	-2.9	5.4	-2.9	5.4	-2.9
68	Little Colorado River (LTCORV)	17.4	5.6	-11.8	5.6	-11.8	5.6	-11.8
69	Nankoweap at river (NANRIV)	6.8	1.1	-5.7	1.1	-5.7	1.1	-5.7
70	Ten X Meadow (TENMED)	24.7	19.3	-5.4	19.6	-5.1	19.2	-5.5
71	Zuni Alpha (ZUNALF)	6.3	6.6	0.3	6.6	0.3	6.6	0.3
72	Zuni Charlie (ZUNCHR)	62.6	43.4	-19.2	43.4	-19.2	43.3	-19.3

Table A.53

Comparison of $25\%TA_{12h}$ at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, West of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		$25\%TA_{12h}$	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference	$25\%TA_{12h}$	Difference
1	NPS Admin Site (ADMIN)	55.1	53.1	-2.0	53.9	-1.2	40.2	-14.9
2	Andrus Canyon (ANDRUS)	36.7	14.9	-21.8	35.5	-1.2	14.9	-21.8
3	Bass Camp (BASCMP)	2.2	2.1	-0.1	2.1	-0.1	2.1	-0.1
4	Bat Cave (BATCAV)	37.5	59.9	22.4	45.7	8.2	60.9	23.4
5	Burnt Springs Canyon (BRNTSP)	15.8	11.4	-4.4	11.4	-4.4	17.2	1.4
6	Castle Peak (CASTLE)	45.4	31.9	-13.5	39.5	-5.9	31.7	-13.7
7	Kanab Point (KANAPT)	50.8	22.7	-28.1	23.3	-27.5	22.0	-28.8
8	Kelly Point (KELLPT)	2.2	0.2	-2.0	0.2	-2.0	27.7	25.5
9	Mt. Dellenbaugh (MTDELL)	24.4	20.8	-3.6	4.7	-19.7	20.7	-3.7
10	Point Sublime (PTSUBL)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
11	Sanup (SANUP)	85.8	84.9	-0.9	83.1	-2.7	93.9	8.1
12	Separation Canyon at Colorado River (SCCORV)	1.3	0.0	-1.3	0.0	-1.3	15.7	14.4
13	Separation Canyon (SEPARC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Shivwitz Fire Camp (SHWZFC)	46.7	47.5	0.8	44.5	-2.2	35.8	-10.9
15	Stone Creek (STONCK)	0.3	0.0	-0.3	0.0	-0.3	0.0	-0.3
16	Suicide Point (SUIPNT)	32.5	59.8	27.3	32.4	-0.1	47.4	14.9
17	Toroweap Overlook (TOROWP)	100.0	91.4	-8.6	100.0	0.0	63.1	-36.9
18	Tower of Ra (TOWER)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
19	Twin Point (TWINPT)	40.0	68.8	28.8	47.0	7.0	66.8	26.8
20	Upper Deer Creek (UPDRCK)	71.0	34.9	-36.1	35.2	-35.8	34.4	-36.6
21	West End (WESEND)	12.3	7.0	-5.3	7.0	-5.3	8.1	-4.2

Table A.54

Comparison of 25%TA_{12h} at Representative Locations in GCNP Considering Continued Growth South of Colorado River, West of GC Airport 2008

	Location	No Action (Alt. 1) 25%TA_{12h}	Alternative 2 25%TA_{12h}	Alternative 2 Difference	Alternative 3 25%TA_{12h}	Alternative 3 Difference	Alternative 4 25%TA_{12h}	Alternative 4 Difference
22	Coyote Canyon (COYCAN)	32.1	0.0	-32.1	0.0	-32.1	0.0	-32.1
23	Diamond Creek (DIACRK)	0.6	0.0	-0.6	0.0	-0.6	9.6	9.0
24	The Dome (DOME)	34.8	0.0	-34.8	0.0	-34.8	0.0	-34.8
25	Granite Gorge (GRAGOR)	58.5	83.7	25.2	76.5	18.0	80.6	22.1
26	Grand Canyon West (GCWEST)	52.4	63.8	11.4	58.6	6.2	63.2	10.8
27	Granite Park (GRNTPK)	2.6	1.8	-0.8	1.8	-0.8	0.0	-2.6
28	Dr. Tommy's Mountain (DRTOMM)	41.3	62.9	21.6	46.6	5.3	35.1	-6.2
29	Havasu Point (HAVAPT)	12.4	0.0	-12.4	0.0	-12.4	0.0	-12.4
30	Havatagvitch Canyon (HAVCAN)	38.3	3.5	-34.8	8.0	-30.3	2.8	-35.5
31	Hermit Basin (HBASIN)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
32	Horse Flat Canyon (HFCAN)	24.9	15.3	-9.6	15.3	-9.6	26.2	1.3
33	Meriwhitca (MERIWH)	7.2	4.3	-2.9	4.3	-2.9	10.3	3.1
34	Mohawk Canyon (MOHAWK)	46.8	26.2	-20.6	32.3	-14.5	25.9	-20.9
35	Mohawk Canyon (MOHCAN)	42.4	14.0	-28.4	24.1	-18.3	14.0	-28.4
36	Mount Sinyala (MTSINY)	87.5	35.7	-51.8	41.9	-45.6	34.2	-53.3
37	National Canyon (NATCAN)	32.5	4.5	-28.0	16.9	-15.6	4.5	-28.0
38	Jackson Canyon (JCKCAN/NONAME)	19.4	15.9	-3.5	15.9	-3.5	37.0	17.6
39	Parashant Wash (PARWAS)	33.1	25.3	-7.8	21.8	-11.3	25.2	-7.9
40	Pumpkin Springs (PMPKIN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Prospect Canyon (PROCAN)	48.0	19.7	-28.3	30.8	-17.2	19.6	-28.4
42	Prospect Canyon (PRSPCT)	45.7	43.1	-2.6	50.0	4.3	32.8	-12.9
43	Peach Spring Canyon North (PSCNNO)	0.7	0.0	-0.7	0.0	-0.7	28.6	27.9
44	Peach Spring Canyon South (PSCNSO)	0.2	0.0	-0.2	0.0	-0.2	10.0	9.8
45	Quartermaster Point (QMPNT)	31.2	45.7	14.5	45.7	14.5	46.9	15.7
46	The Ranch (RANCH)	83.7	100.0	16.3	100.0	16.3	100.0	16.3
47	Spencer/Meriwhitica Canyons (SCMCIG)	4.4	0.9	-3.5	0.9	-3.5	28.9	24.5
48	South Supai Canyon (SOSUPC)	61.2	74.9	13.7	75.5	14.3	64.5	3.3
49	Spencer Canyon (SPENCA)	6.9	3.8	-3.1	3.8	-3.1	25.5	18.6
50	Supai Village (SUPVIL)	38.8	0.0	-38.8	0.0	-38.8	0.0	-38.8
51	Three Springs Rapids (THRSPR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Whitmore Rapids (WHTRAP)	13.0	0.0	-13.0	12.4	-0.6	0.0	-13.0
53	96 Mile Camp (96MILE)	57.1	63.0	5.9	63.1	6.0	62.8	5.7

Table A.55

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
North of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
54	The Basin (BASIN)	73.1	64.0	-9.1	64.0	-9.1	63.7	-9.4
55	Bright Angel Point (BRTANG)	6.5	2.6	-3.9	2.6	-3.9	2.6	-3.9
56	Cape Royal (CAPROY)	39.9	41.0	1.1	41.1	1.2	40.8	0.9
57	Cliff Dwellers Lodge (CLDWEL)	1.6	1.1	-0.5	1.1	-0.5	1.1	-0.5
58	Marble Canyon Dam Site (MARBDM)	0.4	0.0	-0.4	0.0	-0.4	0.0	-0.4
59	Nankoweap Mesa (NANMES)	60.6	62.7	2.1	62.6	2.0	62.6	2.0
60	North Canyon (NOCANY)	1.8	1.8	0.0	1.8	0.0	1.8	0.0
61	Point Imperial (PTIMPL)	24.9	27.6	2.7	27.6	2.7	27.5	2.6
62	Saddle Mountain (SADMTN)	7.2	9.7	2.5	9.7	2.5	9.7	2.5
63	South Canyon (SOCAN)	2.6	2.0	-0.6	2.0	-0.6	2.0	-0.6
64	Temple Butte (TEMBUT)	62.9	62.4	-0.5	62.5	-0.4	62.3	-0.6

Table A.56

Comparison of 25%TA_{12h} at Representative Locations in GCNP
Considering Continued Growth
South of Colorado River, East of GC Airport
2008

	Location	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		25%TA_{12h}	25%TA_{12h}	Difference	25%TA_{12h}	Difference	25%TA_{12h}	Difference
65	Cedar Ridge (CEDRIG)	100.0	100.0	0.0	100.0	0.0	100.0	0.0
66	Lipan Point (LIPAN)	23.1	28.8	5.7	28.9	5.8	28.7	5.6
67	Little Colorado (LITCOL)	8.3	7.5	-0.8	7.5	-0.8	7.5	-0.8
68	Little Colorado River (LTCORV)	17.4	7.8	-9.6	7.8	-9.6	7.8	-9.6
69	Nankoweap at river (NANRIV)	6.8	1.6	-5.2	1.6	-5.2	1.6	-5.2
70	Ten X Meadow (TENMED)	24.7	26.8	2.1	27.2	2.5	26.6	1.9
71	Zuni Alpha (ZUNALF)	6.3	9.1	2.8	9.1	2.8	9.1	2.8
72	Zuni Charlie (ZUNCHR)	62.6	60.0	-2.6	60.1	-2.5	59.9	-2.7

Table A.57

Square Mile Area Covered by L_{Aeq12h} Contours (20-60)
1998 (Base)

Analysis	Contour Level (dB)	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
	20	4539.7	3722.39	-18	3881.38	-14.5	4319.63	-4.85
W	30	2018.46	1632.01	-19.15	1690.95	-16.23	1773.45	-12.14
I	40	532.97	455.4	-14.55	436.64	-18.07	439.22	-17.59
D	50	26.19	28.82	10.04	28.89	10.31	28.82	10.04
E	60	3.24	3.52	8.64	3.58	10.49	3.49	7.72
	20	1572.85	1110.72	-29.38	1111.2	-29.35	1198.62	-23.79
G	30	644.33	558.02	-13.4	523.81	-18.7	560.9	-12.95
C	40	138.04	120.53	-12.68	107.65	-22.02	128.86	-6.65
N	50	3.75	2.44	-34.93	2.44	-34.93	2.52	-32.8
P	60	0.04	0	-100	0	-100	0	-100

Table A.58

Square Mile Area Covered by L_{Aeq12h} Contours (20-60)
Considering Commercial Air Tour Limitations
2000

Analysis	Contour Level (dB)	No Action (Alt. 1(	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
	20	4616.23	3722.39	-19.36	3881.38	-15.92	4319.63	-6.43
W	30	2078.16	1632.01	-21.47	1690.95	-18.63	1773.45	-14.66
I	40	561.11	455.40	-18.84	436.64	-22.18	439.22	-21.72
D	50	28.82	28.82	0.00	28.89	0.24	28.82	0.00
E	60	3.40	3.52	3.53	3.58	5.29	3.49	2.65
	20	1594.31	1110.72	-30.33	1111.20	-30.30	1198.62	-24.82
G	30	667.07	558.02	-16.35	523.81	-21.48	560.90	-15.92
C	40	146.42	120.53	-17.68	107.65	-26.48	128.86	-11.99
N	50	4.46	2.44	-45.29	2.44	-45.29	2.52	-43.50
P	60	0.04	0.00	-100.00	0.00	-100.00	0.00	-100.00

Table A.59

Square Mile Area Covered by L_{Aeq12h} Contours (20-60)
Considering Continued Growth
2000

Analysis	Contour Level (dB)	No Action (Alt.1)	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
	20	4616.23	3808.28	-17.5	3965.71	-14.09	4421.95	-4.21
W	30	2078.16	1673.17	-19.49	1740.66	-16.24	1826.43	-12.11
I	40	561.11	484.96	-13.57	468.22	-16.55	469.94	-16.25
D	50	28.82	30.71	6.56	30.76	6.73	30.75	6.7
E	60	3.4	3.7	8.82	3.77	10.88	3.66	7.65
	20	1594.31	1124.6	-29.46	1125.3	-29.42	1214.03	-23.85
G	30	667.07	571.2	-14.37	539.69	-19.1	577.09	-13.49
C	40	146.42	129.51	-11.55	114.63	-21.71	137.68	-5.97
N	50	4.46	2.88	-35.43	2.88	-35.43	2.99	-32.96
P	60	0.04	0	-100	0	-100	0	-100

Table A.60

Square Mile Area Covered by L_{Aeq12h} Contours (20-60)
Considering Commercial Air Tour Limitations
2008

Analysis	Contour Level (dB)	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
	20	4904.07	3722.39	-24.10	3881.38	-20.85	4319.63	-11.92
W	30	2323.70	1632.01	-29.77	1690.95	-27.23	1773.45	-23.68
I	40	675.58	455.40	-32.59	436.64	-35.37	439.22	-34.99
D	50	42.81	28.82	-32.68	28.89	-32.52	28.82	-32.68
E	60	4.12	3.52	-14.56	3.58	-13.11	3.49	-15.29
	20	1653.95	1110.72	-32.84	1111.20	-32.82	1198.62	-27.53
G	30	759.94	558.02	-26.57	523.81	-31.07	560.90	-26.19
C	40	180.46	120.53	-33.21	107.65	-40.35	128.86	-28.59
N	50	7.64	2.44	-68.06	2.44	-68.06	2.52	-67.02
P	60	0.06	0.00	-100.00	0.00	-100.00	0.00	-100.00

Table A.61

Square Mile Area Covered by L_{Aeq12h} Contours (20-60)
Considering Continued Growth
2008

Analysis	Contour Level (dB)	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
		Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	20	4904.07	4147.1	-15.44	4299.2	-12.33	4825.14	-1.61
	30	2323.7	1836.94	-20.95	1936.29	-16.67	2033.76	-12.48
	40	675.58	596.71	-11.67	587.27	-13.07	588.65	-12.87
	50	42.81	39.76	-7.12	39.79	-7.05	39.98	-6.61
	60	4.12	4.47	8.5	4.55	10.44	4.42	7.28
GCNP	20	1653.95	1177.37	-28.81	1177.96	-28.78	1277.94	-22.73
	30	759.94	624.99	-17.76	603.18	-20.63	641.15	-15.63
	40	180.46	166.52	-7.72	147.1	-18.49	174.87	-3.1
	50	7.64	5.03	-34.16	5	-34.55	5.36	-29.84
	60	0.06	0	-100	0	-100	0	-100

Table A.62

Square Mile Area Where $\%TA_{12h}$ is Greater Than 25%
1998 (Base)

Analysis	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	2821.48	2568.46	-8.97	2638.80	-6.47	2447.31	-13.26
GCNP	1283.96	1107.11	-13.77	1100.56	-14.28	1103.40	-14.06

Table A.63

Square Mile Area Where $\%TA_{12h}$ is Greater Than 25%
Considering Commercial Air Tour Limitations
2000

Analysis	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	2979.89	2568.46	-13.81	2638.80	-11.45	2447.31	-17.87
GCNP	1308.87	1107.11	-15.41	1100.56	-15.92	1103.40	-15.70

Table A.64

Square Mile Area Where $\%TA_{12h}$ is Greater Than 25%
Considering Continued Growth
2000

Analysis	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	2979.89	2680.72	-10.04	2772.16	-6.97	2624.52	-11.93
GCNP	1308.87	1148.45	-12.26	1143.98	-12.60	1154.19	-11.82

Table A.65

Square Mile Area Where %TA_{12h} is Greater Than 25%
Considering Commercial Air Tour Limitations
2008

	No Action (Alt. 1)	Alternative 2		Alternative 3		Alternative 4	
Analysis	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	3419.2	2568.46	-24.88	2638.8	-22.82	2447.31	-28.42
GCNP	1410.07	1107.11	-21.49	1100.56	-21.95	1103.4	-21.75

Table A.66

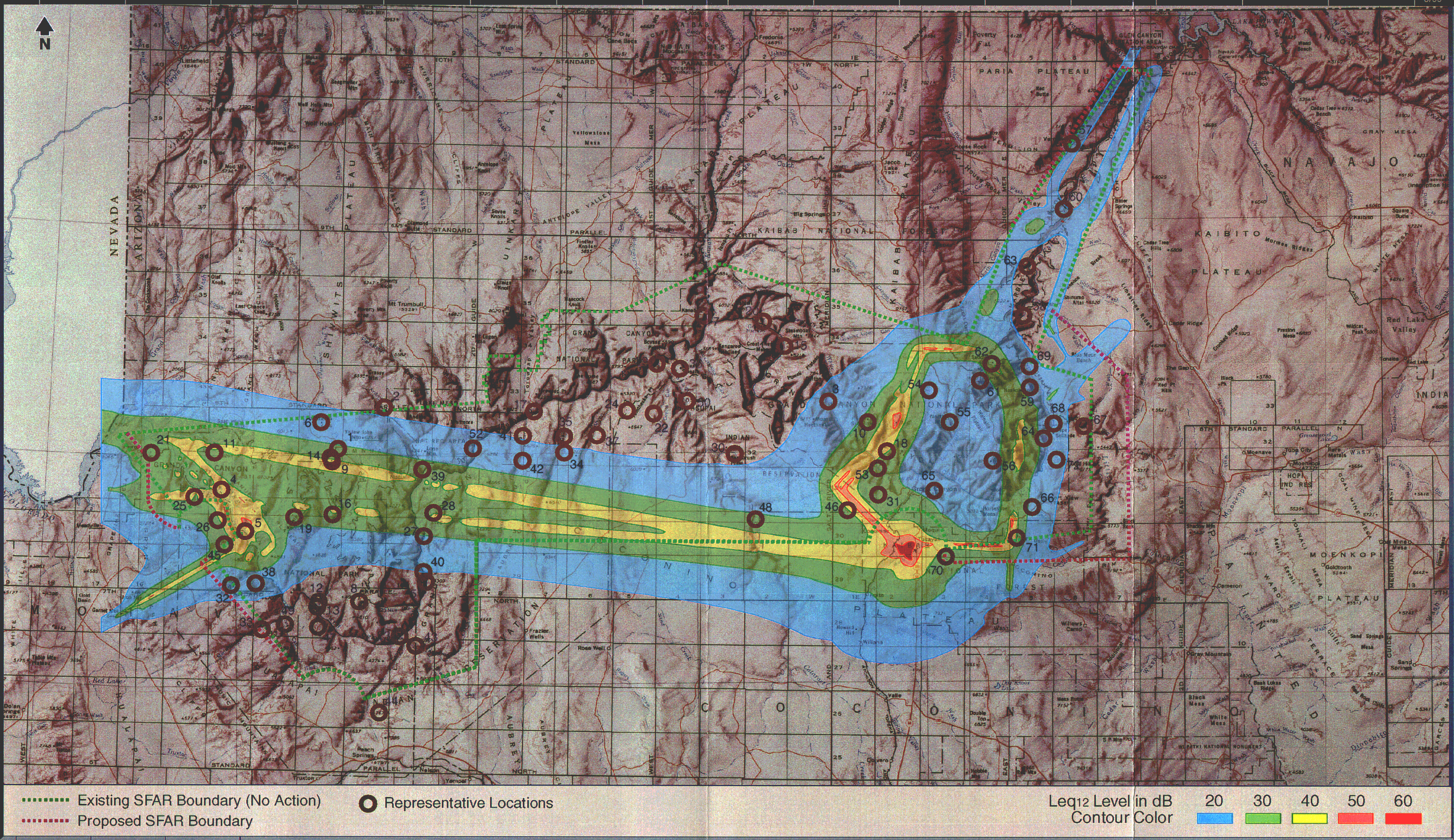
Square Mile Area Where %TA_{12h} is Greater Than 25%
Considering Continued Growth
2008

	No Action (Alt.1)	Alternative 2		Alternative 3		Alternative 4	
Analysis	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
WIDE	3419.20	3126.18	-8.57	3285.78	-3.90	3486.74	1.98
GCNP	1410.07	1341.58	-4.86	1358.12	-3.68	1400.56	-0.67

2003 Alternative 2 With Commercial Air Tour Limitations
Leq_{12h} Contours

FIGURE A-1

6/99

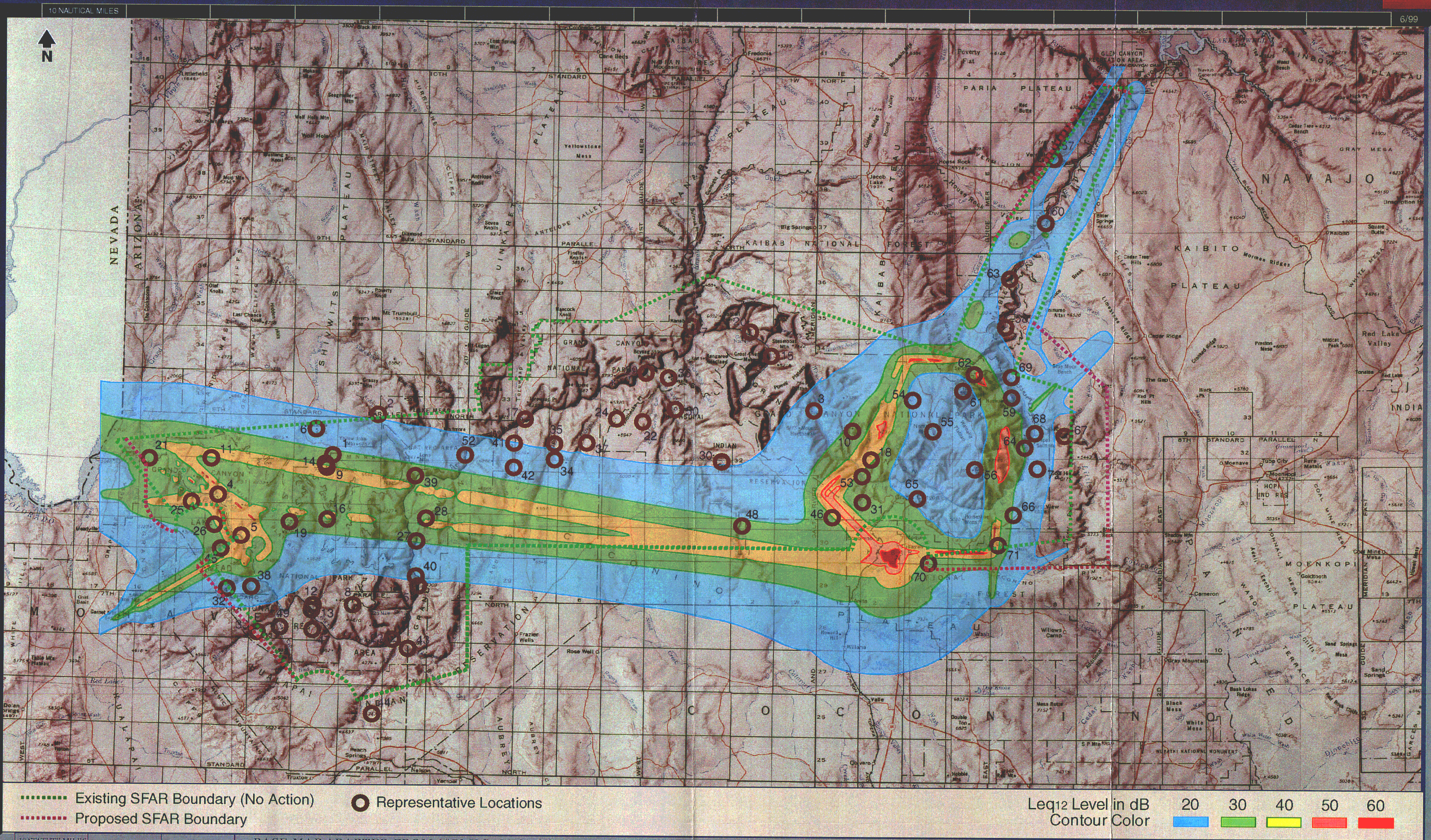


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

2003 Alternative 2 With Continued Growth Leq_{12h} Contours

FIGURE A-2



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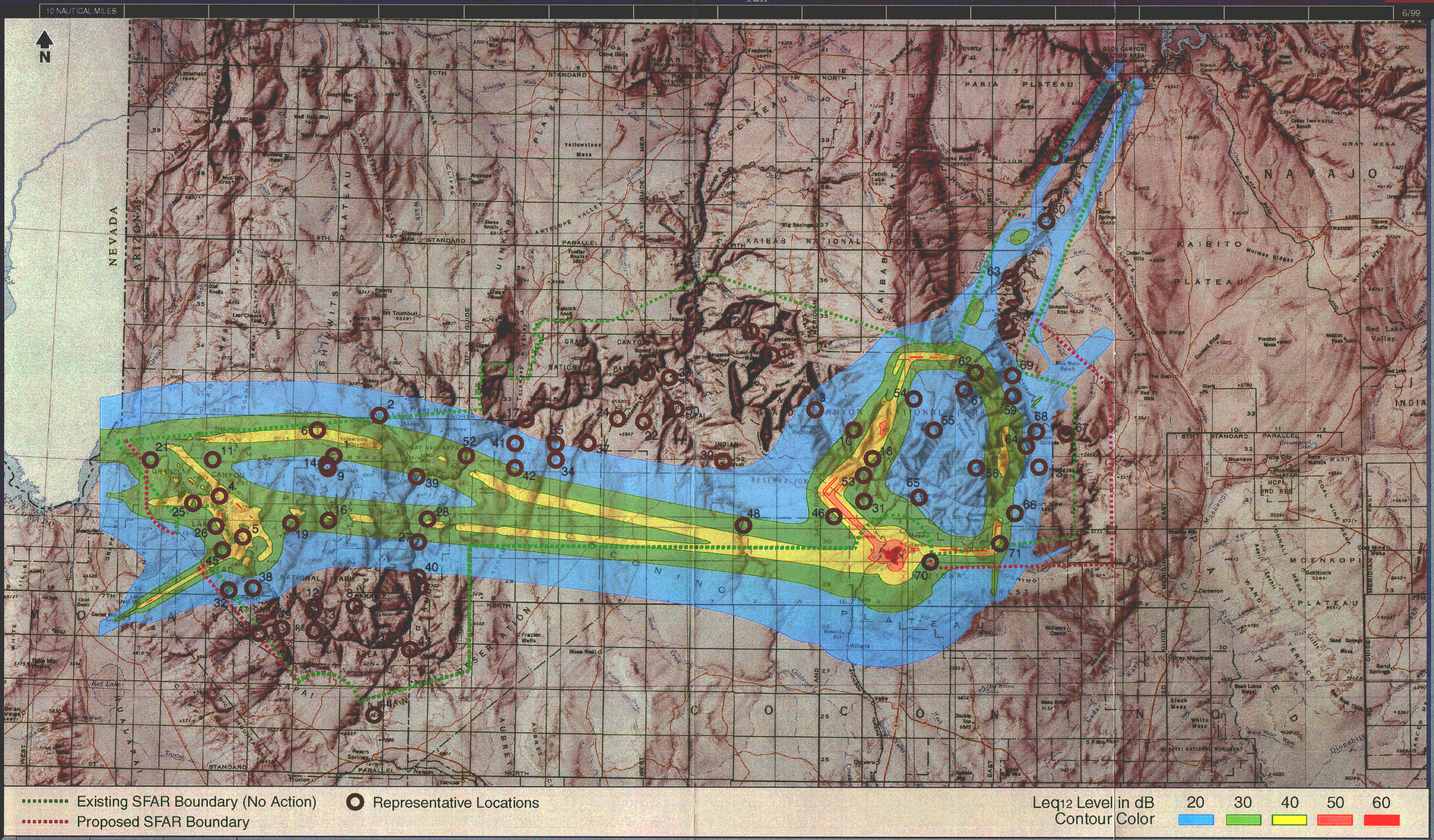
PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Supplemental Environmental Assessment

2003 Alternative 3 With Commercial Air Tour Limitations
Leq $_{12h}$ Contours

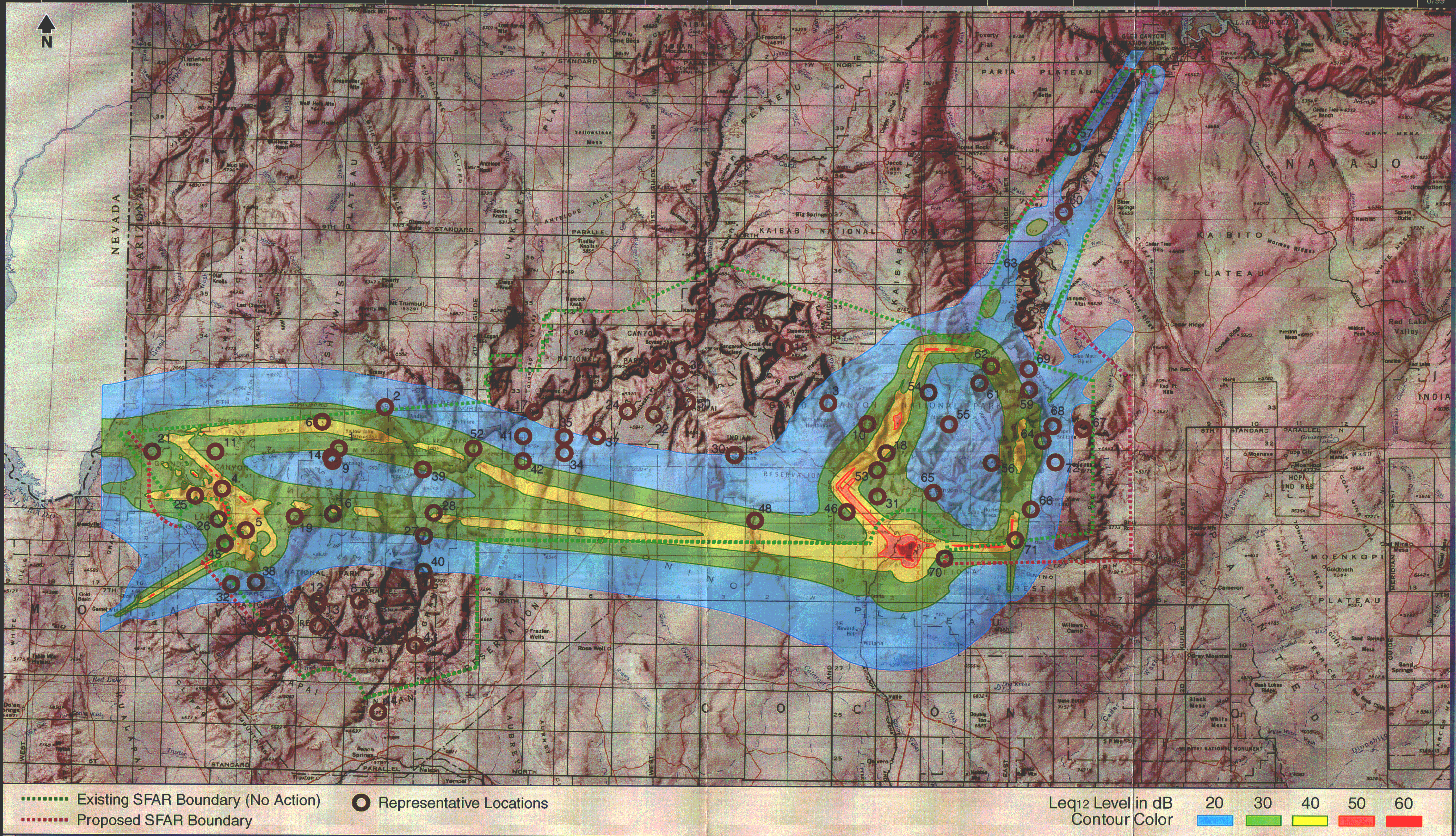
FIGURE A-3



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

FIGURE A-4

2003 Alternative 3 With Continued Growth Leq_{12h} Contours

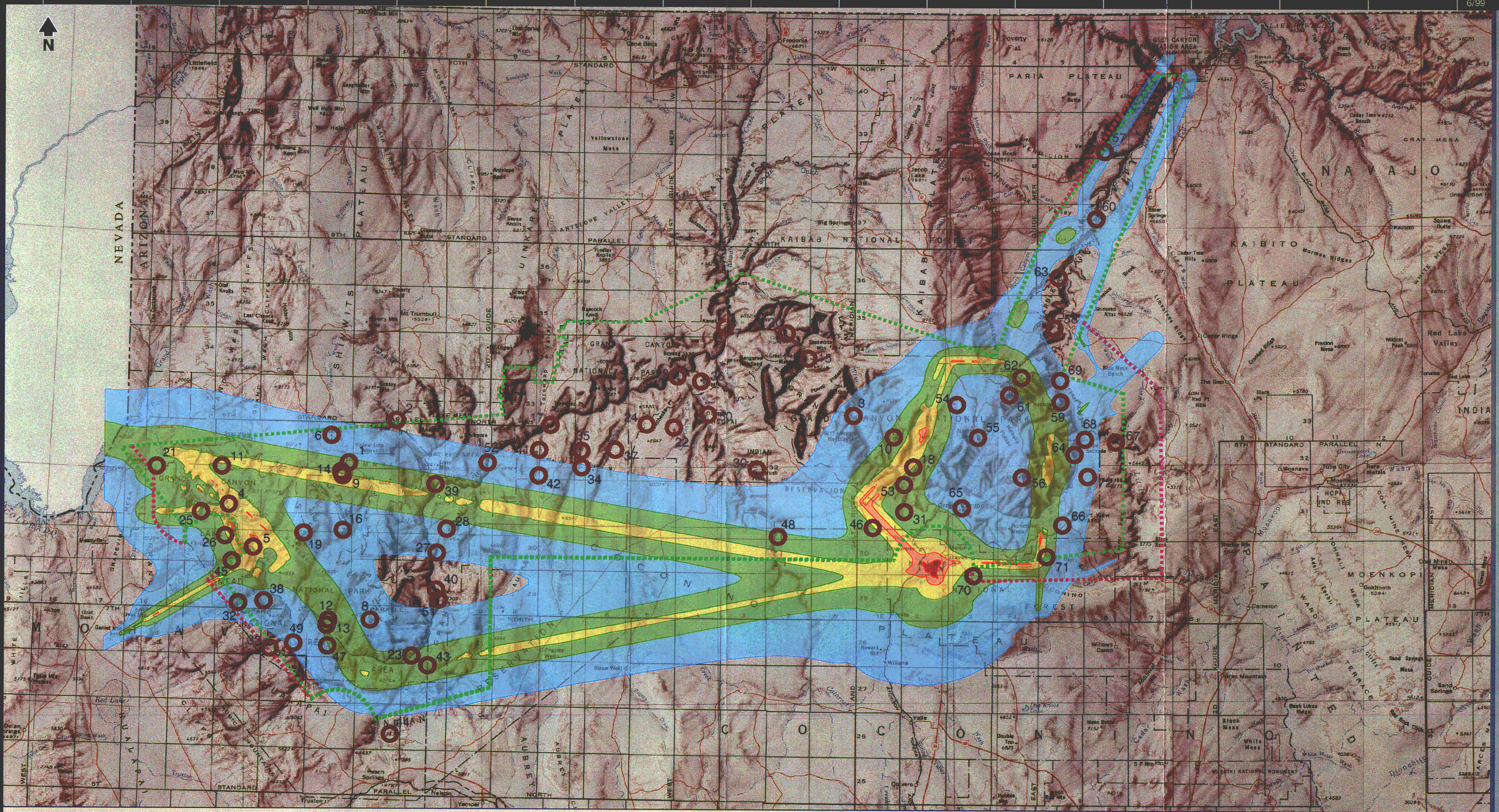


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

2003 Alternative 4 With Commercial Air Tour Limitations
Leq_{12h} Contours

FIGURE A-5



Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Representative Locations

Leq_{12} Level in dB Contour Color: 20, 30, 40, 50, 60

10 STATUTE MILES

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

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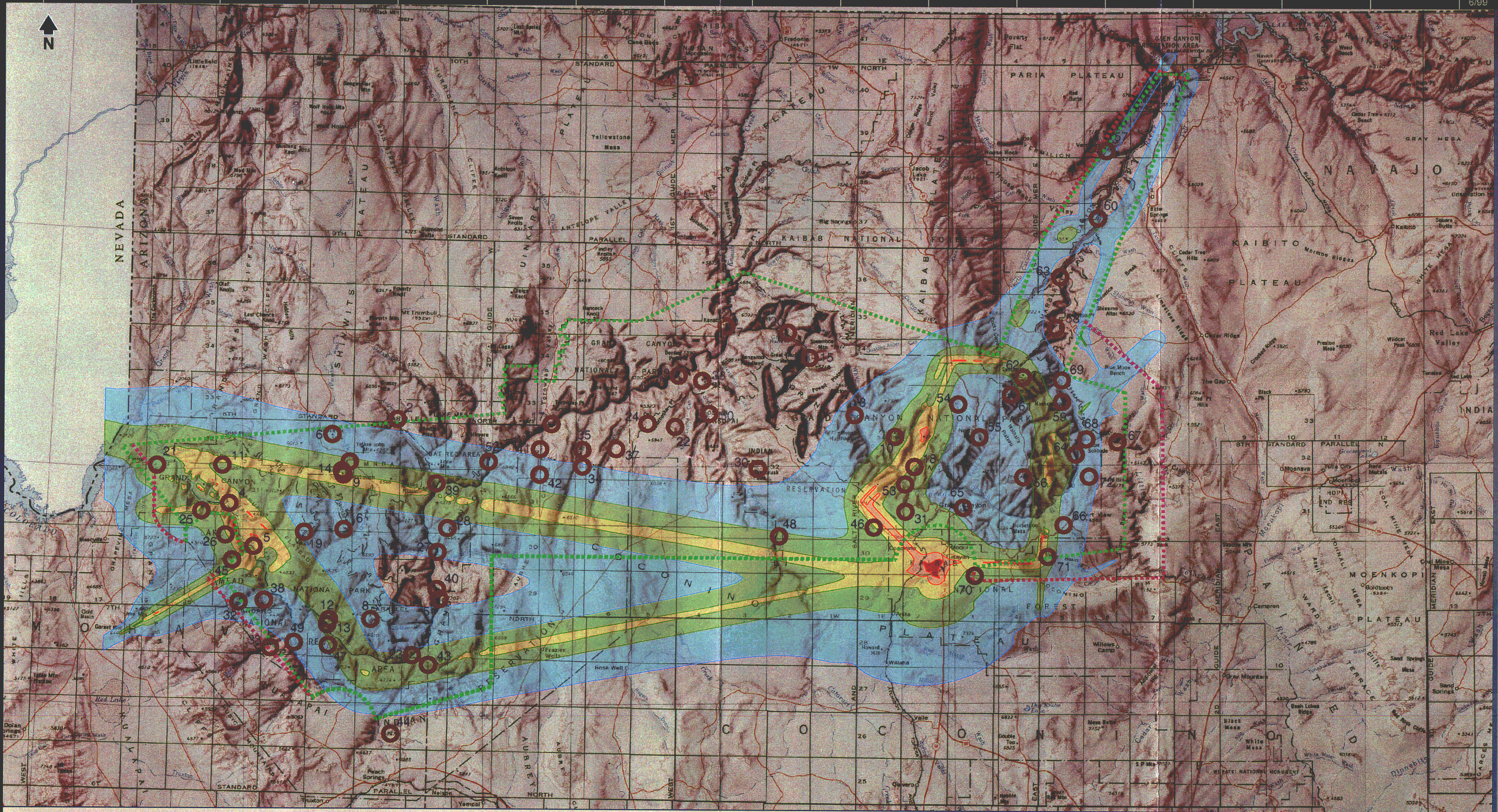
2003 Alternative 4 With Continued Growth Leq_{12h} Contours

FIGURE A-6



Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Representative Locations

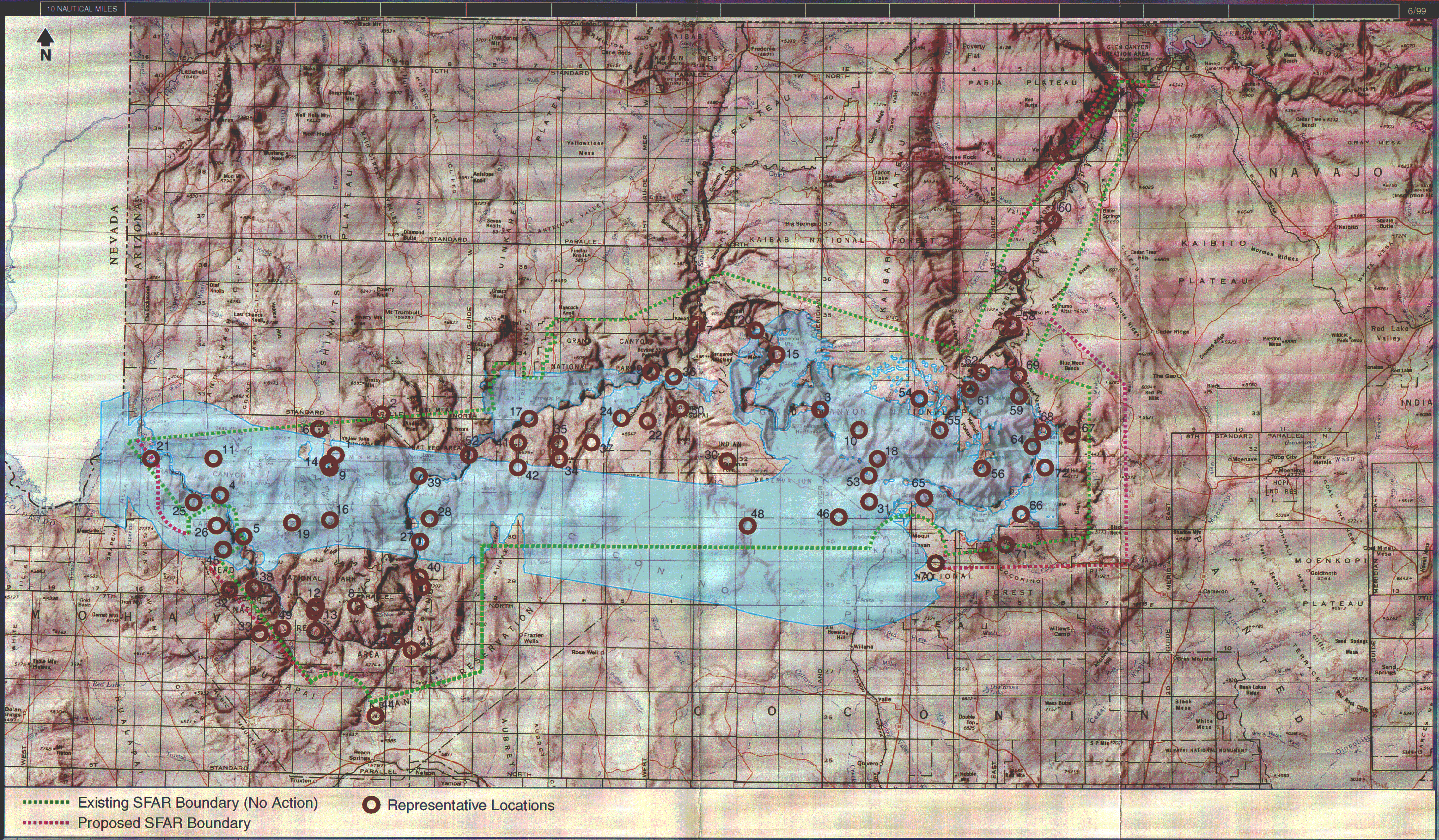
Leq12 Level in dB	20	30	40	50	60
Contour Color	blue	green	yellow	light red	red

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

2003 Alternative 2 With Commercial Air Tour Limitations
Aircraft Audible More Than 25% of Time Contour

FIGURE A-7



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

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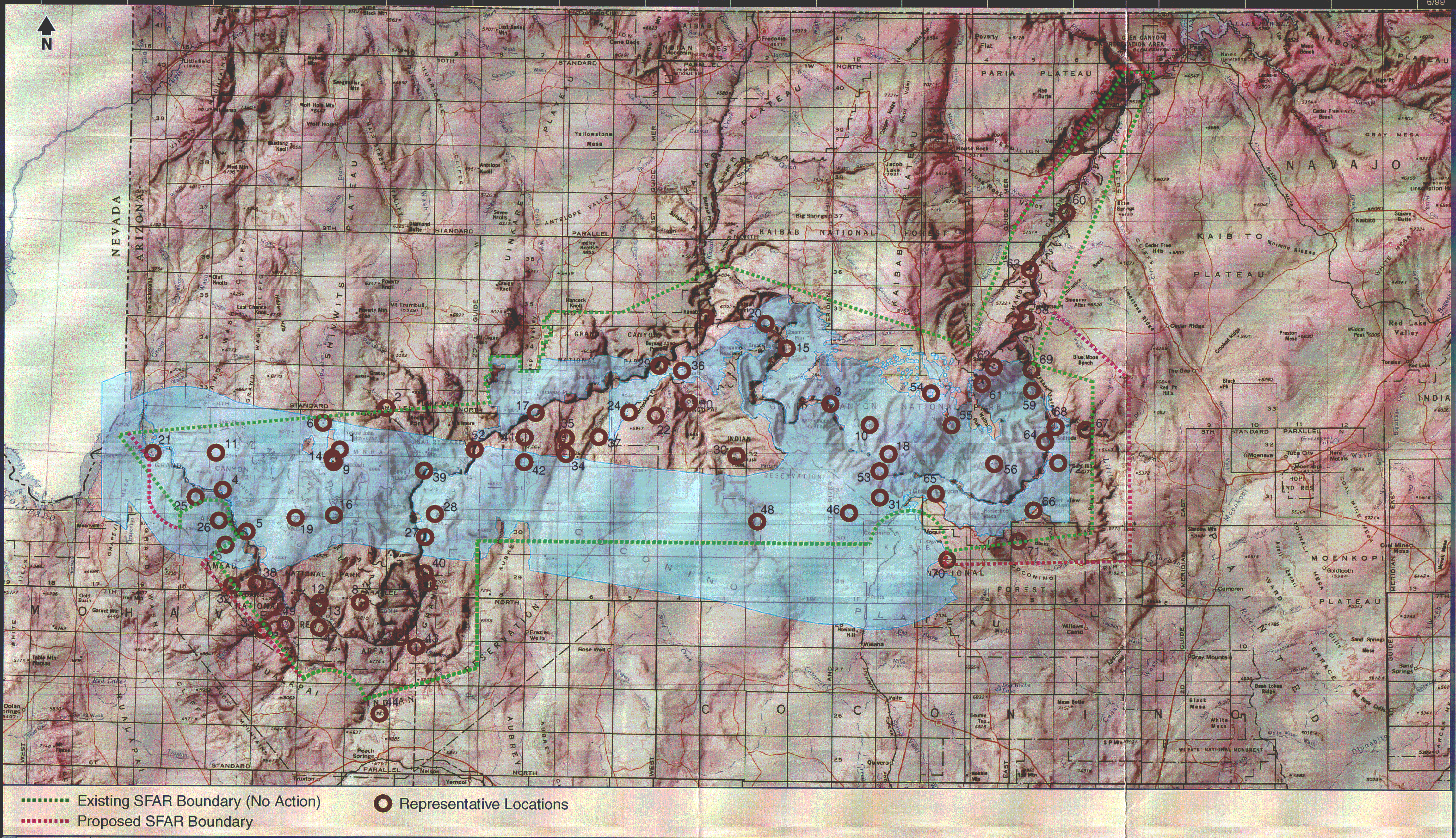
2003 Alternative 2 With Continued Growth Aircraft Audible More Than 25% of Time Contour

FIGURE A-8



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

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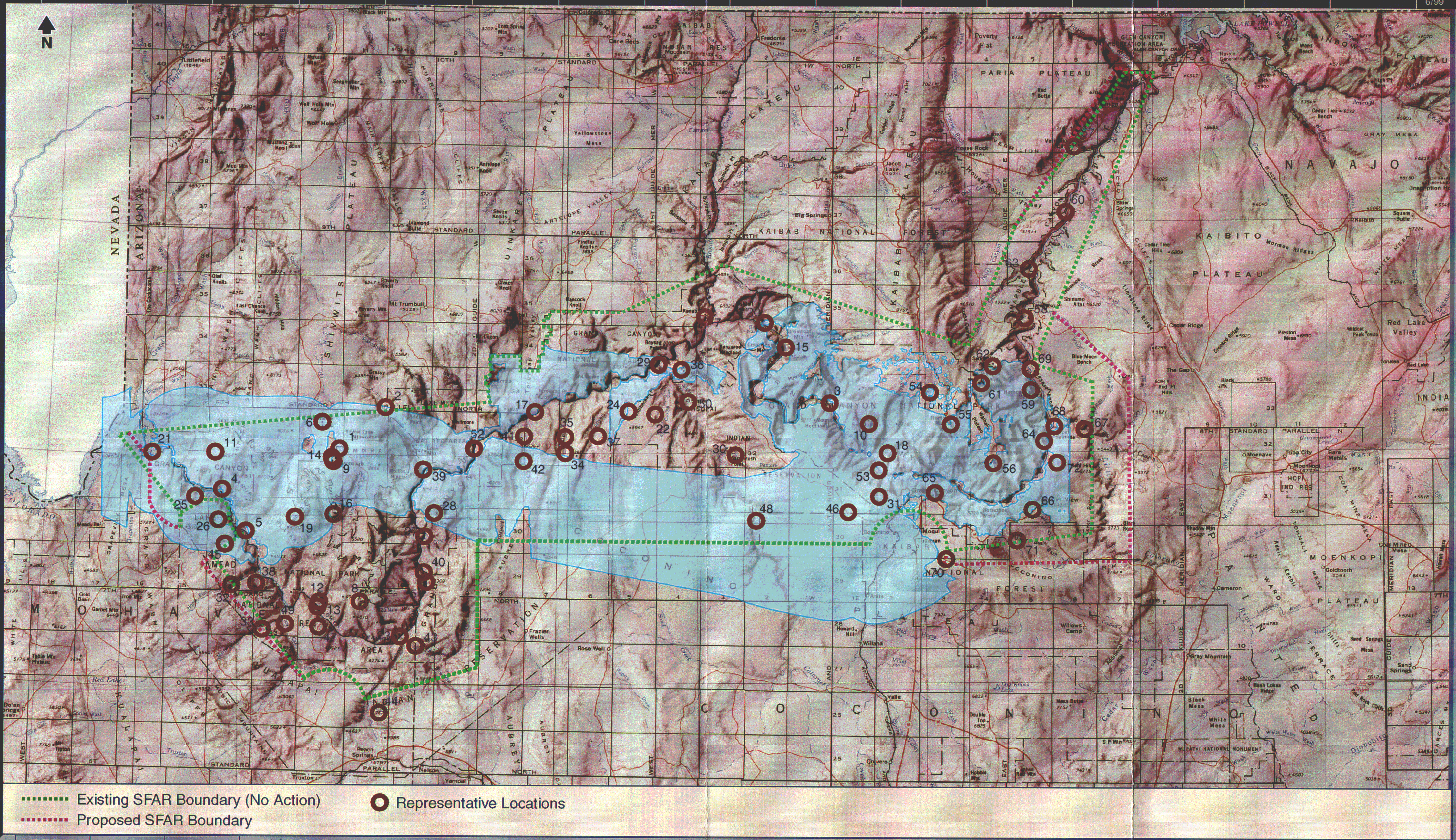
2003 Alternative 3 With Commercial Air Tour Limitations
Aircraft Audible More Than 25% of Time Contour

FIGURE A-9



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

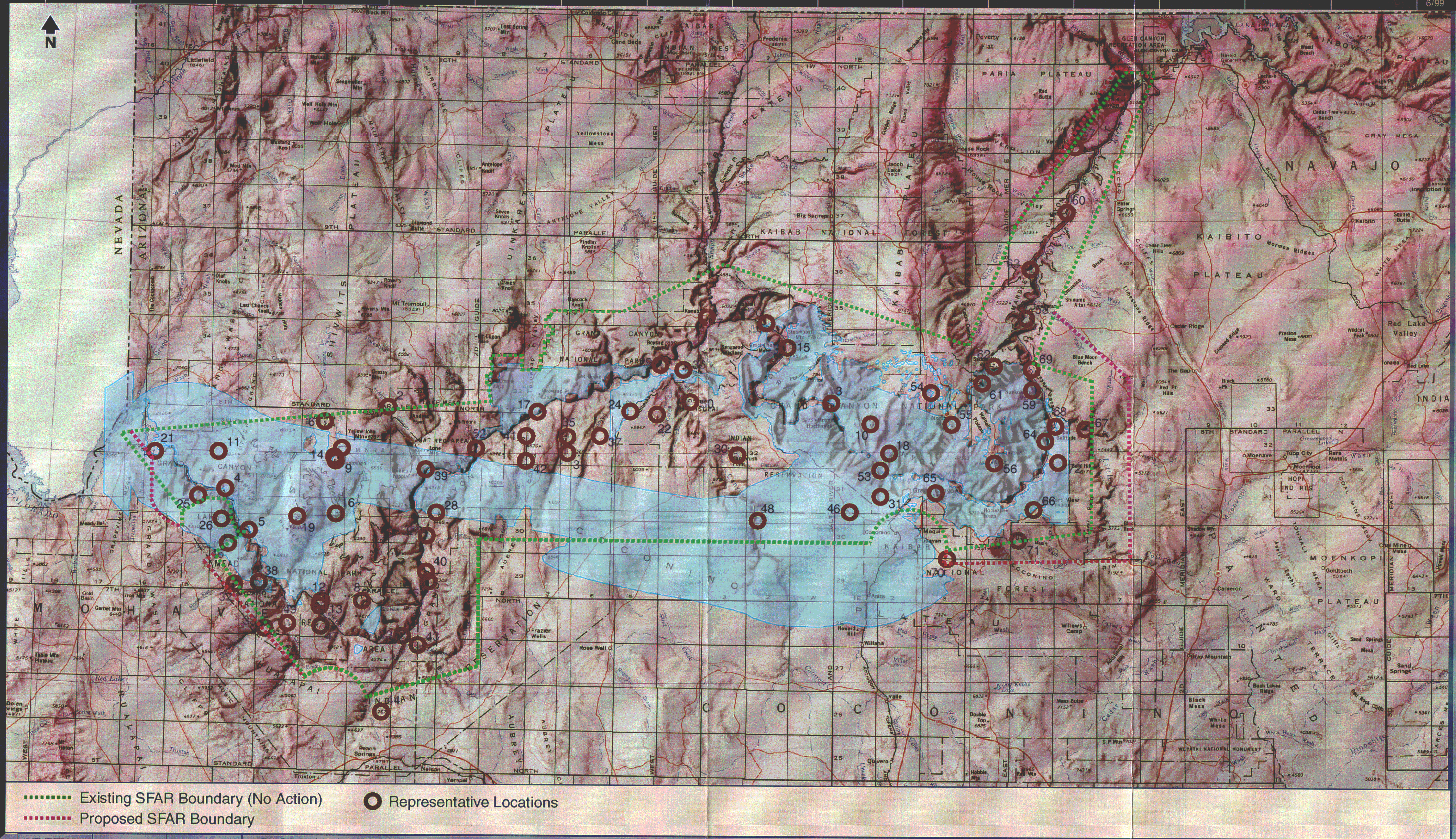
2003 Alternative 3 With Continued Growth Aircraft Audible More Than 25% of Time Contour

FIGURE A-10

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

2003 Alternative 4 With Commercial Air Tour Limitations
Aircraft Audible More Than 25% of Time Contour

FIGURE A-11

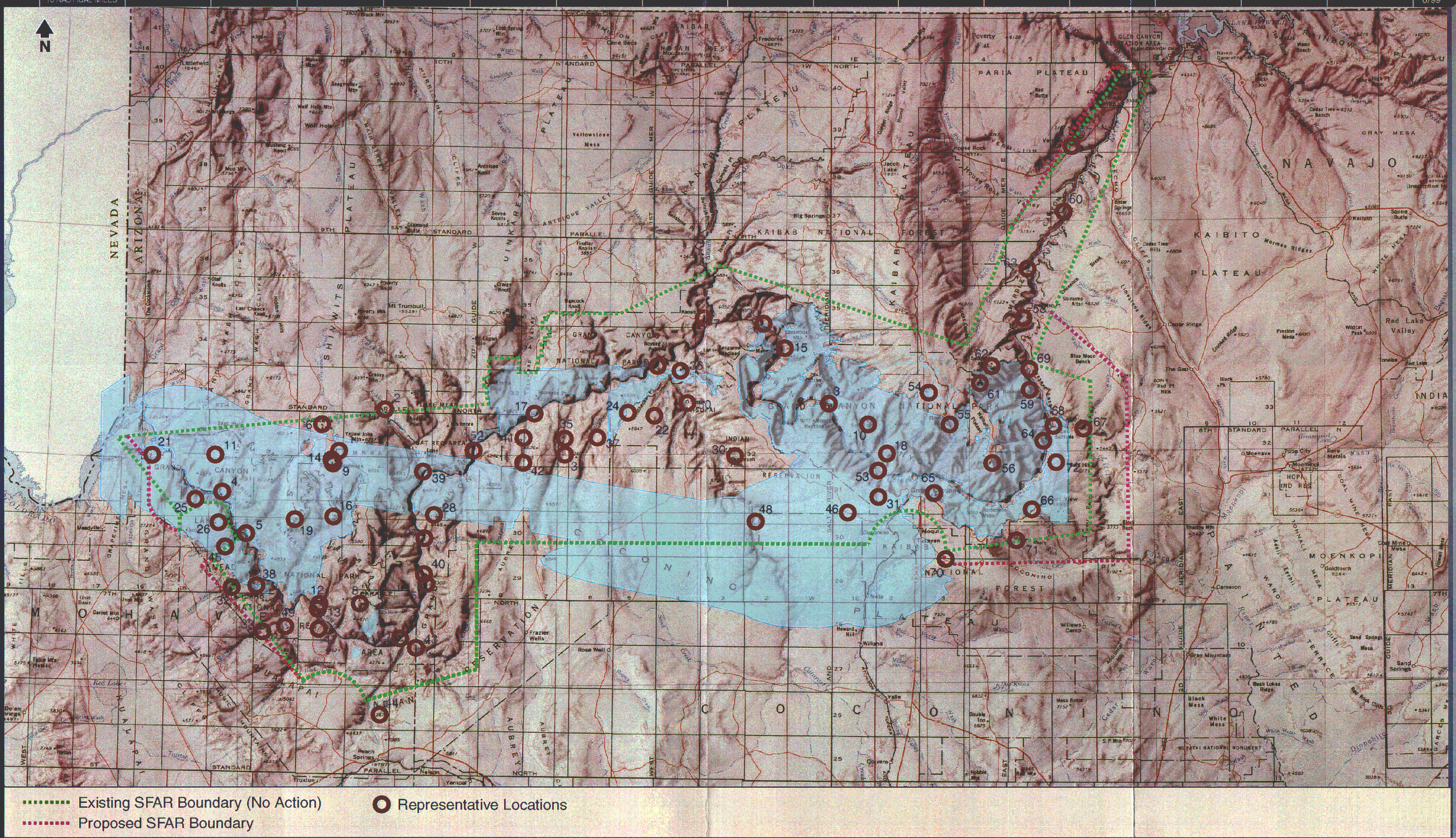


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

2003 Alternative 4 With Continued Growth Aircraft Audible More Than 25% of Time Contour

FIGURE A-12



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

APPENDIX B

GLOSSARY

GLOSSARY

A-weighted Decibel (dBA) -- An acoustic unit of measure which approximates the frequency response of the human ear.

A-weighting -- The sound pressure level which has been filtered or weighted to approximate the human ear's perception of sound.

AEE -- FAA Office of Environment and Energy.

AEM -- Area Equivalent Method.

AGL -- Above Ground Level.

Air Carrier -- A company engaged in providing scheduled commercial air transportation services.

Air Route Traffic Control Center (ARTCC) -- An FAA facility established to provide air traffic control service to aircraft operating on an IFR flight plan within controlled airspace during the en route portion of a flight.

Air Traffic Control (ATC) -- Division of the Federal Aviation Administration responsible for the safe guiding of pilots in their transit of airspace and on the ground at towered airports.

Airport Master Plan -- A long-term (usually 20-year) comprehensive development plan for an airport. Typical elements of a Master Plan include: activity forecasts, airport layout plan, development recommendations with cost estimates and an environmental overview.

Approach Control Descent Area (ACDA) -- Airspace restrictions established to provide for the separation of landing aircraft from departing aircraft.

Approach Procedure -- A general procedure for how an aircraft comes in for a landing at an airport. Includes both visual and instrument approaches.

Day-Night Average Sound Level (DNL or L_{dn}) -- The Federal Aviation Administration's standard noise descriptor, measured in A-weighted decibels (dBA), that represents a cumulative, integrated, average sound level. Based on the equivalent A-weighted sound level (L_{eq}) with a 10-decibel penalty for noise events in the nighttime hours (10 p.m. to 7 a.m.).

dB -- See Decibel.

dBA -- See A-weighted Decibel.

Decibel (dB) -- The smallest unit of measure of acoustic energy that a person can distinguish. A doubling of loudness is generally approximated by a change of about 10 decibels. A doubling of acoustic energy occurs at 3 decibels.

Departure Procedure -- A general procedure for how an aircraft takes off and climbs to a designated altitude. There are various generalized and specialized departure procedures.

Procedures usually describe various velocities, altitudes, or rates of climb that are benchmarks to be followed.

Departure Profile -- The two-dimensional description (altitude and distance from brake release) of the aircraft departure trajectory. Various points along the trajectory may be associated with specific departure procedures.

DNL -- See Day-Night Average Sound Level.

DOI -- U.S. Department of the Interior

DOT -- U.S. Department of Transportation.

Equivalent A-weighted Sound Level (L_{eq}) -- The average (on an energy basis) noise level integrated over some specified period of time.

FAA -- Federal Aviation Administration (part of the U.S. Department of Transportation).

FAAct – Federal Aviation Act of 1958.

FAR -- See Federal Aviation Regulations.

Federal Aviation Regulations (FAR) -- The body of Federal regulations relating to aviation. Published as Title 14 of the Code of Federal Regulations.

Flight Heading -- The direction in which the nose of the airplane points during flight; this is usually expressed by reference to a compass reading from 1° to 360°.

Flight Track -- The path along the ground followed by an aircraft in flight.

GCNP -- Grand Canyon National Park unit of the National Park Service.

General Aviation (GA) -- All civil aviation except commercial carriers.

Glide Slope (GS) -- An instrument landing system facility providing vertical guidance for aircraft during approach and landing.

Head-to-head Operations -- Taking off in one direction and landing in the opposite direction.

IFR -- See Instrument Flight Rules.

IWG – Interagency working group of the DOT and DOI.

Instrument Approach -- An approach to a landing area guided by instruments in the aircraft and on the ground, as opposed to a visual approach.

Instrument Flight Rules (IFR) -- Federal procedures, using instruments in the aircraft and on the ground, which pilots must follow when weather conditions are below the minimums prescribed for visual flight conditions (see also Visual Flight Rules).

ILS -- See Instrument Landing System.

Instrument Landing System (ILS) -- Instrument landing aid providing altitude and directional guidance.

Instrument Meteorological Conditions (IMC) -- Weather conditions expressed in terms of visibility, distance from clouds, and cloud ceilings during which all aircraft are required to operate using instrument flight rules (IFR).

Integrated Noise Model (INM) -- The Federal Aviation Administration-specified computer model for assessing aircraft noise impacts.

Knots -- Airspeed measured as the distance in nautical miles covered in 1 hour.

L_{10} -- The sound level exceeded 10 percent of the time.

L_{90} -- The sound level exceeded 90 percent of the time.

L_{AE} -- Sound exposure level.

L_{AEq12h} -- Equivalent sound level over a 12-hour time period.

L_{dn} -- See Day-Night Average Sound Level.

L_{eq} -- Equivalent A-weighted sound level. Equivalent sound level, L_{eq}, is the energy average noise level (usually A-weighted) integrated over some specified time. Equivalent signifies that the total acoustical energy associated with the fluctuating sound (during the prescribed time period) is equal to the total acoustical energy associated with a steady sound level of L_{eq} for the same period of time. The purpose of L_{eq} is to provide a single number measure of noise averaged over a specified time period.

L_{max} -- Maximum A-weighted sound level.

Mean Sea Level (MSL) -- The average height of the surface of the sea for all stages of the tide, used as a reference for elevations. Also called sea level datum.

NPRM – Notice of Proposed Rulemaking.

NPS – National Park Service of the U.S. Department of the Interior.

Nautical Mile -- A measure of distance equal to 1 minute of arc on the earth's surface (approximately 6,000 feet).

NAVAIDS -- Visual and electronic aids to air navigation.

Noise Abatement -- Measures taken to reduce the off-airport impacts of aircraft noise.

Noise Contour -- A line depicting equal levels of sound exposure, usually drawn on a base map of the area.

Operation -- A landing or a takeoff by an aircraft.

Part 36 -- FAR Part 36 establishes the aircraft noise certification sound levels and associated requirements for certificated aircraft.

Part 91 -- FAR Part 91 are general operating rules which include a schedule for all air carrier jets to meet FAR Part 36 Stage 3 requirements.

Precision Approach Path Indicator (PAPI) -- A landing aid which provides visual approach slope guidance to a runway.

Preferential Runway System (PRS) -- A system of runway use which attempts to route as much traffic as possible over the least noise-sensitive areas around the airport.

SFAR -- Special Federal Aviation Regulation.

SFRA -- Special Flight Rules Area.

Sound Exposure Level (SEL) -- A measure of the total sound energy of an event taking into account amplitude, frequency, and duration.

Stage 1, 2, 3 Aircraft -- Classification of aircraft based on noise emissions, as defined in Federal Aviation Regulation Part 36. Stage 1 aircraft are the noisiest; Stage 3 are the quietest.

TA -- see Time Above.

TACAN -- Tactical Air Navigation. A navigational system used by the military. TACAN provides both azimuth and distance information to a receiver on board an aircraft.

Time Above (TA) – The TA metric provides the duration in minutes for which aircraft related noise exceeded specified A-weighted sound levels. Further, TA can be related directly to some "threshold activated" physiological or annoyance events.

Turboprop Aircraft -- An aircraft whose main propulsive force is provided by a propeller driven by a gas turbine. Additional propulsive force may be provided by gas discharged from the turbine exhaust.

VFR -- See Visual Flight Rules.

Visual Approach -- An approach to a landing area following visual flight rules.

Visual Approach Slope Indicators (VASI) -- A landing aid which provides visual approach slope guidance to a runway.

Visual Flight Rules (VFR) -- Federal procedures which pilots may use when weather conditions are above the minimums prescribed for visual flight conditions. Under these rules, pilots may fly with visual reference to the ground and without reference to radio navigational aids (see also Instrument Flight Rules).

Visual Meteorological Conditions (VMC) -- Weather conditions equal to or greater than those specified in 14 CFR 91.155 for aircraft operations under Visual Flight Rules (VFR).

VORTAC -- Very High Frequency Omnidirectional Range with Tactical Air Navigation. A navigational radio station which provides magnetic bearing and distance (DME) from the station. The most common form of radio navigation currently in use.

APPENDIX C

NOISE BASICS

NOISE BASICS

This appendix provides a brief general description of noise and sound, describes the specific metrics used in this study, and finally gives a derivation of the relationship between $L_{eq(12)}$ and speech intelligibility referenced in the text of the noise section.

1. Description of Sound or Noise

Metrics used to quantify sound or nose are based on three characteristics of sound waves:

- Level - the sound's amplitude, which is related to loudness;
- Frequency Distribution - the pitches that make up a sound; and
- Time History - the variations of the sound over time.

Level

A sound wave is the rapid movement of air molecules back-and-forth about an equilibrium position and may be thought of as a wave that propagates away from a noise source at the speed of sound. The greater the back-and-forth motion, the greater the amplitude and the louder the sound. This motion causes increases and decreases in air pressure, and it is these changes in pressure that may be thought of as moving the ear drum and causing sound to be heard.

The ear, however, responds both to very slight and relatively great changes in pressure; in fact, the difference between the quietest sounds that can commonly be heard and the loudest sounds that can be tolerated is a factor of more than one million in terms of pressure. These great differences between quiet and loud sounds are described in terms of the decibel (dB). The decibel scale is based on logarithms and compresses a sound pressure range of one million to a decibel range of 0 dB to 120 dB. When sounds are quantified in decibels, they are referred to as levels. Thus, a sound has a level of 80 dB, or a noise source may be said to produce a sound level of 80 dB.

Frequency Distribution

Noises having equal levels can have different pitches. Pitch or frequency is a measure of how rapidly the air molecules move back-and-forth, and is denoted as cycles per second or as hertz, (Hz). The human ear's ability to hear sound depends upon the frequencies present. We hear best the frequencies present in speech, generally 1,000 Hz to 8,000 Hz and less well the frequencies outside this range. In order to measure sounds in a way that corresponds to human perception, an electronic "weighting" network was designed into sound-measuring instruments. Levels measured with such an instrument are called A-weighted levels (dBA).

Time History

Sound levels vary as time passes. The variations can occur over very short periods or variations can be longer term. During one hour several arriving aircraft may pass by and, during another hour, no aircraft will pass by. Several methods have been used to quantify time-varying noises, but the most common is the equivalent sound level (L_{eq}). This sound level accounts for all sounds that occur in a given time period. Briefly, it is the level of a constant A-weighted sound that has exactly the same amount of total sound energy as did the actual time-fluctuating sound. L_{eq} is equivalent to an actual time-varying sound level in the sense that it has the same total energy for the same length of time, only the fluctuations in level have been summed up to yield a constant, steady-state level.

Thus, the A-weighted sound level can be used to measure instantaneous sound levels as they occur, or the A-weighted level can be cumulative over a longer time period to yield an equivalent level. The instantaneous A-weighted levels are useful for quantifying sound produced by single events, such as the second-to-second levels produced by a passing truck or aircraft or the maximum level produced during an aircraft overflight. The equivalent level is better for quantifying long-term noise exposure.

2. Sound Metrics

The primary metrics used in this study are of two types: one that quantifies the amount of time that park visitors will hear aircraft, and one that sums all the sound energy produced by tour aircraft during a 12-hour period.

Audibility

The Appendix "A Comparison of A-weighted Signal-to-Noise Ratios and Detectability Metrics for Aircraft Noise" discusses audibility of sounds in some detail. In general, whether or not a person hears and is aware of an intruding sound depends upon the level and frequency content of the sound, the level and frequency of other sounds (often referred to as the "ambient" sound), and whether the listener is engaged in some activity other than listening intently for the intruding sound.

Research conducted by the FAA[1] and NPS[2] has shown that park visitors can be disturbed by the sound of aircraft and that the degree of disturbance tends to increase relative to the amount of noise exposure and the amount of time aircraft are audible. In terms of audibility, visitors who go to easily accessible sites such as overlooks tend to be less disturbed than visitors who take hikes away from easily accessed areas. As a result of these findings, and consistent with the NPS criteria for substantially restoring natural quiet, the metric of percent of the time aircraft are audible was selected to measure the effects of aircraft sound on Grand Canyon National Park.

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[1] U.S. DOT FAA, Development of Noise Dose/Visitor Response Relationships for the National Parks Overflight Rule: Bryce Canyon National Park Study, July 1998

[2] Anderson, G.S., *et al*, "Dose-Response Relationships Derived from Data Collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks," NPOA Report No. 93-6, October 1993.

Baumgartner, R.M., Cary McDonald, "Aircraft Management Studies, Grand Canyon Visitor Survey," NPOA Report No. 93-5, January 1994.

McDonald, C.D., *et al*, "National Park Service Aircraft Management Studies, Visitors Survey," NPOA Report No. 94-2. January 1995.

Because determining audibility rigorously requires frequency content information, the INM, using only A-weighted levels, cannot directly compute this metric. However, as described in the appendix "A Comparison of A-weighted Signal-to-Noise Ratios and Detectability Metrics for Aircraft Noise", an empirical relationship between A-weighted differences and audibility was derived.

Twelve Hour Equivalent Level, $L_{eq(12)}$

Analyses of aircraft noise effects traditionally use equivalent levels, L_{eq}. As discussed above, equivalent levels are a measure of the total sound energy that occurs during a given period of time. Because all tour operations occur within a twelve hour period, the INM was used to compute the equivalent level for this period, $L_{eq(12)}$.

Day-Night Average Sound Level, DNL

The day-night average sound level (L_{dn} or DNL) is an A-weighted equivalent level that accounts for all sound energy occurring over a 24-hour period. DNL treats all noise events occurring between 10 PM and 7 AM (nighttime) as if they were 10 dB louder than they actually were. This 10 dB penalty is intended to account for increased human sensitivity to nighttime noise. DNL may be computed from L_{eq} values by first adding 10 dB to all L_{eq}s which occur at night and then summing the energy over 24 hours.

DNL is the metric specified by FAA in 14 CFR Part 150 for assessment of the effects of aircraft noise, and it is used in this study to judge impacts that occur outside of the park. It was not computed directly, but it is equal to $L_{eq(12)}$ minus 3 dB. Hence, DNL 65 dB, the criterion for significant impact, occurs where $L_{eq(12)}$ equals 68 dB.

Time Above, $\%TA_{(12)}$

The time above computation within INM for percent time above (%TA) is derived from the relationship between L_{ASmx} and L_{AE}. In particular, time above within INM is computed according to the following equation:

$$TA = \frac{4}{\pi}\left[10^{(L_{AE}+L_{ASmx})/10}\right]\left[10^{(L_{ASmx}-L_{TH})/20} - 1\right]^{1/2}$$

where: TA is the time above in seconds;

L_{AE} is the A-weighted sound exposure level;

L_{ASmx} is the A-weighted maximum sound level; and

$_{L.H.}$ is sound level threshold above which the TA is computed.

As can be seen, the **sole** input variables to time above computations within INM are the L_{ASmx}, the L_{AE}, and the $_{L.H.}$. Time is **not** an explicit variable in the computation. Instead time is implicit in the L_{AE}. (For more detailed information about the TA equation, see the INM Technical Manual, Section 3.10 "Computation of Time-Above Metrics" p. 65).

Interpreting Changes in Sound Metrics

Changes in Single Event Levels

People have difficulty judging the absolute magnitude of a noise but are much more reliable at judging the relative magnitudes of two sounds. The barely noticeable difference between two sounds when compared sequentially in a laboratory setting is 0.5 to 1.0 dB, depending on the characteristics of the sounds and the absolute level[3]. On the other hand, for clinical audiometry (hearing tests), a difference of 5 dB is used as the minimum difference between tones presented for comparison because the use of smaller differences produced less reliable comparisons. Thus, little significance can be attributed to a difference of 1 dB to 2 dB between sounds, while differences of 5 dB or more can be considered readily noticeable. For single noise events, the following guidelines are offered.

Single Event Noise Level Changes (L_{max})

Change in Level	Expected Reaction to Change
0 dB to 2 dB	Generally not noticeable
2 dB to 5 dB	May be noticeable
5 dB or more	Generally noticeable

Changes in DNL or $L_{eq(12)}$

Determining the probable noticeability of a change in cumulative metrics (DNL or $L_{eq(12)}$) is more complex than interpreting changes in single events. First, there is little published data that give the effects on communities of changes in cumulative levels. Second, it is likely that changes that occur slowly over many years are less likely to be noticed than changes that occur suddenly in a day's or few week's time. Third, reaction to noise depends not only upon the level of the noise, but on people's perceptions of the noise and the noise maker. If people understand and accept the need for the change that resulted in an increase in noise, there may be greater acceptance of (and less reaction to) the noise increase than if the change is regarded as unnecessary or improper. With these considerations in mind, the following interpretation guidelines are offered:

Cumulative Noise Level Changes (DNL or $L_{eq(12)}$)

Change in Level	Expected Reaction to Change
0 dB to 2 dB	May be noticeable
2 dB to 5 dB	Generally noticeable

3 Small, A. and Gales, R. "Hearing Characteristics," Chapter 17 of "Handbook of Acoustical Measurements and Noise Control, 3rd Edition," edited by Cyril Harris, McGraw Hill, 1991.

5 dB or more	Change in community reaction likely

3. Speech Intelligibility and Sound Levels

The analysis presented the following relationships between $L_{eq(12)}$, maximum aircraft sound level and speech intelligibility.

Approximate Relation of $L_{eq(12)}$ Values to Single Aircraft Flyovers and to Conversation Distances[4]

$L_{eq(12)}$, dBA	Approximate Typical Aircraft Produced Maximum Level (dBA)	Talker - Listener Distance for 99% Sentence Intelligibility with Relaxed Conversation During Maximum
50	65	(some brief need to use normal rather than relaxed voice)
40	55	1 meter
30	45	3 meters
20	35	10 meters

This table was derived by assuming that typical air tour traffic on a given corridor amounts to approximately 120 flights per 12 hours. The relationship of the 12 hour equivalent level to the average Sound Exposure Level (SEL[5]) is given by:

Leq(12) = Average SEL + 10* log (operations / 12 hours) - 10* log (seconds / 12 hours)

Or

Average SEL = Leq(12) + 10* log (seconds / 12 hours) - 10*(operations / 12 hours)
= Leq(12) + 25.6
= Leq(12) + 10* log (43,200) - 10* log (120)

Hence, for this situation, the average SEL is approximately equal to the $L_{eq(12)}$ plus 25 dB. Since SEL is about 10 greater than the maximum level from an overflight then the maximum level is about 15 dB higher than the $L_{eq(12)}$.

The relationships between speech intelligibility and maximum levels are derived from Figure D-2 of the "Levels Document."[6]

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4 US EPA, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," NTIS PB-239 429, March 1974.

5 SEL is a measure, in A-weighted decibels, of the total sound energy produced by a single overflight, compressed to a duration of one second. In general, the SEL for an overflight is approximately 10 dB greater in magnitude than the maximum level. The SEL accounts for not only the loudness of an overflight, but also the duration of that overflight.

6 US EPA, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," NTIS PB-239 429, March 1974.

APPENDIX D

TECHNICAL MEMORANDA

U.S. Department
of Transportation

Research and
Special Programs
Administration

Memorandum

Subject: Comparison of Measured and Predicted Noise Levels in Grand Canyon National Park Letter Report: DTS-75-FA465-LR11

Date: August 9, 1994

From: Gregg G. Fleming *Gregg G. Fleming*

Reply to Attn. of: DTS-75

To: Thomas L. Connor; FAA, AEE-100

This letter report presents the results of comparisons between measured and predicted noise levels in the vicinity of Grand Canyon National Park (GCNP). The attached Figures 2 through 4 present the results of comparisons between measured and predicted sound exposure levels (SEL) for individual flyover operations. Tables 1 through 5 present the results of comparisons between measured and predicted equivalent sound levels (L_{eq}) for composite, hourly operations. The measured SEL and L_{eq} data were provided to the Volpe Center by Harris Miller Miller and Hanson Inc (HMMH). These data were obtained during two separate time periods at five sites in GCNP as shown in Figure 1. Sites 1 and 2 (separated by less than 2000 ft) were the SEL measurement sites. Sites 3, 15, and 16 were the hourly L_{eq} measurement sites.

The comparative predicted values were obtained by the Volpe Center using a modified version of the Integrated Noise Model (INM) Version 4.11. The modified version of the INM neglects the effects due to lateral attenuation. This modification is considered appropriate for predictions at the five sites examined in the current study due to their close proximity to the rim of the Canyon. In addition, the terrain beneath the source-to-receiver propagation path for the five sites is primarily hard-packed sand and rocks - a surface which lends itself to little if any over-ground attenuation. The specific methodology for computing aircraft flight tracks, and takeoff and approach profiles is outlined in the previous Volpe Center Letter Report DTS-75-FA465-LR8.

Comparison of Measured and Predicted SEL

Figure 2 graphically displays the measured SEL data, linear regression line drawn through the data, and the associated 90 percent confidence interval (CI) as a function of slant distance for the DeHavilland DHC-6 Twin Otter aircraft. Although the SEL data were measured at two sites (Sites 1 and 2 as shown in Figure 1) no distinction is made in Figure 2. Also displayed is the INM-predicted SEL and the adjusted-predicted SEL as a function of slant distance. The predicted SEL was computed at two slant distances representing the approximate extremes of the measured slant distances. It was assumed that the predicted SEL was a linear function of slant distance between these points. The specific slant distances were achieved in the INM input file by varying the SFAR 50-2 flight tracks in the horizontal plane while holding the prescribed altitudes constant. The adjusted-predicted SEL was then obtained by subtracting a constant 5 dB, regardless of slant distance, from the INM-predicted SEL. The 5 dB adjustment is an estimate of the noise reduction associated with the quiet propellers installed on the DHC-6 aircraft operating at GCNP. As can be seen there is good agreement between the measured and the adjusted-predicted SEL for the DHC-6 aircraft (the adjusted-predicted conservatively overstates the measured noise by approximately 3 dB regardless of slant distance). However, the two data sets are statistically different.

Figure 3 graphically displays the measured SEL data, linear regression line drawn through the data, and the associated 90 percent CI as a function of slant distance for the Cesna Models 182, Stationair 6/7/8, and 414A aircraft. Although the SEL data were measured at two sites (Sites 1 and 2 as shown in Figure 1) no distinction is made in Figure 3. Also displayed is the INM-predicted SEL as a function of slant distance. The predicted SEL was computed at two slant distances representing the approximate extremes of the measured slant distances. It was assumed that the predicted SEL was a linear function of slant distance between these points. The specific slant distances were achieved in the INM input file by varying the SFAR 50-2 flight tracks in the horizontal plane while holding the prescribed altitudes constant. In computing the predicted SEL for these aircraft, the noise curves and performance information for the Beechcraft Model 58P were utilized. This was considered reasonable based on an evaluation of available data in the INM Data Base and previous FAA studies. As can be seen there is good agreement between the measured and the INM-predicted SEL for the Cesna aircraft (the predicted conservatively overstates the measured noise by approximately 2 dB regardless of slant distance). However, the two data sets are statistically different.

Figure 4 graphically displays the measured SEL data, linear regression line drawn through the data, and the associated 90 percent CI as a function of slant distance for the Bell Models 206 and 206L, and the Aerospatiale Model 350/355 helicopters. Although the SEL data were measured at two sites (Sites 1 and 2 as shown in Figure 1) no distinction is made in Figure 4. Also displayed is the INM-predicted SEL as a function of slant distance. The predicted SEL was computed at three slant distances representing an intermediate point and the approximate extremes of the measured slant distances. It was assumed that the predicted SEL was a linear function of slant distance between these points. The specific slant distances were achieved in the INM input file by varying the SFAR 50-2 flight tracks in the horizontal plane while holding the prescribed altitudes constant. In computing the INM-predicted SEL for these helicopters, the noise curves in the Heliport Noise Model (HNM) for the centerline-flyover and left-flyover configuration (depending upon the position of the helicopter relative to the site) of the Bell 206L were utilized. This was considered reasonable based on an evaluation of available data in the HNM's Data Base. The predicted values computed by the INM were then normalized to a nominal flyover speed of 90 kts (considered typical for tour operations at GCNP according to C.R. Cox at Bell Helicopter) by adding a constant 1.1 dB, regardless of slant distance. As can be seen there is good agreement between the measured and the predicted SEL (the predicted conservatively overstates the measured noise by approximately .5 dB). In addition, for most slant distances the two data sets are statistically equivalent.

Comparison of Measured and Predicted Hourly L_{eq}

Tables 1 through 5 present a comparison of the measured and predicted hourly L_{eq} for Measurement Sites 3, 15, and 16 (See Figure 1 for measurement site locations). The predicted hourly L_{eq} for the three measurement sites was computed using the output from the detailed grid report generated by the INM. Specifically, the SEL values for the most significant propeller flight and the most significant helicopter flight were used in conjunction with the number of operations (as logged by HMMH) to compute the predicted hourly L_{eq}. For example, in Table 1, at 10:00, two propeller-driven aircraft and 22 helicopters were logged. The INM predicted the SEL for the most significant propeller flight to be 64.8 dB, and the SEL for the most significant helicopter flight to be 65.3 dB. The hourly L_{eq} (neglecting jet aircraft operations) was then computed as follows:

$$L_{eq,1hr}^{*} = 10\log\{A\log[(64.8 + 10\log(2))/10] + A\log[(65.3 + 1.1 + 10\log(22))/10]\} - 35.6$$

where 1.1 = constant speed correction which normalizes the helicopter SEL in the HNM Data Base from a speed of 117 kts to a speed of 90 kts; and

35.6 = constant which normalizes the L_{eq} to a 1-hour time period, (i.e., 10log(1/3600 sec) equals -35.6.

$$L_{eq,1hr}^{*} = 44.5 \text{ dB}$$

* Jet aircraft operations were neglected in the computation of the predicted hourly L_{eq}.

As can be seen the agreement between the measured and predicted hourly L_{eq} was quite good for Sites 3 and 15 (Tables 1 through 3). Taking into consideration all hours for which measured-versus-predicted comparisons were made, the average difference (predicted minus measured) was 1.7 dB, i.e., the INM conservatively overstated the noise by 1.7 dB. There are some hours where the INM underpredicted the noise, e.g., Table 1, Hours 10:00 and 11:00, and some hours where the INM overpredicted the noise by a fairly significant amount, e.g., Table 3, Hours 14:00 and 16:00. These anomalies are likely due to: (1) the lack of knowledge regarding the aircrafts' dispersion from the nominal flight track; and to a lesser degree (2) the specific aircraft type represented by the measured data.

There is a general lack of agreement between the measured and predicted hourly L_{eq} for Site 16 (Tables 4 and 5). In fact, the predicted values consistently overstate the noise at Site 16 by an average of 9.9 dB. This overprediction is a result of the source-to-receiver geometry at the measurement site. According to HMMH, for most aircraft pass-bys at Site 16, the rim of the Canyon formed a barrier between the aircraft and the microphone; and the barrier was only broken occasionally. Since the INM currently does not account for barrier attenuation, a fairly significant overprediction was expected. The 9.9 dB overprediction appears reasonable since a simple break in the line-of-site (from source-to-receiver) typically results in a 5 dB reduction in sound level at the receiver.

If you have any comments or questions please do not hesitate to contact me.

Attachments

cc: J.A. Plante; AEE-120
D.G. Warren; AEE-120
R.D. Horonjeff; HMMH
C.R. Cox; Bell

Figure 1: GCNP Site Locations

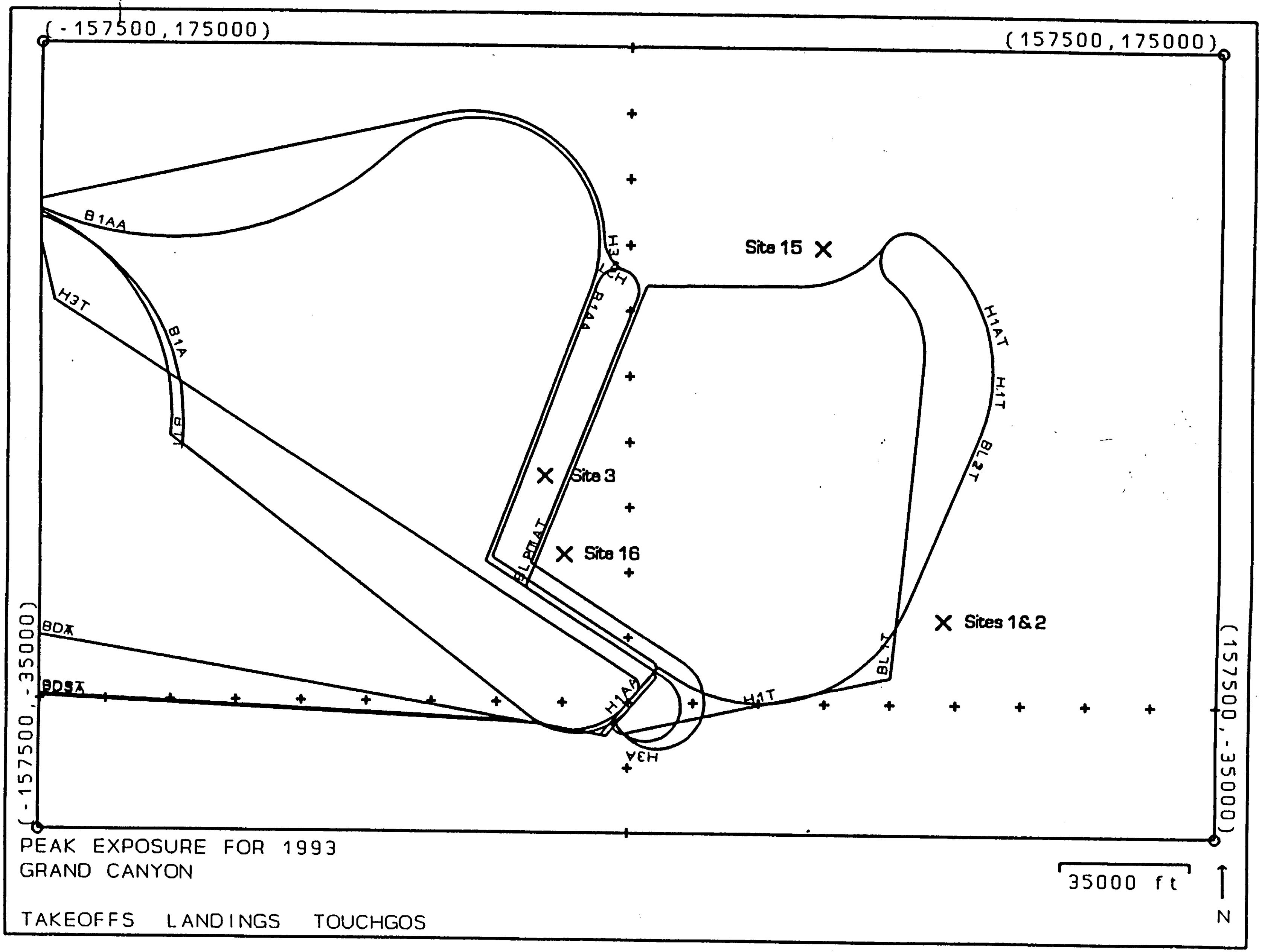

Figure 2: DeHavilland DHC-6 Twin Otter
SEL vs Slant Distance

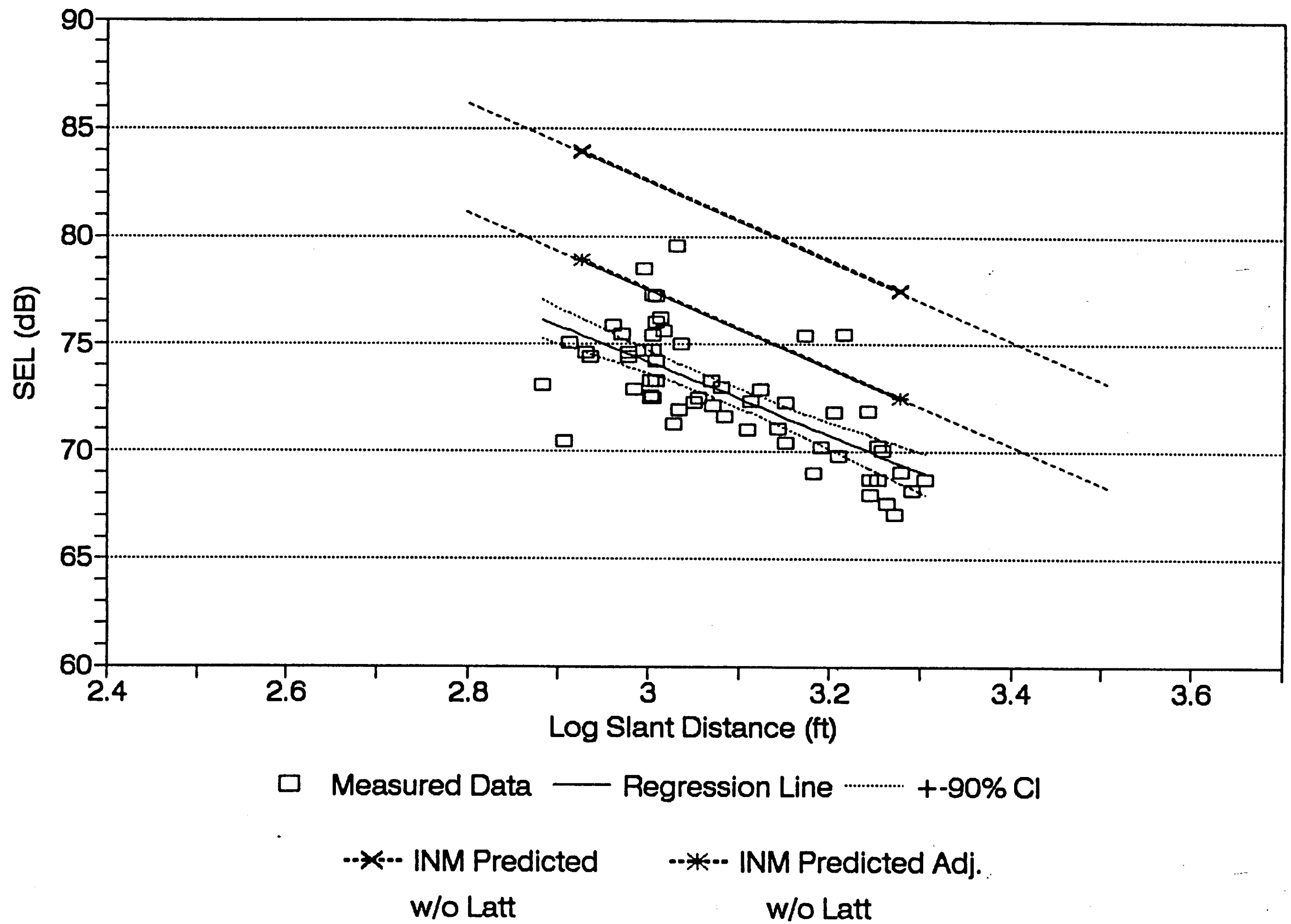

Figure 3: Cessna
SEL Versus Slant Distance

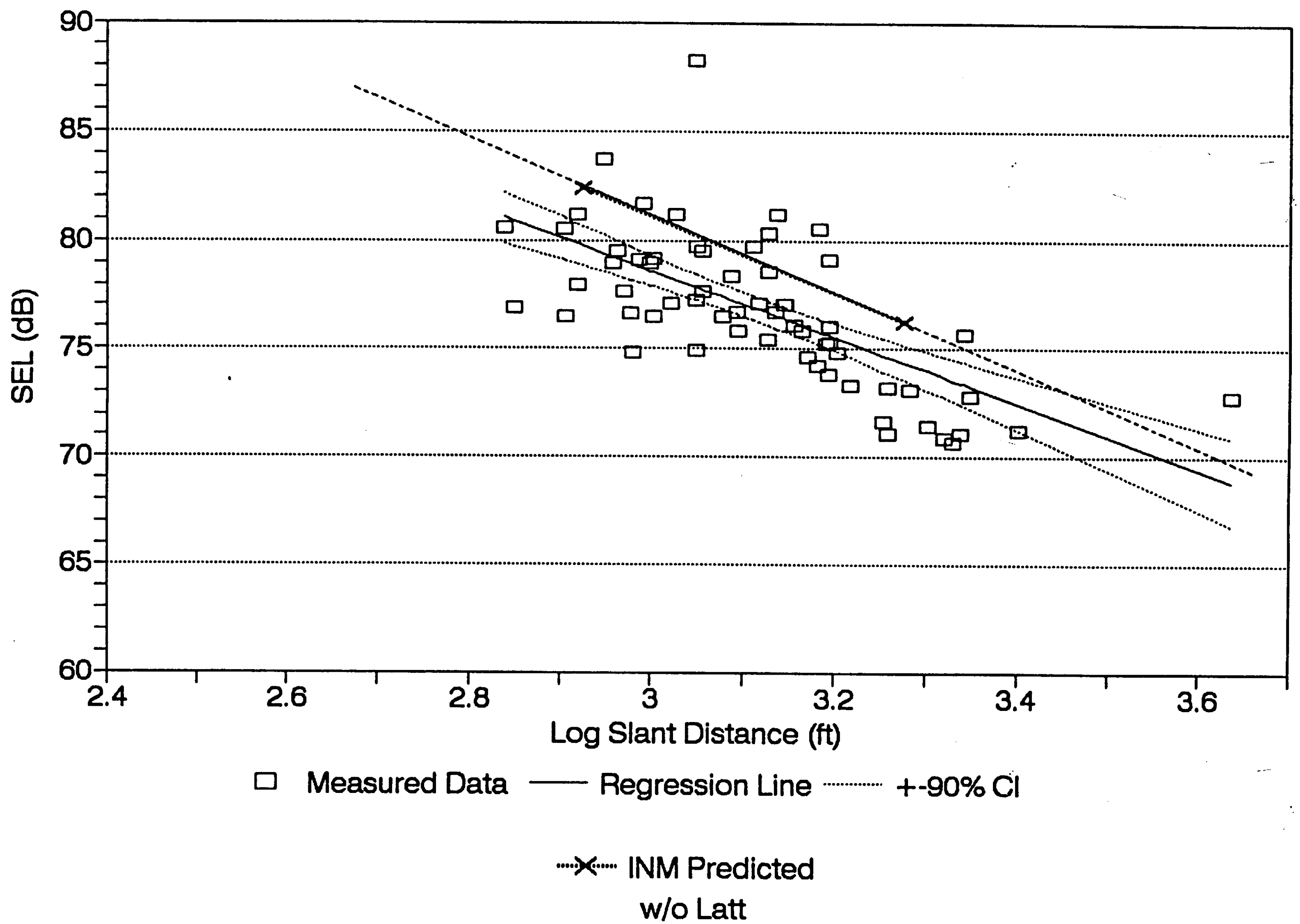

Figure 4: Helicopters
SEL Versus Slant Distance

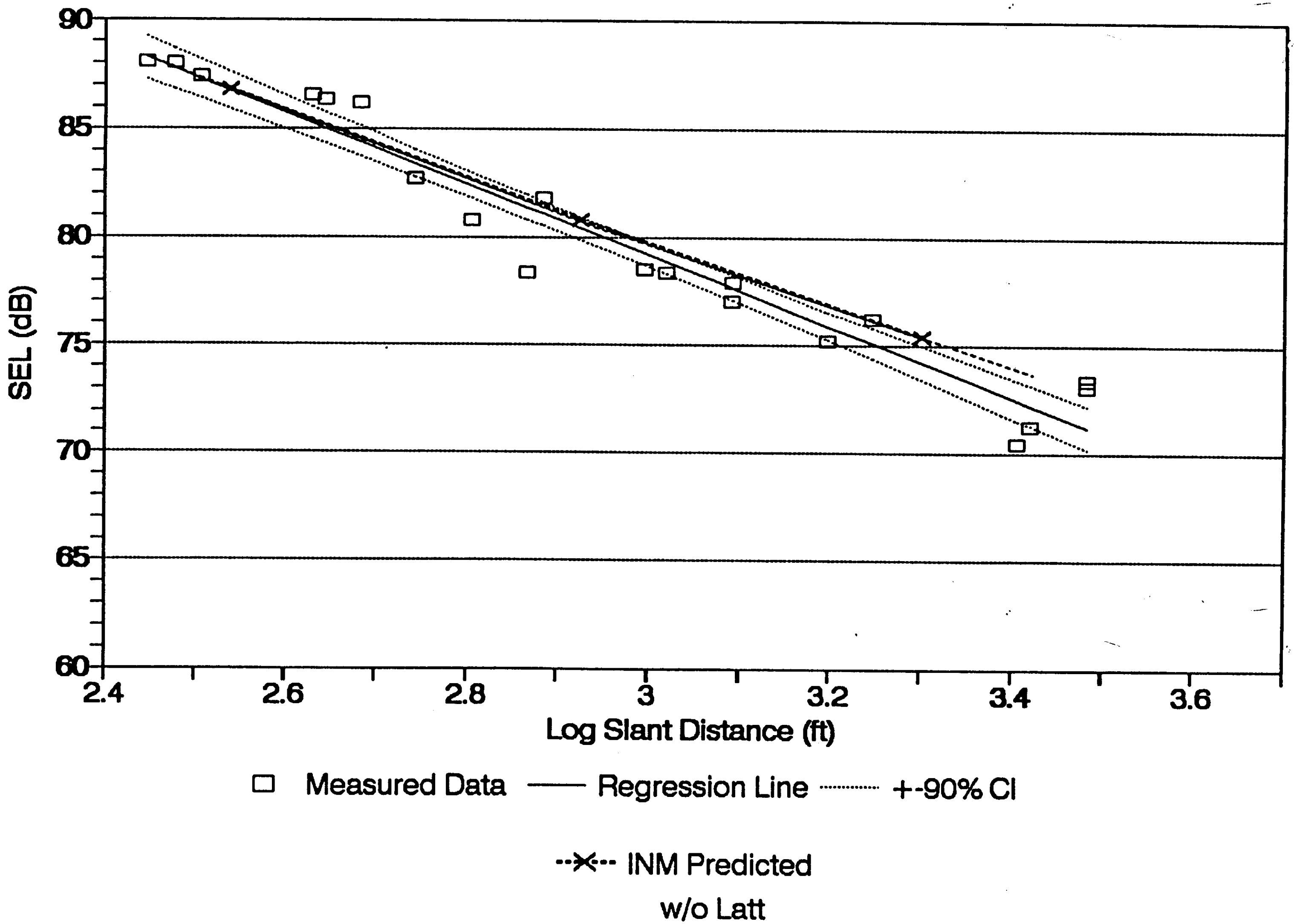

Table 1. Comparison of Measured and Predicted Hourly Leq's for Site 3, 30-Aug-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
10:00	2	22	1	25	46.9	44.5	-2.4
11:00	5	16	1	22	46.2	43.7	-2.5

Table 2. Comparison of Measured and Predicted Hourly Leq's for Site 15, 5-Sep-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
11:00	13	1	0	14	37.7	40.4	2.7
13:00	6	1	1	8	36.2	37.3	1.1
14:00	6	4	3	13	36.3	38.3	2.0
15:00	6	3	1	10	35.6	38.0	2.4
16:00	13	3	0	16	39.0	40.7	1.7

Table 3. Comparison of Measured and Predicted Hourly Leq's for Site 15, 6-Sep-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
10:00	9	2	4	15	37.1	39.1	2.0
11:00	8	6	0	14	37.9	39.6	1.7
12:00	2	1	7	10	33.4	33.2	-0.2
13:00	7	1	3	11	36.1	37.9	1.8
14:00	6	1	2	9	30.7	37.3	6.6
16:00	12	1	4	7	34.6	40.1	5.5

* Jet Aircraft operations were neglected in the computation of predicted Leq.

Table 4. Comparison of Measured and Predicted Hourly Leq's for Site 16, 25-Aug-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
12:00	4	11	5	20	35.1	45.3	10.2
13:00	8	7	7	22	35.9	45.2	9.3
14:00	9	14	1	24	34.3	47.1	12.8

Table 5. Comparison of Measured and Predicted Hourly Leq's for Site 16, 1-Sep-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
09:00	9	12	7	28	37.5	46.7	9.2
10:00	10	17	7	34	41.2	47.8	6.6
11:00	6	9	3	18	35.8	45.2	9.4
12:00	8	11	5	24	35.9	46.2	10.3
13:00	7	7	5	19	35.1	44.9	9.8
14:00	3	9	4	16	33.1	44.3	11.2

* Jet Aircraft operations were neglected in the computation of predicted Leq.

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MEMORANDUM

To:	Wesley Henry National Park Service
From:	Nicholas P. Miller
Date:	May 15, 1997
Subject:	A-weighted Level Differences Compared with Detectability
Reference:	HMMH Job No. 294530.22

This memorandum summarizes additional comparisons of A-weighted differences of sounds with corresponding measures of detectability. Detectability of a sound in the presence of background "noise" is normally determined quantitatively with the metric **d'** ("dee-prime") or a logarithmic equivalent, **10 log(d')**. This metric is computed in a complex manner from the differences in the one-third octave band sound levels of the sound and of the noise. In other words, detectability is normally determined through use of detailed frequency information about both the sound to be detected and the background or "masking" sound.

Currently, however, the INM is being used to estimate audibility of tour aircraft in the Grand Canyon, and this model uses only A-weighted sound levels. It is of interest, therefore, to determine how differences in A-weighted levels correspond to the standard detectability metric **d'** or **10 log(d')**.

Harris Miller Miller & Hanson Inc., as part of previous work conducted for the National Park Service, collected frequency content information on aircraft overflights and non-aircraft sound levels, as measured in the Grand Canyon and in Hawaii. From tape recordings made as part of this previous work, eight specific sounds of aircraft and five types of Grand Canyon background sounds have been used to analyze empirical relationships.

Four of the aircraft sound levels (aircraft 1 through 4, see next page) were developed by analysis of tape recordings at the time the aircraft overflight maximum A-level occurred. Spectra for two additional propeller aircraft and two additional helicopters were developed by analysis of similar tape recordings, but by using the sound recorded shortly after these aircraft became detectable. Grand Canyon background sound level spectra were also obtained from tape recordings of up to one minute in duration. For each aircraft type and each background environment, two types of data were determined: 1) one-third octave band levels; 2) A-weighted sound levels. The attached plots show the one-third octave band levels; both A-weighted level differences and detectability were computed from these spectra for each source and background combination.

Specifically, aircraft A-weighted sound level minus background A-weighted sound level was the A-weighted metric computed. This analysis provides tables of the empirical relationships between aircraft minus background A-weighted levels and detectability, **10 log** (*d '*) for typical aircraft and Grand Canyon background sound spectra.

The tables on the following page present the computed A-level differences for **10 log** (*d '*) equal to 7 dB, and the values of **10 log** (*d '*) for aircraft minus background A-weighted level equal to 3 dB.

Table 1. A-Weighted Aircraft minus Background for 10 Log (d') = 7 dB

Background Spectrum	Aircraft Spectrum: 1 Prop Burnt Springs	2 Jet Toroweap	3 Helo 1 Sliding Sands	4 Helo 2 Kalahaku Overlook	5 Prop 1 Point Imperial	6 Prop 2 Point Imperial	7 Helo 3 Sliding Sands	8 Helo 4 Sliding Sands
1. Hermit Basin	-11.5	-10.2	-8.7	-8.0	-10.5	-10.9	-8.9	-8.2
2. Toroweep Overlook	-6.6	-4.4	-6.7	-7.9	-5.9	-6.5	-4.1	-7.2
3. Point Imperial	-11.9	-9.3	-5.4	-6.9	-10.8	-11.2	-8.1	-5.8
4. 117.4 Mile Camp	-20.9	-18.0	-13.8	-13.5	-20.0	-21.2	-21.9	-19.3
5. Haleakala Crater	-7.0	-4.8	-6.5	-8.3	-6.4	-6.9	-4.5	-7.1

Table 2. 10 Log (d') when Aircraft A-weighted Level = Background A-weighted Level + 3 dB

Background Spectrum	Aircraft Spectrum: 1 Prop Burnt Springs	2 Jet Toroweap	3 Helo 1 Sliding Sands	4 Helo 2 Kalahaku Overlook	5 Prop 1 Point Imperial	6 Prop 2 Point Imperial	7 Helo 3 Sliding Sands	8 Helo 4 Sliding Sands
1. Hermit Basin	21.5	20.2	18.7	18.0	20.5	20.9	18.9	18.2
2. Toroweep Overlook	16.6	14.4	16.7	17.9	15.9	16.5	14.1	17.2
3. Point Imperial	21.9	19.3	15.4	16.9	20.8	21.2	18.1	15.8
4. 117.4 Mile Camp	30.9	28.0	23.8	23.5	30.0	31.2	31.9	29.3
5. Haleakala Crater	17.0	14.8	16.5	18.3	16.4	16.9	14.5	17.1

Table 1 gives the A-weighted differences for **10 log (*d* ')** equal to 7 dB. Negative values in the table mean that the aircraft level is less than the background level. So, for example, the propeller aircraft measured at Burnt Springs (aircraft 1) would produce a value of **10 log (*d* ')** equal to 7 dB in Hermit Basin when its A-weighted level is 11.5 dB below the ambient A-weighted level. When **10 log (*d* ')** equals 7 dB, a sound should be just detectable to a vigilant aircraft observer whose sole task is to listen for the presence of aircraft.

The value of **10 log (*d* ')** equal to 7 dB is important not only because it represents the level at which an aircraft will become just detectable to an intent listener, but also because detectability was the criteria used to develop the dose values in the dose-response data collected for the National Park Service. In other words, the dose-response curves developed by the National Park Service are based on detectability, and if those data are to be appropriately used in assessing the effects of aircraft on visitors, predictions of aircraft sound must be based on the level at which aircraft become just detectable - when the value of **10 log (*d* ')** equals 7 dB. The "time audible" curves in the dose response report were derived from observations of aircraft detectability judged by a vigilant listener.

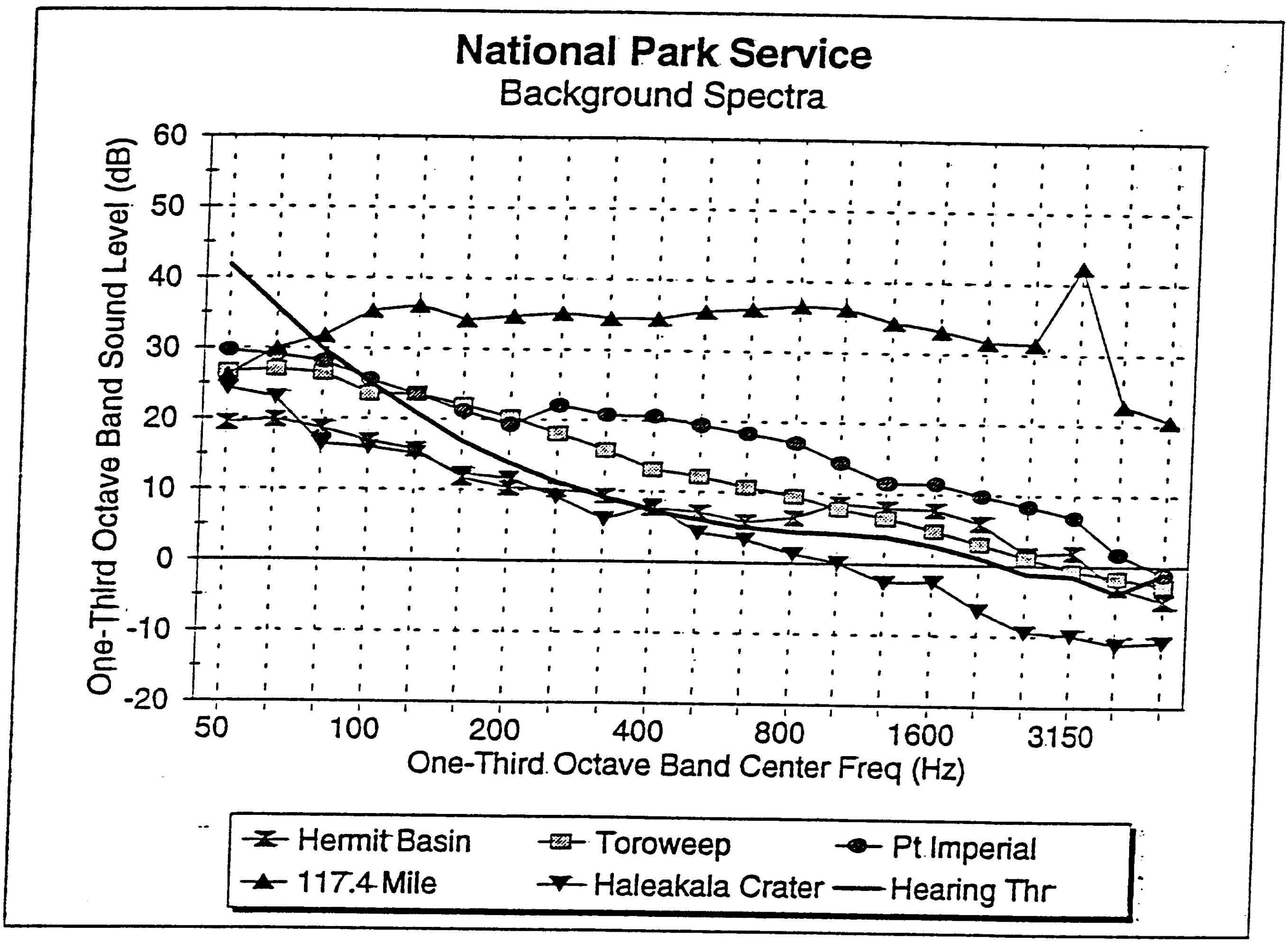
Table 2 presents the values of **10 log (*d* ')** computed to occur when the aircraft A-weighted level is 3 dB greater than the background sound level. The difference of 3 dB is of interest because that is the value that has been used in INM modeling to estimate the level at which aircraft become noticeable - i.e. to define when aircraft sound reduces natural quiet.

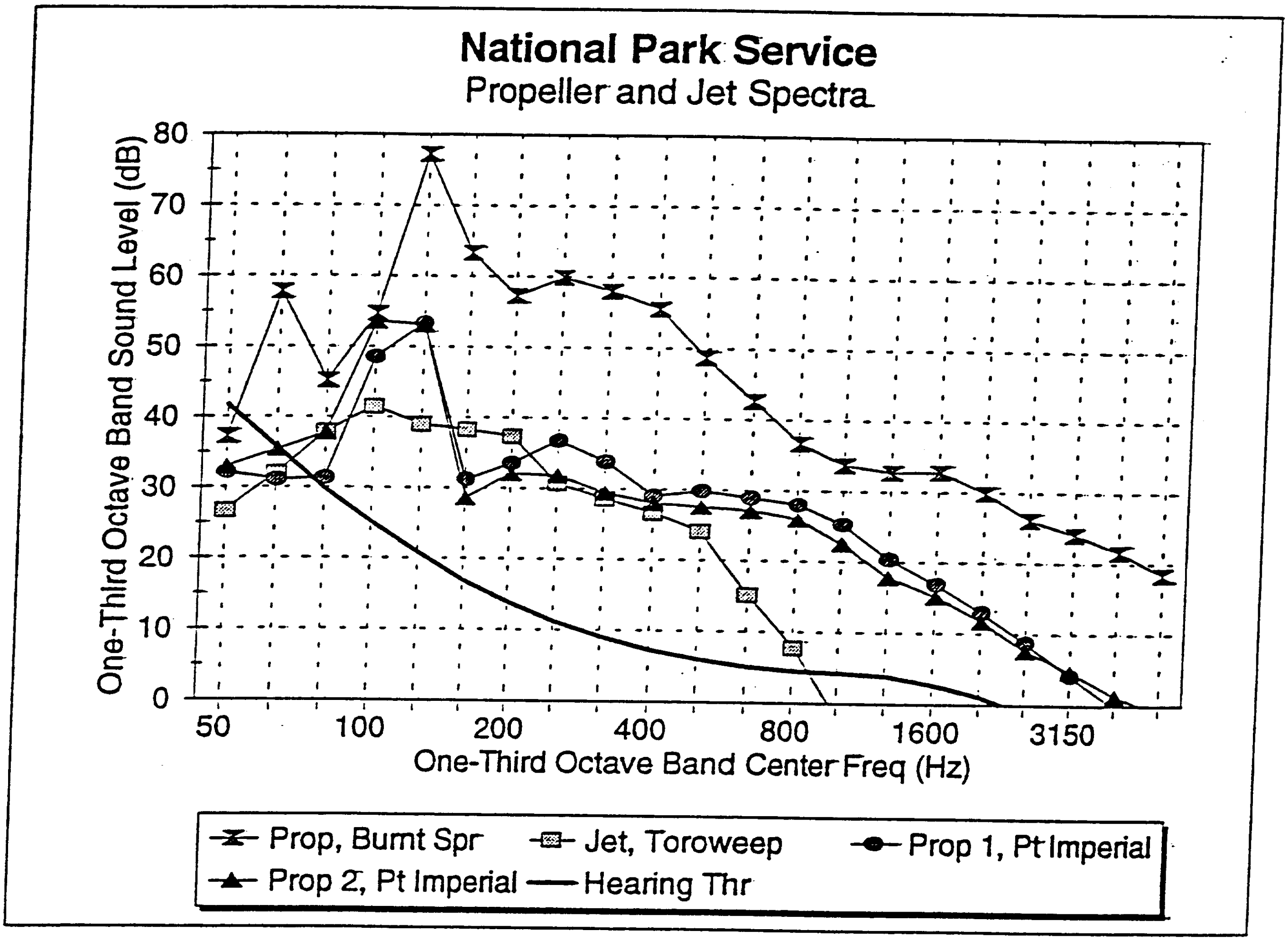
Two important observations should be noted. First, for a given background sound environment (given location), the relation of **10 log (*d '*)** to A-weighted difference varies over a range of 4 to 5 dB across aircraft types. For example, at Hermit basin, **10 log (*d '*)** equals 7 (Table 1) when the aircraft levels range from 8 dB to 12 dB below background. Second, if background 4, 117.4 Mile Camp, is excluded, for a given aircraft, the relation across backgrounds also varies by 4 to 6 dB. (Note that 117.4 Mile Camp spectrum contains water noise and is quite different from the other four background spectra, see attachments.) If jets and 117.4 Mile Camp are excluded, all results generally fall within a range of ± 4 dB.

Observations

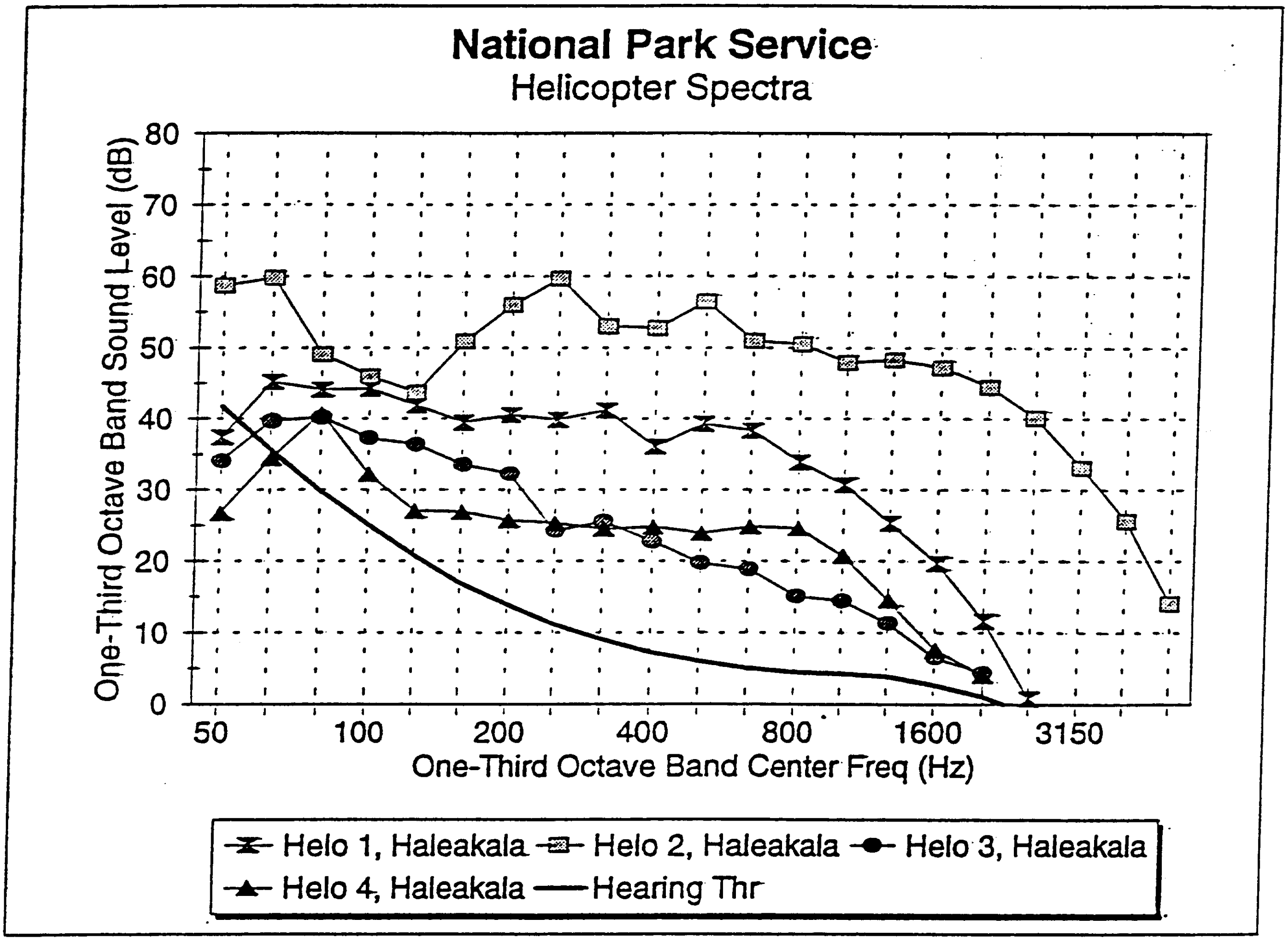
These data show that using a single A-weighted difference between background and aircraft A-weighted sound levels to judge when an aircraft becomes detectable is likely to produce results that differ considerably from what a listener on the ground would experience. The tabulated results do show, however, that some generalization may be possible: For a given background spectrum (acoustic environment), the level at which aircraft become detectable may fall into categories. For example, Table 1 values suggest for a Hermit Basin type spectrum, propeller aircraft could be considered detectable when the aircraft A-weighted level is about 11 dB below the background, or that the comparable number for detectability of helicopters is about 8.5 dB.

These data suggest that A-weighted differences to judge detectability could be derived for background / aircraft type combinations. Possibly through a carefully designed measurement and computation protocol, a matrix of appropriate differences could be determined for a defined set of park environments and aircraft types.


National Park Service
Background Spectra
One-Third Octave Band Sound Level (dB)
60
50
40
30
20
10
0
-10
-20
50
100
200
400
800
1600
3150
One-Third Octave Band Center Freq (Hz)
Hermit Basin
Toroweep
Pt Imperial
117.4 Mile
Haleakala Crater
Hearing Thr



National Park Service
Propeller and Jet Spectra
One-Third Octave Band Sound Level (dB)
80
70
60
50
40
30
20
10
0
50
100
200
400
800
1600
3150
One-Third Octave Band Center Freq (Hz)
Prop, Burnt Spr
Jet, Toroweep
Prop 1, Pt Imperial
Prop 2, Pt Imperial
Hearing Thr



National Park Service
Helicopter Spectra
One-Third Octave Band Sound Level (dB)
80
70
60
50
40
30
20
10
0
50
100
200
400
800
1600
3150
One-Third Octave Band Center Freq (Hz)
Helo 1, Haleakala
Helo 2, Haleakala
Helo 3, Haleakala
Helo 4, Haleakala
Hearing Thr

Distribution of A-level Differences for 10Log(d') = 7
For the three Grand Canyon Environments
(Hermit Basin, Toroweep, Pt. Imperial)

dBA (AC) - dBA (background)
from Table 1

Helos	Props
-8.9	-11.9
-8.7	-11.5
-8.2	-11.2
-8.1	-10.9
-8.0	-10.8
-7.9	-10.5
-7.2	-6.6
-6.9	-6.5
-6.7	-5.9
-5.8	
-5.4	
-4.1	

	Helos	Props
Median =	-7.55	-10.8
Low	-1.4	-1.1
High	3.4	4.9
Ave =	-7.2	-9.5

COMPARISON OF ASSUMED AMBIENT AND MEASURED NON-AIRCRAFT SOUND LEVELS FOR GRAND CANYON ACOUSTIC PROFILE SITES

Shaded sites are judged as having measured levels dominated by natural sources

Site Number	Site Description	Estimated Ambient, dBA (Fig 3.2 FEA)	Measured Ambient L10	L50	L90	Sources of Non-aircraft Levels
1.0	Marble Canyon (Mile 35.2), 30 ft from river	15	53	52	51	water from rapids near by
2.1	Phantom Ranch Overlook (Edge)	?	42	41	40	water from Bright Angel Creek below
2.2	Phantom Ranch Overlook (10' From Edge)	?	33	31	30	same as 2.1, but shieldied by edge
3.0	96 Mile Camp	?	42	38	37	water. wind
5.0	Stone Creek Camp	?	51	49	48	Dubendorff Rapids
6.1	Deer Creek Falls (Across River)	?	47	45	44	ripples in water over rocks
6.2	Deer Creek Falls (1/2 Mile NE of Falls)	? or 15	29	28	26	only birds flying, river not audible
7.0	Havasu Creek	?	56	56	56	Creek and Havasu Rapids
8.0	Whitmore Rapids, 150 feet from river	? or 15	40	37	35	Water. wind, insects
9.0	Separation Canyon	15	26	21	16	mostly insects and birds, no rapids
10.0	Bright Angel Point Overlook	26	30	24	21	
12.0	Desert View Overlook	17	51	43	35	Traffic and voices
13.0	Little Colorado River, 25 ft. from river	15	42	38	36	Sounds of water and wind
14.0	Toroweap Overlook	15	33	22	14	Mostly wind. Note that model act. has rapid noise.
			24	17	12	
15.0	Point Imperial Overlook	26	35	28	25	Mostly visitor activity
			41	34	28	High winds
16.0	Hermit Basin	17	29	22	17	insects and birds
			25	19	15	
17.0	Lipan Point Overlook	17	40	33	27	Parking lot activities
			38	33	27	
			41	35	30	
18.0	Yaki Point Overlook	26	50	41	33	Vehicles, gusty winds
19.0	Point Sublime Overlook	26 or 17	28	17	12	Birds and insects; wind not significant
20.0	117.4 Mile Camp, 20 feet from river	15 or ?	45	43	41	Levels due to ripples on rocks about 300 ft downstrea
			45	43	42	
21.0	Burnt Springs Canyon, 20 feet from river	15	25	20	16	birds and wildlife only contributors
23.0	Diamond Creek	15?	35	28	24	insects (mostly cicadas)
			50	28	25	
31.0	Marble Canyon Dam Site / Buck Farm Canyon	15	27	24	22	water and insects

Averages of Measured Levels for:		L10	L50	L90
	model = 15	32	23	19
	model = 17	27	19	15
	model = 15 or 17	30	22	18

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MEMORANDUM

To:	Wes Henry - National Park Service
From:	Nicholas P. Miller
Date:	February 5, 1999
Subject:	Addendum: Natural Ambient Sound Levels for use in Noise Modeling of Grand Canyon NP
Reference:	HMMH Job No. 295860.05

1. INTRODUCTION

In our memorandum to you of December 2, 1998, we reviewed the sound monitoring data acquired at 23 sites in the Grand Canyon during August and September, 1992, with the intent of determining from these data what sound levels could be used to characterize the "natural ambient" conditions in the park.[1] These levels for the "natural ambient" will be applied in the computer modeling of the airspace use over the Canyon. The modeling determines the areas of the park where air tour aircraft are audible or noticeable, and will aid in decisions about how airspace use should be altered to provide for "substantial restoration of the natural quiet."[2]

Volpe National Transportation Systems Center (Volpe) through the FAA, has commented on the December 2 memorandum and its recommendations.[3] The Volpe memorandum raised several concerns with our analysis methods and conclusions. The following specific concerns were identified:

1. **Site Selection.** Our memorandum identified 8 of the 23 monitoring sites as locations where only natural sounds (non-human) were audible and measured and hence were candidate sites for characterizing the natural ambient conditions. Three of these 8 we judged as not applicable to the specific park environments that were to be modeled. Volpe questions why these three were not included. Volpe also questions not using data from overlooks, implying that data from overlooks could be used to quantify

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[1] The measurements are documented in Horonjeff, R.D., *et al*,"Acoustic Data Collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks," Harris Miller Miller & Hanson Inc., HMMH Report No. 290940.18, NPOA Report No. 93-4, August 1993.

[2] Public Law 100-91, National Parks Overflights Act, §3.(b)(3)(B), requires that the use of the Grand Canyon airspace "..provide for substantial restoration of the natural quiet...."

[3] January 8, 1999 memorandum from Gregg Fleming to Jake Plante, FAA; ref DTS-34

the ambient levels in the vicinity of overlooks.

2. **Sound Level Metric Used.** Our memorandum recommended the use of L_{50} to characterize the natural ambient levels. Volpe objected to this metric as it is unsupported in the literature, and because an alternative, the equivalent level, L_{eq}, is supported by "...all previous work."

3. **Use of "Spike Smoothing" Algorithm.** Volpe suggests that our stated concern about the use of L_{eq} is rendered moot because of our use of a spike smoothing algorithm.

4. **Averaging Process.** In deriving our recommendations, we arithmetically averaged the sound levels from several sites located within a given vegetation type. This average was then used to characterize all areas of the park identified as having the given type of vegetation. Volpe suggests keeping the data separate for the different sites and applying the results from each site to only the specific surrounding area having the same vegetation. Volpe also comments on use of arithmetic and logarithmic averages.

5. **Other Sources of Data.** Volpe questions why we relied on only one of several documents that contain sound measurement data collected in the Grand Canyon, suggesting that possibly the other documents contained only L_{eq} and not L_{50} values.

6. **May 15, 1997 HMMH Memorandum.** Volpe questions why our December 2, 1998 recommendation for natural ambient sound levels in the "Desert Scrub" environment differ from the recommendations in our May 15, 1997 memorandum.

This memorandum first provides background information that defines some specific terms used, describes why natural ambient conditions need to be quantified, how they are quantified, and how the natural ambient is used in analysis of the airspace over the Grand Canyon. It then addresses each of the six areas described above in Sections 3.1 through 3.6.

The six areas addressed can be simplified into four fundamental questions that need to be answered in order to select values for the natural ambient sound levels in the Grand Canyon. Information for answering the following four questions is provided in the sections given:

1. Which measurement site data should be included in each Grand Canyon environment category? (**§3.1**)
2. Should averages across several sites be used, rather than individual site data? (**§3.1**)
3. What metric of sound should be used to quantify the natural ambient? (**§3.2**)
4. What type of averaging process should be used? (**§3.4**)

The final sub-section of each of these sections provides our observations related to these questions. The other sections (3.3, 3.5 and 3.6) provide clarifying information for the other issues raised by Volpe.

2. BACKGROUND

2.1 Definitions

In order to communicate unambiguously, some definitions are necessary. Generally, terms to describe various sound environments have been used loosely, with words such as "ambient," "background," or "residual" sometimes being synonymous, sometimes not. In this memorandum, the following terms are used only as they are here defined, or any different uses are noted specifically, except when occurring in quotations from other sources. Not all terms below are used in the memorandum.

Natural Ambient (sound levels, conditions) - These terms refer to the natural, non-human produced sounds at a location in a park or throughout a park. The natural ambient conditions can be measured only when no human-produced sounds are audible or evident in any way. The modeling of the Grand Canyon airspace has as a primary goal the computation of the time that tour aircraft will be audible or noticeable in otherwise natural ambient conditions.

Natural Quiet - Treated here as synonymous with **natural ambient**.

Background Sound Environment - Natural ambient plus human-produced **residual sound**. This is the sound environment that may prevent accurate measurement of the **natural ambient** because distant and or quiet human-produced sound can still be heard or measured.

Traditional Ambient - The composite, all-inclusive sound associated with a given environment, excluding the sound of aircraft.

Total Sound Environment - All sounds measured or heard in a park (including aircraft).

Residual Sound - The all-encompassing sound minus all uniquely identifiable discrete sound sources. This type of sound is of interest here primarily to the extent that it is a result of human-produced sources (mechanical or other).

Audible - A sound is audible if an attentive listener with normal hearing can hear the sound. Presently, the accepted means for computationally estimating whether an intruding sound is audible in the presence of an existing sound is the "detectability" index d' or, alternatively, ten times the logarithm of this value, 10 log d'. For calculation purposes, a value of 10 log d' = 7 is used in NPS analyses as the threshold of audibility.[4] Calculation of audibility depends upon the sound level and frequency content of both the target / intruding

[4] Reddingius, N.H., "User's Manual for the National Park Service Overflight Decision Support System," BBN Report 7984, 10 May 1994, p. 97.

sound and of the masking / existing sound. In the analyses of park situations, audibility of aircraft will depend upon the sound level and frequency content of the aircraft and of the masking sounds.

Though audibility is normally calculated using frequency information of both the intruding and the masking sound, one computer model used to examine Grand Canyon airspace, the FAA's Integrated Noise Model (INM) works solely with A-weighted sound levels.[5] In using the INM, therefore, audibility has to be stated in terms of the difference between the A-weighted level of the aircraft and the A-weighted level of the natural ambient. This approach must necessarily be an approximation of the usual calculations. The masking effects of different natural ambients on different aircraft depends on the frequency content of the two sounds which may not be accurately reflected by a single A-weighted difference between the two. Nevertheless, in using the INM for the current Grand Canyon modeling, NPS and FAA have agreed that the threshold for audibility of aircraft occurs when the aircraft A-weighted sound level is approximately 8 dB below the natural ambient A-weighted sound level.

Noticeable - A sound is considered noticeable when a person engaged in some activity other than listening responds spontaneously that the sound is heard.[6] The threshold of noticeability is assumed to be 10 log d' = 17.[7,8] As with audibility, noticeability depends upon the sound level and frequency content of both the aircraft and of the natural ambient. In the use of the INM for this analysis of the Grand Canyon, the NPS and FAA have agreed that the threshold for noticeability of aircraft occurs when the aircraft A-weighted level is approximately 3 dB above the natural ambient A-weighted level.

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5 A-weighting sums the levels in all frequencies together to yield one number. The different frequency levels are not treated equally, but the low and high frequencies are de-emphasized to approximate the frequency response of the human ear.

6 The concept of noticeability has been defined and measured only in the laboratory. Hence, its application to park situations is ambiguous. A reasonable interpretation might be that a sound is noticeable in a park environment if a visitor, when asked, remembers hearing the sound. This definition, however, still raises questions. For example, how long after the sound event is the visitor asked the question? Audibility, (the detectability index) though also defined and measured in the laboratory, is assumed to be solely a physiological phenomenon. Hence, for a given person, the threshold of audibility for a given intruding sound and masking sound should be the same, whether that person is in the laboratory or in a National Park.

7 Op. Cit., Reddingius, p 97.

8 Note that NPS and FAA have agreed for this Grand Canyon analysis, that *audibility* of aircraft will be the criterion judged to represent a loss of natural ambient conditions in certain park areas, while in other areas of the Canyon, *noticeability* of aircraft will be the criterion to represent that loss. (Loss of natural ambient is identical to loss of natural quiet.)

2.2 Need for Quantifying Natural Ambient Conditions

In 1987, Congress passed Public Law 100-91, the National Parks Overflights Act, which directed the Secretary of the Interior to conduct studies to provide information regarding the effects and values of aircraft overflights on National Park units. One of the requirements of the law was that a plan be developed that would substantially restore natural quiet in the Grand Canyon. In the July 1995 Report to Congress, NPS defined "substantial restoration" in the Grand Canyon to mean "...that 50% or more of the park achieve 'natural quiet' (i.e., no aircraft audible) for 75 - 100 percent of the day."

Congress recognized in PL 100-91 that the need for a plan to restore natural quiet required the involvement of the Secretary of Transportation, through the Federal Aviation Administration (FAA). Working in cooperation with the NPS, the FAA designed special use airspace (SFAR 50-2) to help channel air tour routes away from sensitive areas and restore natural quiet. However, in the July Report to Congress, through use of both sound monitoring and computer modeling, the park service concluded that implementation of SFAR 50-2 had not brought a substantial restoration of natural quiet to the Grand Canyon. Because the goal of substantial restoration of natural quiet was not achieved, NPS and the Federal Aviation Administration (FAA) are currently working on analysis and redesign of the Grand Canyon airspace so that this goal will be met in the foreseeable future.

The primary approach to the analysis and redesign of the airspace is through use of computer models. These models can compute, for a given airspace configuration and use, the amount of time aircraft will be audible or noticeable. In order to make these computations, the computer models require estimates of the natural ambient conditions for areas of interest in the Canyon. **Hence, it is necessary to quantify the natural ambient sound levels in the park, and this memorandum examines previously collected data to determine reasonable A-weighted levels that characterize the natural ambient for use in the INM modeling of the Grand Canyon airspace.**

2.3 Method for Quantifying Natural Ambient Conditions

The December 2, 1998 memorandum described an orderly approach for measuring sound levels in a park. In general, the method includes determination of where, when, what and how to measure in a park. A series of measurements should be made in several different "homogeneous" natural ambient environments - different areas of the park judged to have similar sound environments. (Vegetation types are thought to define the main environments. Areas where water is audible would identify other environments.) The measurements made in each type of environment would be examined for consistency within each type and averaged as appropriate to provide a reasonable characterization of the natural ambient in each environment.

In choosing a number to characterize natural ambient for a given environment, two fundamental assumptions are used here. First, it is of primary importance to keep in mind that the purpose of the natural ambient value is to characterize the non-human sound levels that serve to *cover up or mask* the audibility or noticeability of aircraft overflights. **Thus, the natural ambient chosen should typify the natural sound levels in a given environment that are to be preserved.**

Second, **the natural ambient should be quantified in a way such that the INM calculation of the amount of time aircraft are audible is a realistic estimate of what a person standing at a given location in the park might experience.** To achieve this goal, it is of great importance that the natural ambient quantification method provide values that actually represent what the natural ambient could be if a person stood and listened. The method chosen here is to examine approximately equal time periods of data collection (18, 19 or 20 minutes), and use averages of these periods. The underlying assumption is that a 20 minute period is a not unreasonable length of time for a person to be in any one area of a park. Hence, straight arithmetic averages across these periods yield an estimate of what a visitor might experience at the site, on average.

2.4 Sound Monitoring Data Collected in the Grand Canyon

As stated above, sound monitoring data were acquired at 23 sites in the Grand Canyon during August and September, 1992. These data were collected at locations of interest to the National Park Service, and were intended to provide documentation of the Grand Canyon sound levels, both natural and human-produced. In an effort to respond to the present need to quantify the natural ambient conditions throughout the Canyon for use in computer modeling, the NPS reviewed the 23 sites to determine in which of the three identified sound environments each site was located: 1) Desert Scrub; 2) Pinyon-Juniper Woodland; 3) Sparse Coniferous Forest. Table 1, repeated from the December 2 memorandum, summarizes this review and categorization of the measured levels. Note that an additional characterization of some sites as "-f" for flat water has been added. These are sites that include the sound of water, but not from rapids. This categorization is addressed in Section 3.1, Site Selection.

Table 1. Summary of Measured Non-Aircraft Sound Levels for 23 Sites in the Grand Canyon

MEASURED NON-AIRCRAFT SOUND LEVELS FROM GRAND CANYON ACOUSTIC PROFILE SITES (See Notes to Table 1, following page)

Site Number	Site Description	Canyon Environment*	Number of 18, 19, 20 Min. Samples	Measured Traditional Ambient (Arithmetic Ave) Leq	L50 (dBA)	L90	Sources of Non-aircraft Levels (Traditional Ambient)	**
1	Marble Canyon (Mile 35.2), 30 ft from river	DS	6	52	52	51	water from rapids near by	w
2.1	Phantom Ranch Overlook (Edge)	DS	8	41	41	40	water from Bright Angel Creek below	w-f
2.2	Phantom Ranch Overlook (10' From Edge)	DS	1	36	31	30	same as 2.1, but shielded by edge	w-f
3	96 Mile Camp	DS	8	40	38	37	water. wind	w-f
5	Stone Creek Camp	DS	7	50	49	48	Dubendorff Rapids	w
6.1	Deer Creek Falls (Across River)	DS	10	46	45	44	ripples in water over rocks	w
6.2	Deer Creek Falls (1/2 Mile NE of Falls)	DS	5	28	27	26	only birds flying, river not audible	n/w-f
7	Havasu Creek	DS	33	57	56	56	Creek and Havasu Rapids	w
8	Whitmore Rapids, 150 feet from river	DS	23	40	37	36	Water. wind, insects	w
9	Separation Canyon	DS	11	23	21	18	mostly insects and birds, no rapids	n
10	Bright Angel Point Overlook	SCF	17	27	24	22	human activities	h
12	Desert View Overlook	PJW	19	48	43	37	Traffic and voices	h
13	Little Colorado River, 25 ft. from river	DS	7	39	38	37	Sounds of water and wind	w-f
14	Toroweap Overlook	DS	19	24	19	15	Mostly wind. Note that FEA shows rapid noise.	n
15	Point Imperial Overlook	SCF	38	31	29	27	Mostly visitor activity	h
16	Hermit Basin	PJW	24	23	21	18	insects and birds	n
17	Lipan Point Overlook	PJW	34	37	34	29	Parking lot activities	h
18	Yaki Point Overlook	SCF	16	44	41	34	Vehicles, gusty winds	h
19	Point Sublime Overlook	PJW	13	23	19	15	Birds and insects; wind not significant	n
20	117.4 Mile Camp, 20 feet from river	DS	16	44	43	42	Levels due to ripples on rocks about 300 ft downstream	w-f
21	Burnt Springs Canyon, 20 feet from river	DS	10	22	20	18	birds and wildlife only contributors	n
23	Diamond Creek	DS	14	35	33	28	insects (mostly cicadas)	n/w-f
31	Marble Canyon Dam Site / Buck Farm Canyon	DS	2	25	24	23	water (no rapids)and insects	n/w-f

* Based on three Canyon Environments:
1) DS = Desert Scrub
2) PJW = Pinyon-Juniper Woodland
3) SCF = Sparse Coniferous Forest

** w = significant water noise, -f=flat water
n = natural only
n/w = natural, plus some water, -f=flat water
h = significant human noise

Notes to Table 1

Site Number	The number assigned to the measurement location.
Site Description	Brief description of the location.
Canyon Environment	One of the three types of Canyon environments listed at the bottom of the table.
Number of Samples	Number of samples of 18, 19 or 20 minutes in length used to compute the arithmetic values of the three metrics.
Measured Traditional Ambient	The average of each metric, determined from the samples.
Sources of Non-Aircraft Levels	Description of primary sources of sound.
**	Simplified characterization of sound sources dominating the measurements, see bottom of table.

3. RESPONSES TO SPECIFIC ISSUES

3.1 Site Selection

As indicated above, the 23 sites were originally selected by NPS for the general purpose of quantifying a range of aircraft and non-aircraft sound levels, both in intensity of sound level as well as in the length of time both types of sounds were heard. The selection of sites was not based on the newer concept outlined in Section 2.3 of choosing sites by acoustic environment and by type of natural ambient to preserve. Hence, using these 23 sites for this latter purpose requires considerable examination of each to determine whether or not it conforms to one of the three environments (Desert Scrub, Pinyon-Juniper Woodland, Sparse Coniferous Forest).

As a first step, NPS personnel identified the Canyon environment category for each site by its location, and the column in Table 1 labeled "Canyon Environment" provides these categorizations. Next, the general descriptions of the "Acoustic Environment" given for each site were reviewed[9] for further categorization, as given in the column labeled "Sources of Non-Aircraft Levels (Traditional Ambient)."

[9] Op. cit., Horonjeff, R.D., *et al.*

Third, the cumulative distributions of the sites were examined, by acoustic environment, to understand in particular how water sounds may or may not have influenced the levels. Fifteen of the 23 sites were along the river, and the intent of this effort is primarily to quantify non-river Grand Canyon environments. Hence, it is important to decide whether or not water influenced the measured levels. Finally, for sites where the descriptions of the acoustic environment and the cumulative distributions left some ambiguity as to the sources of the measured sounds, the original observer logs were examined to determine what specific sources were identified and how often they were identified. (These logs were examined for sites 6.2, 10, 15, 18, 23 and 31.)

The following subsections provide responses to questions raised about proper use of measurement site data. The sections first examine the sites that provide useful information for estimating natural ambient conditions in various Grand Canyon environments. The specific types of sites examined are: 1) sites with natural sounds only, no water; 2) sites that have some water influenced sound levels; 3) sites in the Sparse Coniferous Forest environment; and 4) sites that have dominant water sounds. Section 3.1.5 then summarizes the measured sound levels from all these sites, and Section 3.1.6 discusses an alternative approach to using these measured data. Finally, Section 3.1.7 provides observations relative to the use of measurement site data for estimating the natural ambient conditions.

3.1.1 Natural Only Sites

First, the examination yielded the eight sites that are shaded in Table 1 as sites with significant amounts of measured natural ambient conditions, without significant water noise. The unambiguous sites of this type are: 1) Site 9 - Separation Canyon; 2) Site 14 - Toroweap Overlook; 3) Site 16 - Hermit Basin; 4) Site 19 - Point Sublime Overlook; 5) Site 21 - Burnt Springs Canyon. The cumulative distributions of these sites are given in Attachment 1. Note that these five sites have all been judged to lie in either the Desert Scrub or Pinyon-Juniper Woodland environments.

Referring to the distributions of Attachment 1, the similarity of these measured levels is quite striking. Except for the occasional louder sounds (to the left of the plot - these are the occasional loudest sound levels measured) all distributions fall within a band of ± 5 dB or narrower. This similarity occurs despite the fact that some of the sites are as far separated as 50 miles or more. Because of this consistency, these distributions are thought of as typical of natural no-water sound sites. That is to say, the general shape of these curves is representative of sites with no constant level sound source, such as water or constant insect sound levels. Also, their similarity, despite great distance separation, suggests that these data should be quite reliable representations of the type of natural ambient conditions for these sites.

3.1.2 Natural Sites, Some Water

The three remaining sites of the eight sites without significant water are somewhat more difficult to judge for their applicability to the non-water Grand Canyon Environments. They must be examined in some detail to determine whether or not water sounds have affected the measurements. (Attachment 2 provides the cumulative distributions for these sites.)

Site 6.2 - Deer Creek Falls (½ mile NE of falls). In Horonjeff, *et al*, the Acoustic Environment is described as follows: "The area is extremely quiet, as the river is not audible at this altitude. The only natural sounds are from birds flying." This description certainly suggests that there should be no water noise in the measured levels. However, the cumulative distribution for this site suggests that there are fairly constant sound levels at this location. Both Attachment 2 and Table 1 show that the measured sound levels here are very constant.

In discussions with G. Sanchez who made this measurement, he said that the sounds of birds flying were the occasional movement of wings, but in no sense constant. The site also had no vegetation and no insect activity was heard. Otherwise, his observer record showed mainly that he logged "wind in ear" which, since it was not particularly windy, is indicative of very low sound levels when nothing identifiable can be heard over the sounds generated at the ear by slight air movement. In other words, he could identify no continuous source of sound, despite the clear evidence of continuous levels in the cumulative distribution. He agreed that it was possible that low frequency water noise might have occurred there, and that the shielding provided by the edge of a drop-off would have removed the higher frequencies that help identify a sound as water produced. Others who have measured in quiet areas have also observed that when sound levels are low, it is often difficult to identify the type of source(s) that produce the sound.

As further confirmation of the likelihood that 6.2 is a measure of water produced sound, consider the distributions in Attachments 3 and 4. Attachment 3 gives distributions at "Sparse Coniferous Forest" sites. These sites are affected by wind in foliage, and the distributions show that constant sound levels are not produced in such circumstances. It is clear that the variable nature of the wind is reflected in the sound levels produced also being quite variable (i.e., the cumulative distribution is slanted, not flat or almost flat).

Attachment 4 provides the distributions for all sites with some water sounds other than near-by rapids. With the exception of Site 23, the effect of constant sound levels is apparent; the distributions are all quite flat. Note how the Site 6.2 distribution slope is similar to the slopes of the other site distributions (except Site 23).

Based on this examination, we judge the measured sound levels from Site 6.2 to be affected by water sounds, and that this site does not provide sound levels clearly representative of either the Desert Scrub or Pinyon-Juniper Woodland categories.

Site 23 - Diamond Creek. (Attachment 2 provides the cumulative distributions for two different days of measurement here.) The description of the Acoustic Environment says for the natural sounds only that "The levels can go up to 42 dB(A) as a result of insect noise (mostly cicadas)." Examination by G. Sanchez of the observer log showed that the sounds on the first day included water noise (rocks/ whirlpools) and wind in nearby tall vegetation. The second day observer log included water between 8:00 am and 9:53 am, locust/cicadas between 9:53 am and 11:22 am with maximums up to 64-65 dB(A). Hence, the distributions contain the sounds from these sources for the two days, with the effects of the insects obvious in the distribution of the second day (the slope is steeply increasing to the left, from about 50 percent on the horizontal axis down to 0 percent). Also note, however, that though there may have been water sounds included, they were not continuous enough or loud enough to appear as constant in either day's cumulative distribution. We conclude that the measured levels from this site result from water, insects and wind in foliage and seem unlikely to be sufficiently representative of any of the three Canyon environment categories.

Site 31 - Marble Canyon Dam Site / Buck Farm Canyon. (Distribution in Attachment 2.) The Acoustic Profile reads: "The ambient sound levels in the absence of aircraft are between 22 and 25 dB(A). These levels are mostly due to water and insect noise." G. Sanchez recalled that the water noise was audible and was due to water trickling through the rocks. The water (river) level changed dramatically through the day, with the highest levels between noon and 6:00 pm. Higher water levels would generally mean lower sound levels from water as rocks became submerged. This site was in a location of straight (vertical) sided canyon walls where sounds would echo for long periods. The cumulative distribution reflects the presence of continuous sound levels, typical of water. We conclude that this site too is affected by water, and seems inappropriate for quantifying any of the dry Canyon environment categories.

3.1.3 Sparse Coniferous Forest

The measurements applicable to this environment (Sites 10, 15 and 18, Attachment 3) were examined in some detail in the December 2, 1998 memorandum. Volpe does not comment. In the December 2 memorandum, however, a recommendation was made that the sound level for Sparse Coniferous Forest be unchanged at 26 dBA, assuming that the quietest periods should be the ones protected. Though using this level may be deemed appropriate by NPS if the objective is to preserve the quietest (least wind) times, for completeness and consistency with the levels presented here for the other environments, the averages of the Sparse Coniferous Forest sites should also be considered, and are presented in Section 3.1.5.

3.1.4 Flat Water Sites

Volpe suggests that measurement site results might be applied only locally, to the immediate region in which they were acquired. Though we believe such use of data is likely to be too sensitive to the precise site and time of data collection, (see Section 3.1.6 below), the concept of making more use of the available data is a good one, and we offer the following analysis of the sites with water sounds, excluding sites significantly affected by rapids.

The preceding analyses of Sites 6.2, 23 and 31 suggest that an additional Canyon environment might be

"Water Affected - No Rapids". All 23 sites were reviewed and eight sites categorized has having a "flat water" component, as indicated in Table 1. Attachment 4 presents the cumulative distributions of these 8 sites. Though the sound levels across these sites have a wide range, except for Site 23 their cumulative distribution curves are quite similar in slope, i.e., essentially flat, implying constant sound levels over time. All of these sites were at river side, (within about 100 feet) though two, Sites 2.1 and 6.2 were approximately 1000 feet from the river. Note that greater distance from the water does not necessarily mean quietest; Site 2.1 has sound levels of predominantly 40 to 42 dBA.

We conclude that, in terms of the available data, it is as reasonable to create a "Water Affected - No Rapids" category and corresponding natural ambient from these sites as it is to quantify the other three previously identified categories using the 23 site data. Though we know that sound levels certainly decrease with distance from the source of water sound, there presently is insufficient data to derive such a function. Rather, we propose that the average of the levels from the eight sites be applied to a corridor extending along either side of constant flowing water sources. (We cannot judge how much of the year / season a water source must flow constantly to be considered for this treatment.) As a first estimate of the width of such a corridor, 1000 feet along either side might be reasonable because two of the eight sites were about this distance from the water. The width to use probably depends upon the level of activity of the water (how loud) and on the openness of the Canyon. Less active water and / or narrower, steeper canyons likely mean less sound propagation and a narrower corridor.

3.1.5 Summary of Natural Ambient Sound Levels by Environment Category

From the above analyses, natural ambient sound levels for four different environments may be determined. Within these four environments, several options may be developed, depending upon which sites are included or excluded. Table 2 summarizes the results.

Referring to the specific observations in Section 3.1.2, we believe that Site 23 is probably best excluded from all environment categories, and that Sites 6.2 and 31 are reasonable water affected sites. Hence, we regard as most consistent in their derivation, options 1), 4), 5) and 7). We regard as fundamental in this determination the use of the distributions to separate the water affected sites from the non-affected sites and the realization that these sites were originally selected for purposes different from characterizing natural ambient by type of Canyon environment. Thus, the detailed exploration and analysis presented above is viewed as necessary and significant in arriving at a consistent use of the data from these 23 sites.

Table 2. Summary Natural Ambients by Category and Sites Included

Environment Category (Sites Included)	Average Values of the Three Metrics, dBA		
	L_{eq}	L_{50}	L_{90}
Desert Scrub			
1) Sites 9, 14, 21	23	20	17
2) Sites 9, 14, 21, 23	26	23	20
3) Sites 9, 14, 21, 6.2, 23, 31	26	24	20
Pinyon-Juniper Woodland			
4) Sites 16, 19	23	20	17
Sparse Coniferous Forest			
5) Sites 10, 15, 18	33	31	27
Water Affected - No Rapids			
6) Sites 2.1, 2.2, 3, 6.2, 13, 20, 23, 31	38	37	35
7) Sites 2.1, 2.2, 3, 6.2, 13, 20, 31	39	38	37

3.1.6 Alternative Uses of Measurement Data

Volpe comments twice suggest using single sites to characterize areas of the park, rather than averaging across sites. They first suggest including overlook data in "...the ambient mapping process." They also suggest that "... in the mapping process assign measured ambient sound levels for a desert scrub site to all desert scrub in the vicinity of that site; and for desert scrub areas geographically closer to another desert scrub site use the ambient sound level from that site. Therefore, if there are localized natural noise sources, e.g., a bird sanctuary, at a particular site they will be more accurately represented."

Single sites are likely to be affected by different conditions at different times, and the measured levels may vary considerably time to time. Further, single sites may be affected by atypical conditions or sources. Hence, we argue against applying the results from one site to a broad area, unless the measurements can be shown in some way to be representative of the area. If there is a wide-spread local source, such as a bird sanctuary, then that area could be designated as a category of its own (similar to Water Affected - No Rapids). It is worth noting, however, that subdividing a park too finely risks creating significant increases in data collection and associated increased use of human and financial resources.

If large areas of parks are to be categorized with a single natural ambient level, then averages over both time and area are necessary to provide some degree of confidence. Suppose, for example, each of the eight water affected sites had been used to characterize a length of the river. Results for each section of river would be very different from adjacent sections (and, we would argue, provide a questionable basis for decision making). By averaging the seven or eight sites, a more reasonable picture is produced. Levels do vary from place to place in the river, but it is very likely that these variations occur over short stretches and vary considerably depending on exact location (see Site 2.1 and 2.2 results, Table 1). Determining natural ambient conditions, we believe, should not be a micro-scale exercise.

There is no reasonable way natural ambient sound levels can be measured / determined meter-by-meter, or even mile-by-mile. Both natural ambient conditions and amount of time aircraft are audible must be considered as estimates for planning purposes, but that they are required to be reasonable averages. Ideally, the process of quantifying natural ambient conditions in the future can follow a more orderly approach, similar to that described in the December 2 memorandum: identifying "homogeneous" park environments; selecting accessible sites; measuring at quasi-random times, based on judgements of times of greatest sensitivity to sound intrusions; uniform reporting of measured levels, including cumulative distributions and brief, accurate descriptions of the sound environment; appropriate averaging over both time and space.

If it is possible to demonstrate that natural ambient conditions are similar site to site, additional measurements may be focused on a smaller number of sites. The sites used for options 1) and 4) are remarkably consistent in terms of their levels and distributions. Long term monitoring at perhaps two of these sites could be used to quantify trends over a season and season to season. In general, however, such consistency cannot be known without measuring at several distributed sites. We believe that use of single sites for characterizing a large area can easily be subject to significant error.

3.1.7 Observations Regarding Use of Measurement Site Data to Estimate Natural Ambient

The preceding discussions address two of the four critical questions that must be answered if values are to be selected to characterize the natural ambient conditions:

1. Which measurement site data should be included in each Grand Canyon environment category?
2. Should averages across several sites be used, rather than individual site data?

Regarding the first question, each site selected for each category should, we believe, apply to the given category as unambiguously as possible. A site applies unambiguously if it includes only sources of sound that are judged typical for the category. For example, no significant water sound should be included in site data characterizing dry areas; no significant wind in foliage in categories without vegetation. (However, see Section 3.2.2, Observations Regarding Use of Metric.) For this reason, we believe that options 1) and 7) of Table 2 are the least ambiguous sites for characterizing the Desert Scrub and the Water Affected - No Rapids categories. Also, because of the consistency across the sites included in these options, we assign a high level of confidence to these options as appropriately characterizing the two categories.

Regarding the second question, we believe that the risk of inaccurately characterizing a Grand Canyon environment decreases to the extent that measurement data from more locations are included in the averaging process. Use of single sites should be done only when there are clearly no other similar sites measured in the category.

3.2 Sound Level Metric Used

3.2.1 Discussion of Possible Metrics

Volpe suggests that use of L_{50}, though not entirely disagreeing with its use because it may make some intuitive sense, is not supported in the literature, and the equivalent level, L_{Aeq} (or L_{eq}) is supported by all previous work. Though it is certainly accurate that L_{Aeq} is widely used to characterize both intruding sounds (from aircraft, roadways, trains, etc.) and to quantify "ambient sound" or "background sound." We must emphasize, however, that most, if not all analyses of environmental sounds have as primary goals the assessment of the effects the sounds will have on humans - activity interference, annoyance, behavioral responses, health effects.

The presently accepted hypothesis about these types of effects is that they are reasonably correlated with total sound energy, as quantified by equivalent levels. This hypothesis is that the human reactions of interest are the same whether a sound is short and loud or long and quiet, provided both produce equal total sound energy.[10] However, these effects are not the present issue. The modeling has as its goal, estimation of the amount of time aircraft will be audible or noticeable.

Audibility is a physiological response, strongly correlated with fundamental physical parameters of the sound. It is these fundamental physical parameters that are to be determined: What is the sound level of the aircraft? What is the sound level of the natural ambient? Equivalent levels are inappropriate in this application. Except for very unusual situations (e.g., when sound levels are almost constant for more than half the time, and drop quite low for just less than half the time), natural ambient L_{Aeq} will be a level that is exceeded less than half of the time. (For examples, see the values for the sites given in Table 1.) Hence, it will almost always overstate the ability of the natural ambient to mask intruding sounds. Put another way, L_{Aeq} of the

10 We note that a recent U.S. Air Force study produced initial evidence that park visitors' annoyance with overflights is reduced if aircraft fly over close together (as a single noise event), rather than as several individual events. See Miller, N.P., *et al*, "Mitigating the Effects of Military Aircraft Overflights on Recreational Users of Parks," HMMH Report 294470.04 (Draft).

natural ambient will almost always result in underestimates of the amount of time an intruding sound can be heard.

For a sound level distribution that is representative of the natural ambient conditions in a given environment category, the median sound level, L_{50}, is in our view the best single number unbiased characterization of those natural ambient conditions. It is the level that the natural ambient is greater than half the time and that the natural ambient is less than half the time. The lack of use of L_{50} in the literature for current and previous studies is likely due to two factors. First, as mentioned, most analysis effort is directed at assessing human responses, which have been shown to strongly correlate with total sound energy (L_{Aeq}). Second, it is unlikely that A-weighted levels have been used very often to assess audibility of sounds. Neither of these factors can be said to invalidate the proposed use of L_{50} to characterize the natural ambient conditions.

It is often the case, however, that acquiring a sufficient sample of sound levels that represent the natural ambient conditions of interest may be difficult or impossible. Much monitoring, because of cost, is conducted with no observer present; sources of sound thus are not identified. Adequate numbers of measurements, both at different times and in different locations, may not be possible. Human-produced sounds are sometimes so ubiquitous, that it is virtually impossible to obtain sufficient samples of solely natural ambient levels. An alternative quantification approach is required.

A metric often used for characterizations of "background" or "ambient" is L_{90}, the level exceeded 90% of the time. Though for most recent studies of aircraft noise around airports (and transportation noise in general), the background noise is rarely considered, some state laws and previous broad-based examinations of noise have included the concept of using L_{90} as a measure of the "background" sound levels. State laws in Massachusetts, Connecticut and Illinois contain the concept of using L_{90} to determine the "ambient". Attachment 5 provides a copy of the Massachusetts policy for enforcing its noise regulation. The L_{90} metric is used as an estimate of the basic sound levels that would exist when all intruding sources are quiet.

Both the metric of L_{90} and the concept of the importance of residual sound (non-specific sound levels that exist in the absence of the intruding sources of concern) were introduced early in developing an understanding of how intruding noises affect people. One of the original U.S. EPA studies that examined the overall noise pollution problem associated with outdoor noise in the community laid the initial ground-work for examining the effects of outdoor noise on people.[11] This report provides case studies of communities affected by noise intrusions, and concludes that "residual noise level" (as measured by L_{90}) has

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11 "Community Noise", U.S. Environmental Protection Agency, NTID300.3, December 31, 1971.

a significant effect on how communities react to such noise intrusions.[12] In fact, to measure the magnitude of intruding noises, relative to community reaction, the difference between the equivalent level, L_{eq}, of the intruding noise and L_{90} was recommended.[13]

The metric L_{90} continues to be used to regulate community noise levels. A recent noise ordinance in New Jersey uses both L_{90} and L_{eq} to limit noise in sensitive areas of a township.[14] In developing a noise ordinance, a sound survey was used to provide data for establishment of rational minimums. "[The sound survey] should be designed to evaluate sound levels over a period of several days, preferably during the season in which they will be lowest to identify the lowest levels to be preserved."[15] These surveys resulted in selection of limits on sound levels, in terms of both L_{90} and L_{eq}.

In the 1989 study sponsored by NPS, L_{90} was recommended as the metric for quantifying the background levels in parks.

> "The measurements showed that background sound played a significant role in determining the relative loudness of an aircraft event and the duration for which the aircraft signal was audible. In these quiet park/wilderness settings, even low-levels of aircraft sound were clearly audible for extended durations.
>
> ....
>
> Accurate information relative to the background sound levels is the most critical and variable element in quantifying the detection of the aircraft events. The background level is the level above which the aircraft event becomes intrusive. The influence of temporal variations in the ambient sound levels are minimized by using the L_{90} descriptor to represent the background sound level. This study recommends that L_{90} in each ⅓ octave band and the A-weighted L_{90} be used to define the background sound level."[16]

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12 See Table 11 of NTID300.3, and associated text. The essence of the case study analysis is that quieter background environments can result in greater community opposition to intruding noise sources.

13 See page 92 and Table 20 or NTID300.3.

14 "Developing Rational Environmental Noise Standards," Erdreich, J., **Sound & Vibration**, December 1998.

15 Ibid, p26.

16 "Methodology for the Measurement and Analysis of Aircraft Sound Levels within National Parks," Dunholter, P., *et al*, MGA Technical Report 89-P07, March 198,. pvi.

All of these uses of L_{90} are intended to quantify the underlying "background" or residual sound level as it would be when all occasionally or regularly intruding sound sources are absent. In these applications, it is understood that these intruding sources can not necessarily be "turned off" or quieted during the sound measurements. In such circumstances, off-the-shelf noise monitors can be used to approximate the absence of these sources by measuring L_{90}.

Thus, in cases where monitoring is unattended, or where a reasonable size sample of sound levels that are unambiguously produced by characteristic natural sources cannot be obtained, then use of L_{90} appears appropriate. Precedent in the acoustics community suggests that these are reasonable situations for use of L_{90}.

Section 3.2.2 Observations Regarding Use of Metric

The preceeding discussions address the third of the four critical questions:

3. What metric of sound should be used to quantify the natural ambient?

The above discussions suggest that a two-part approach to selecting a metric may be appropriate. If, on the one hand, the available site data are ambiguous as to the types of sources measured, are insufficient in number or are not clearly representative of the specific category of natural ambient conditions, the use of the L_{90} metric seems the most appropriate. Not only has this metric been used in the past to quantify sound environments that would exist in the absence of intruding sources, but its use reduces the risk of inadvertently including intruding sounds in the natural ambient conditions. If, on the other hand, all site data are judged to include only sources applicable to the given category, are sufficient in both number of times and number of locations measured, then L_{50} would be the metric of choice.

Two important points need emphasis. First, some degree of informed judgement will always need to be applied to use of sound measurement data collected in parks. So many sources of sound, both natural and human produced, may be present and measured, that some flexibility in orderly selection of natural ambient values is appropriate. In our view, measurements should rarely be made blindly, without information about what sources of sound were measured. Rather, as much information should be acquired as is feasible so that decisions about the use of the data are based on information, rather than on a single strict procedure. Using two metrics provides a choice, an opportunity for application of reasoned judgement, but a fairly simple binary one.

Second, beware of arguments over decibels. Measured (and predicted) sound levels should be thought of as values with some range of confidence. For example, the distributions shown in Attachment 1 represent a sample of the true conditions. Basic statistics tell us that a sample of information can give only an estimate of the true average within some range of confidence. So, for example, measured data may yield an average L_{90} of 20 dBA with 95% confidence that the true average is 20 dBA ±2 dB. It is rare in environmental acoustics that such confidence limits are less than ±2 dB, and may be as large as ±3 dB to ± 5 dB. The magnitude of these limits depends upon the "scatter" of the data. For example, the distributions of Attachement 1 would have considerably smaller confidence limits than the distributions of Attachments 3 or 4.

3.3 Use of "Spike Smoothing" Algorithm

Volpe states that the "spike smoothing" algorithm effectively eliminates the occasional louder sounds that provide little useful masking of intruding sounds, and that therefore the L_{Aeq} calculated with this algorithm should be appropriate to characterize the natural ambient.

The spike smoothing (actually spike removal) algorithm was developed to account for situations experienced in the Canyon. Loud bird calls occur occasionally, and in some of the very quiet natural ambient conditions, it was feared that these calls would affect the L_{Aeq}. The algorithm examines the rise time and duration of the sound levels. If the sound level rises more than 10 dB in one second, and stays at a high level for less than 5 seconds, the samples for that time period are removed from the analysis.

In practice, this algorithm rarely removes samples. Of 12 one hour samples collected in Rocky Mountain National Park, one had 2 seconds of data removed by this algorithm. Not using the algorithm had no effect on the calculated L_{Aeq}. G. Sanchez reports that for 29 one hour samples acquired in Everglades and Biscayne National Parks, only 6 had any samples removed. Five of these samples had less than 5 seconds of data removed, one had 30 seconds removed. When these sites were reprocessed without the spike removal operational, L_{Aeq} values for the natural ambient changed by less than ½ dB. We conclude that the spike removal has no significant effect on natural ambient L_{Aeq}, and our concern that L_{Aeq} overstates the natural ambient conditions remains.

3.4 Averaging Process

Section 3.4.1 Discussion of Averages

Volpe proposes two different approaches: 1) do not average across sites, but use single sites to characterize only the surrounding area; 2) use logarithmic averages.

In Section 3.1.6 we discuss in some detail several reasons for our reluctance to use single sites to represent larger, surrounding areas. In essence, natural ambient levels may or may not vary significantly from site to site within a given category of the park (desert scrub, etc.). If they do vary, then either further analysis is important to determine why the levels vary, or more samples need to be collected. (For example, do the sites not really represent the same category of environment, or were the categories or sites incorrectly chosen?) Because the measured results differ from site to site is not sufficient reason for treating each site as unique and applying its results to only a limited surrounding area. More information is needed to understand why they differ.

Logarithmic averaging results in a number heavily affected by the loudest samples included. Suppose a site is measured one hour on each of ten different days with the resulting levels given in Table 3. Which is a more realistic estimate of what a visitor might experience during an hour at this site, the arithmetic average or the logarithmic average?

Table 3. Hypothetical Measurement Results for Ten Different Days

Sample Number	Measured Level, dBA
Day 1	23
Day 2	24
Day 3	22
Day 4	25
Day 5	23
Day 6	21
Day 7	27
Day 8	42
Day 9	17
Day 10	25
Arithmetic Average	24.9
Logarithmic Average	32.5

Section 3.4.2 Observations Regarding Averages

The preceding discussions address the last of the four critical questions that must be answered if values are to be selected to characterize the natural ambient conditions:

4. What type of averaging process should be used?

Though logarithmic averages have a role, specifically in determining the appropriate sound level to use for characterizing a class of noise sources, their use is based on a fundamental assumption - that the effects of sound from a given source correlate with the total sound energy produced by that source. In the park situations the focus is, as mentioned, not on the effects on humans, but on the amount of time an intruding sound is audible or noticeable. Times of audiblity and noticeability depend on the total distribution of the natural ambient sound levels, not on the total sound energy of the natural ambient sound levels. A park location that is quiet most of the time, but very loud on the day of a flash flood should not be characterized in a way that emphasizes the one loud day. Aritmetic averages are, we believe, the appropriate type of metric.

3.5 Other Sources of Data

Volpe questions why data from the other studies were not used in determining values for the natural ambient conditions. In large part, the other studies were not used due to their lack of comprehensive or comparable information and because of the effort required to make their data comparable. (Refer to the December 2 memorandum for full references.)

Ref 1. Contains C-weighted ranges measured and some ⅓ octave band data.
Ref 2. Single levels for various aircraft overflights.
Ref 3. Listening only, no quantitative data.
Ref 4. Histograms of 50 samples each, taken in 5 second intervals, excluding aircraft noise intrusions.
Ref 5. Samples at various sites, reporting aircraft L_{max}, L_{90}, ⅓ octave band levels, critical frequency for detection, duration of aircraft levels above L_{90}, detectability index.
Ref 6. "Mean" A-weighted values and percent of time audible for samples of many continuous hours.
Ref 8. Aircraft L_{max} and ranges of aircraft and of A-weighted sound levels for various sources.

We agree that from a few of these, possibly Refs 4 and 5, some additional useful data might be extracted, but the effort involved to categorize the sites where measurements were taken, translate the data to comparable forms (especially cumulative distributions), and understand exactly what contributed to the measured sound levels was judged too great for the utility of the added information. All of these data have been examined at some length in 1992 to estimate the quantitative effects of SFAR 50-2 in reducing sound levels in the Canyon.[17] The difficulties of use were judged too great compared with the additional information likely.

17 May 7, 1992, Memorandum from N. Miller to E. Hernandez, NPS, "Comparison of Pre- and Post-SFAR 50-2 Acoustic Data." At that time it was found difficult or not possible to determine exactly where measurements had been made, and the only common metric that could be found was the amount of time aircraft sounds could be heard - and this for only a

3.6 May 15, 1997 HMMH Memorandum

Volpe points out that the recommendation of a May 15, 1997 HMMH memorandum for the Desert Scrub environment was 3 dB higher than our present recommendation. Our copy of that memorandum "A-weighted Level Differences Compared with Detectability" addressed only the issue of detectability, and not the derivation of natural ambient levels for the Grand Canyon. However, on July 16, 1998, at a meeting of NPS, Volpe, HMMH and ETC to discuss data collection protocols, HMMH may have distributed a worksheet of estimated natural ambient levels derived from the 23 site data. Perhaps this worksheet is the Volpe reference. The worksheet was prepared only to suggest that the ambient levels used for modeling the Grand Canyon seemed to us to be too low. The values were roughly prepared the preceding day to give people a sense for the possible magnitudes of the increases in natural ambient that might result. The level of detail in that brief analysis was very rough compared with that used to derive the levels presented here in Table 2.

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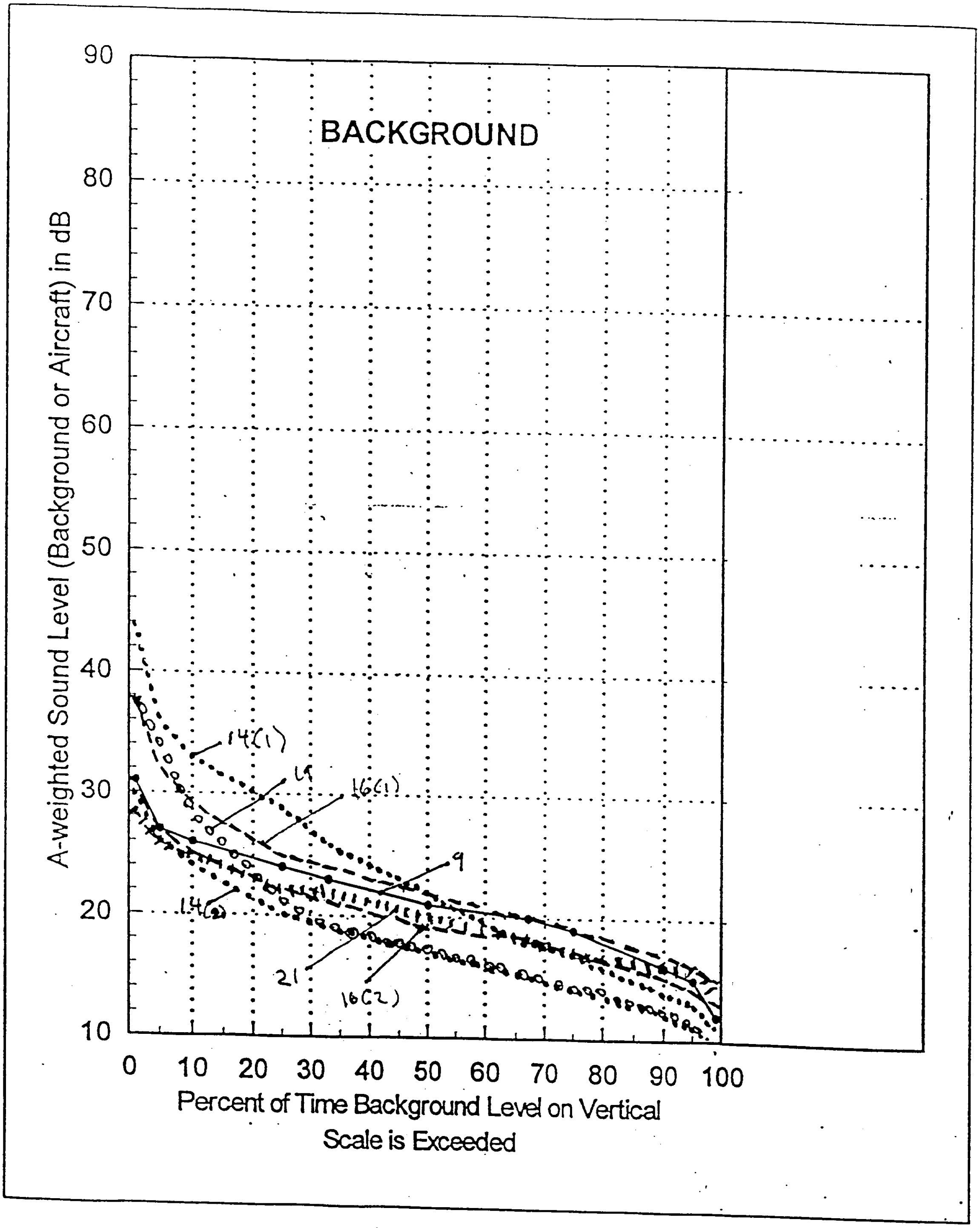
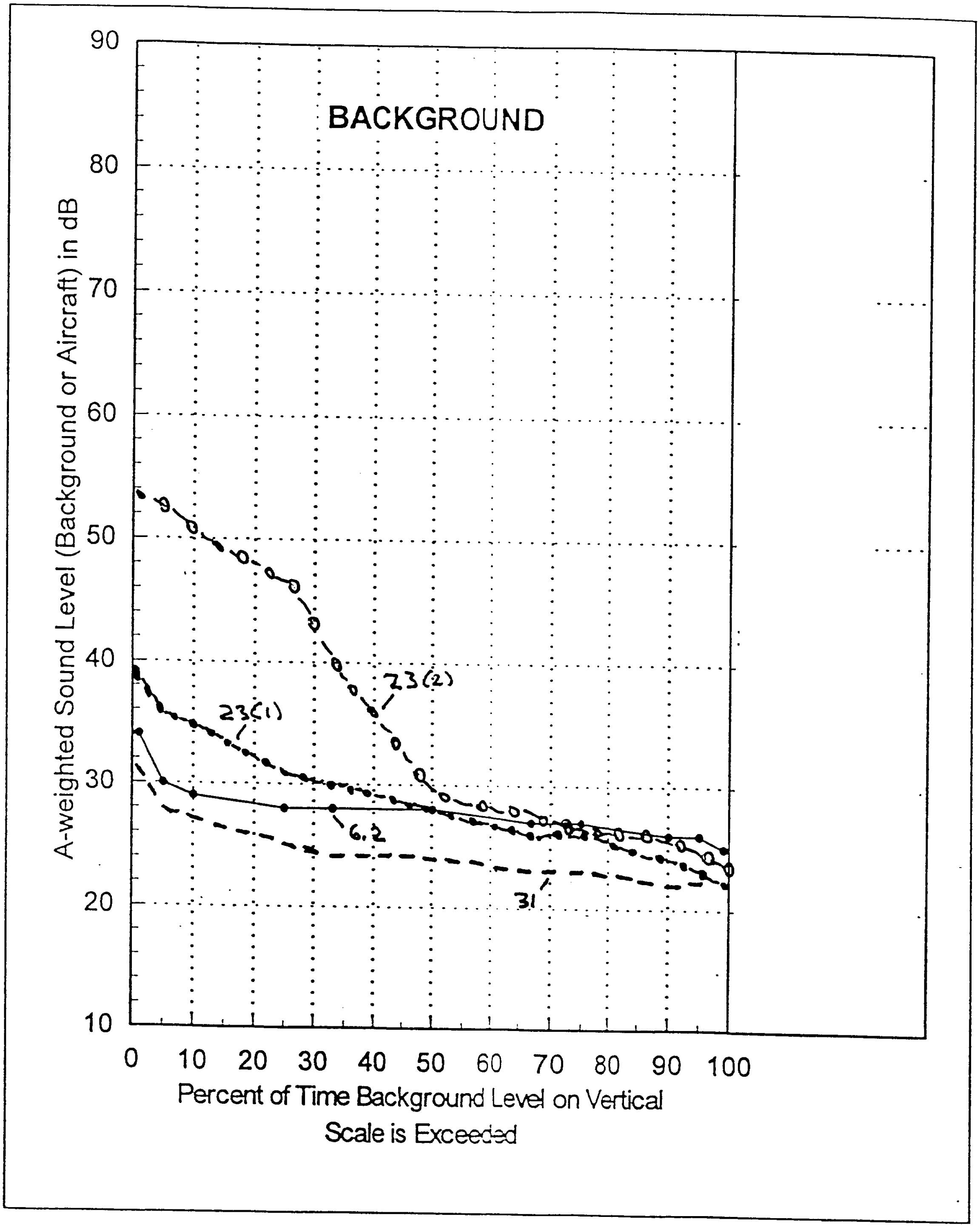
few locations. The memorandum stated: "For the Phantom Ranch / Tip-Off area and for the Horn Creek / Plateau area, the pre- and post-SFAR monitoring suggests that the amount of time aircraft sounds can be heard post-SFAR has been reduced to one-half to two-thirds of the time that they were heard pre-SFAR, and that the number of aircraft heard per hour may have declined by about thirty percent." The difficulties of using these studies, in fact, helped in the design of the extensive monitoring survey conducted for Ref 7.

Attachment 1
Natural Only Sites
Cumulative Distributions
(Sites 9, 14, 16, 19, 21)



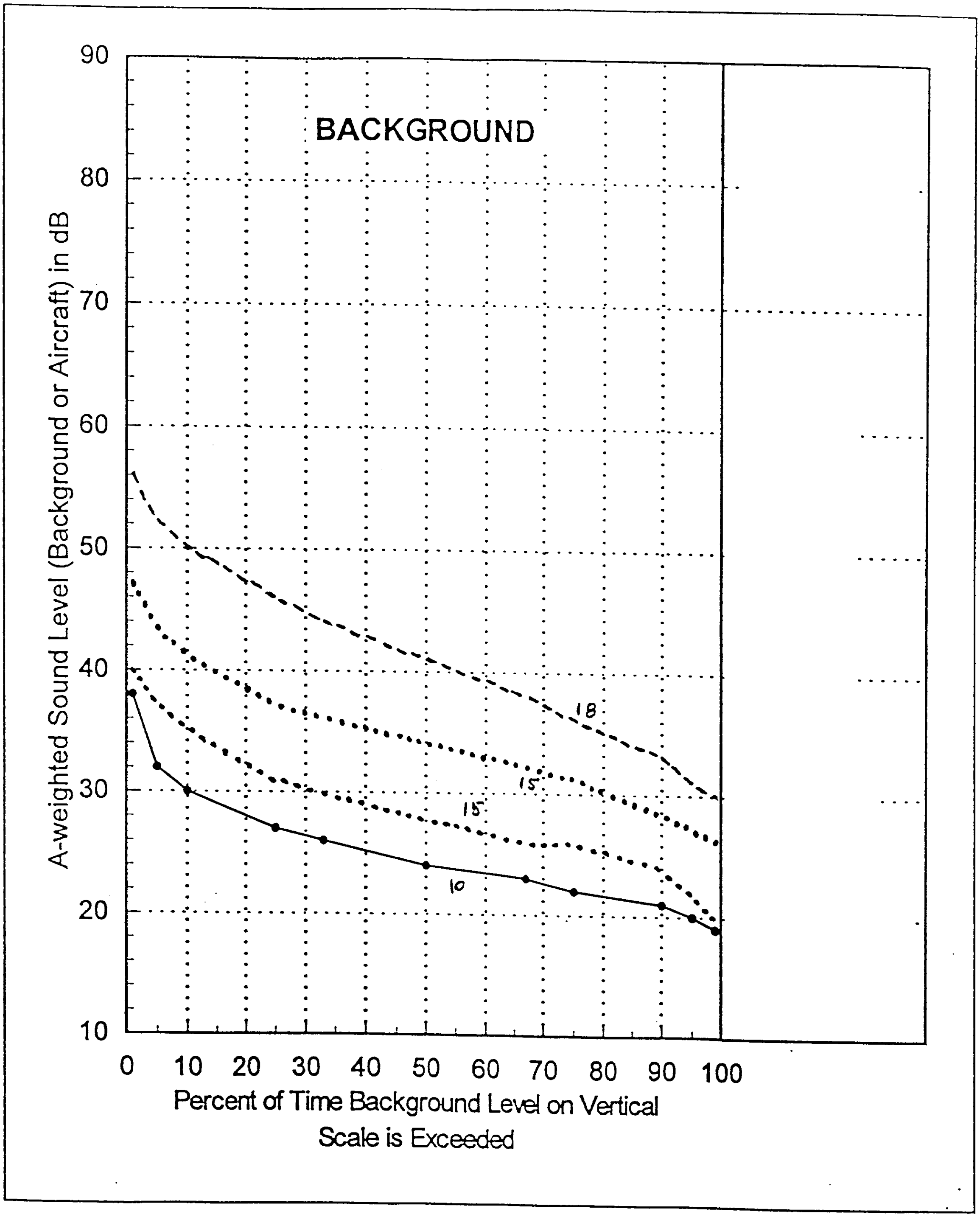
Sites: 9, 14(2), 16(2), 19, 21

Attachment 2
Natural Sites, Some Water
Cumulative Distributions
(Sites 6.2, 23, 31)



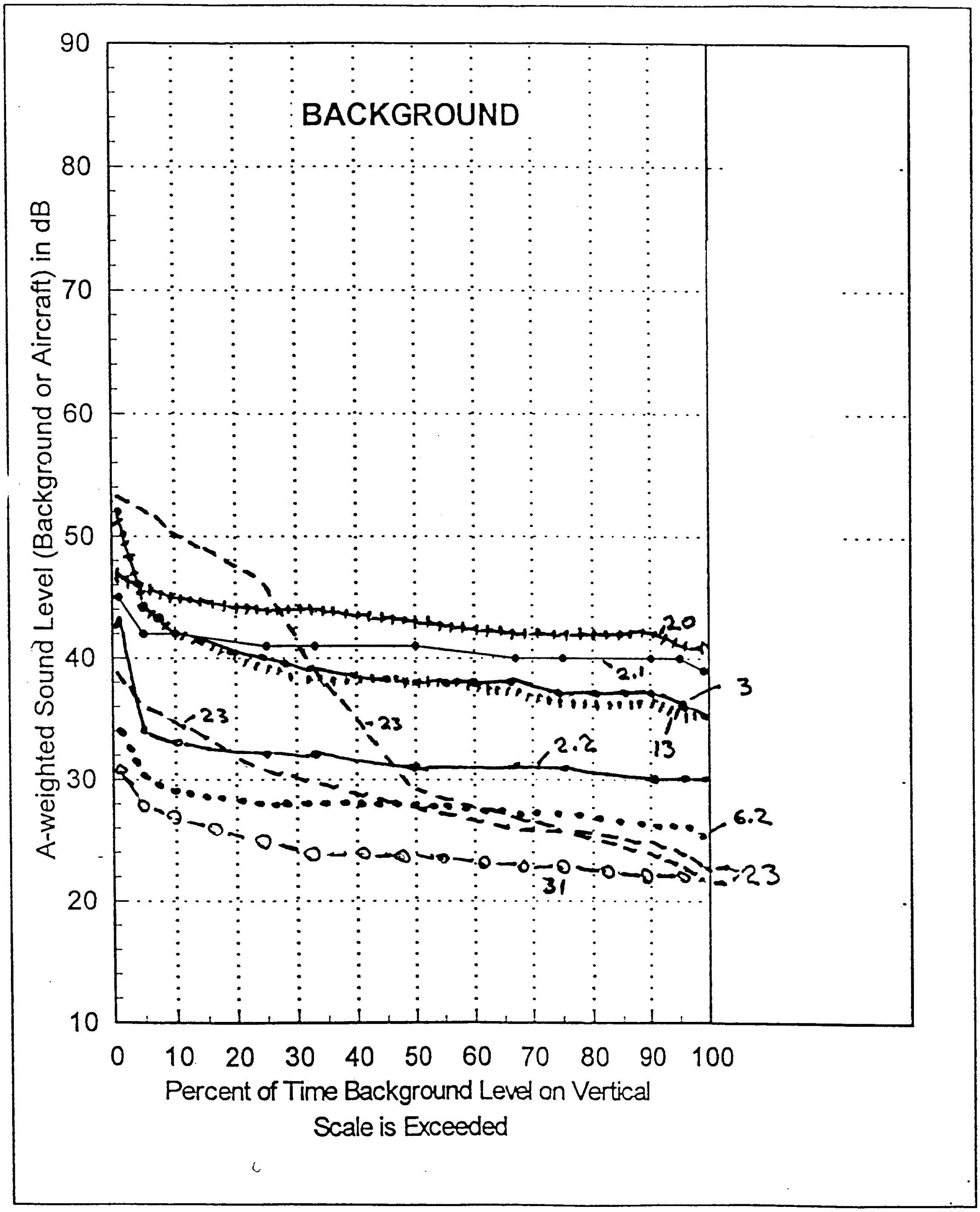
NATURAL, SOME WATER, 6.2, 23(2), 31

Attachment 3
Sparse Coniferous Forest Sites
Cumulative Distributions
(Sites 10, 15, 18)



SITES 10, 15(2), 18

Attachment 4
Flat Water Sites
Cumulative Distributions
(Sites 2.1, 2.2, 3, 6.2, 13, 20, 23, 31)



FLAT WATER SITES - 2.1, 2.2, 3, 6.2, 13, 20, 23(2), 31

Attachment 5
Massachusetts Policy for Enforcing its Noise Regulation

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Air Quality Control
One Winter Street, Boston 02108

February 1, 1990

DAQC Policy 90-001

DIVISION OF AIR QUALITY CONTROL POLICY

This policy is adopted by the Division of Air Quality Control. The Department's existing guideline for enforcing its noise regulation (310 CMR 7.10) is being reaffirmed.

P O L I C Y

A source of sound will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or

2. Produces a "pure tone" condition - when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. Ambient is defined as the background A-weighted sound level that is exceeded 90% of the time measured during equipment operating hours. The ambient may also be established by other means with the consent of the Department.

Approved: February 1, 1990 Effective: Immediately

Barbara A. Kwetz
Barbara A. Kwetz
Acting Director
Division of Air Quality Control

U.S. Department
of Transportation

**Research and
Special Programs
Administration**

Memorandum

Subject: Information: NPD Data for MD900 and DHC-6 in Support of INM and GCNP Modeling Effort

Date: March 19, 1999

From: Gregg G. Fleming *Gregg G. Fleming*

Reply to Attn. of: DTS-34

To: Thomas L. Connor; FAA, AEE-100

As you know, in October and November of 1996 we participated in an aircraft noise measurement program at the NASA Ames Crows Landing Test Facility, located south of Modesto, CA. As part of the Crows program, Volpe conducted noise characterization studies of the McDonnell Douglas MD900 Explorer Helicopter and the DeHaviland DHC-6 installed with the Raisbeck Quiet Propeller. One of the many objectives of this program was to conduct noise measurements of these two aircraft under controlled, research-quality conditions, with an ultimate goal of generating noise-power-distance (NPD) curves for input to the Integrated Noise Model (INM). These data have been processed in accordance with the procedures outlined in FAR Part 36, and INM-ready NPD curves have been generated. This memorandum documents these NPD curves which will be used in the current GCNP modeling analysis, and will be included in an upcoming version of the INM.

The data for the MD900 were collected during the actual FAR Part 36 Appendix H certification test for the craft, and therefore included takeoff, approach and level flyover operations measured at three microphones, a centerline and two 500 ft sideline microphones.

The data for the DHC-6 were collected at a centerline microphone. Specific operations included full power takeoff, a derated takeoff, an approach and two level flyover configurations. As you are aware, INM does not currently include data for fixed-wing aircraft operating in a level flight configuration. The sole purpose of measuring the craft under this type of configuration was to support future anticipated GCNP noise modeling efforts. In fact, it is essential to point out that the DHC-6 measured was provided by Twin Otter International, a major tour operator at GCNP at the time of measurements. Further, Twin Otter also provided the pilot who was a registered tour pilot in GCNP. During the level flight portion of the tests the pilot was instructed to fly the aircraft exactly as he would during two types of GCNP operations: a direct cruise to Las Vegas, which tended to occur at comparably higher airspeeds and increased power settings, and an east-end GCNP tour, which tended to occur at lower speeds and power settings.

Table 1 presents the NPD data for the MD900 operating in a takeoff, approach and level flyover configuration. Table 2 presents the reference conditions for the MD900 tests. Table 3 presents, for the DHC-6, NPD data for two takeoff configurations, one approach configuration, and two level flyover configurations. The reference conditions for DHC-6 are presented in Table 4.

If you have any comments or questions please do not hesitate to contact me.

Attachments

cc: J.M. Skalecky; FAA, AEE-110
K.E. Jones; FAA, AEE-110
M. Marsan; FAA, AEE-110
J.A. Plante; FAA, AEE-120
J.M. Gulding; FAA, AEE-120

C:\My Documents\GCNP_NPD WP6 wpd

Table 1: MD900 NPD Data

L_{AE}									
	Takeoff			Approach			LFO		
Distance	Left	Center	Right	Left	Center	Right	Left	Center	Right
200	82.9	89.3	83.2	85.3	92.1	84.6	78.4	83.9	80.0
400	81.9	85.1	82.2	84.3	88.7	83.7	77.3	80.2	79.0
630	80.5	82.1	80.7	82.9	86.2	82.3	75.9	77.6	77.7
1000	78.3	78.9	78.5	80.8	83.4	80.2	73.8	74.8	75.6
2000	73.7	73.4	74.0	76.3	78.6	76.0	69.4	70.2	71.5
4000	67.7	67.0	68.0	70.5	72.9	70.5	63.8	64.7	66.1
6300	62.9	62.0	63.3	66.0	68.5	66.2	59.3	60.4	61.9
10000	57.3	56.4	57.8	60.9	63.4	61.2	54.1	55.5	57.1
16000	51.0	50.2	51.6	55.1	57.6	55.4	48.3	49.9	51.7
25000	46.0	44.3	46.4	49.5	51.7	49.8	44.4	45.3	47.0

L_{ASmx}									
	Takeoff			Approach			LFO		
Distance	Left	Center	Right	Left	Center	Right	Left	Center	Right
200	73.9	83.9	74.7	74.9	85.9	75.4	71.0	80.4	73.2
400	72.3	77.2	73.0	73.1	79.3	73.6	69.2	73.9	71.5
630	70.0	72.6	70.8	70.7	74.9	71.3	66.9	69.5	69.2
1000	66.6	67.7	67.4	67.2	70.2	67.9	63.4	64.8	65.8
2000	59.7	59.6	60.5	60.5	62.7	61.2	56.6	57.4	59.1
4000	51.0	50.4	52.1	52.6	54.3	53.0	48.4	49.3	51.1
6300	44.4	43.7	45.6	46.7	48.3	46.9	42.2	43.3	45.1
10000	36.9	36.5	38.3	40.0	41.7	40.1	35.2	36.7	38.4
16000	28.4	28.3	30.0	32.6	34.3	32.6	27.3	29.1	30.8
25000	20.4	20.1	21.7	24.9	26.8	25.1	19.9	21.5	23.2

L_{EPN}									
	Takeoff			Approach			LFO		
Distance	Left	Center	Right	Left	Center	Right	Left	Center	Right
200	84.8	92.5	85.3	87.6	95.2	87.6	80.4	87.2	83.5
400	83.6	87.6	84.0	86.4	91.2	86.4	79.1	82.9	82.3
630	81.8	84.1	82.2	84.8	88.3	84.9	77.5	79.8	80.7
1000	79.1	80.0	79.5	82.3	85.1	82.5	74.9	76.4	78.3
2000	73.6	73.5	74.1	77.2	79.7	77.5	69.7	71.0	73.3
4000	66.6	66.4	67.3	70.6	73.6	71.1	62.7	64.9	67.0
6300	60.9	61.1	61.7	65.4	68.9	66.0	57.0	60.1	61.8
10000	53.5	53.0	54.4	58.3	61.4	59.0	49.7	51.7	54.6
16000	43.3	42.6	44.7	49.4	52.8	49.9	39.5	42.4	45.1
25000	24.1	23.5	26.2	36.0	40.1	35.7	29.8	24.6	28.7

L_{PNLTmx}									
	Takeoff			Approach			LFO		
Distance	Left	Center	Right	Left	Center	Right	Left	Center	Right
200	85.4	96.4	86.8	87.6	99.0	88.3	83.4	93.4	87.0
400	83.5	89.3	85.0	85.7	92.1	86.4	81.5	86.5	85.1
630	80.9	84.2	82.4	83.3	87.4	83.9	79.0	81.6	82.6
1000	77.0	78.6	78.4	79.6	82.3	80.2	75.2	76.5	78.9
2000	69.3	69.5	70.9	72.3	74.1	72.8	67.6	68.5	71.5
4000	60.0	60.5	61.9	63.4	65.3	63.9	58.4	60.0	62.7
6300	53.2	54.1	55.1	57.3	59.5	57.7	51.3	53.9	56.5
10000	43.9	43.9	46.2	48.5	50.3	48.6	42.3	43.6	47.2
16000	32.7	32.7	35.4	38.4	40.5	38.4	31.1	33.3	36.3
25000	12.9	12.9	16.7	24.7	27.6	24.0	8.4	14.9	19.4

Table 2: MD900 Reference Conditions

	Angle (°)	Speed (kts)	Altitude (ft)
LFO	0	118.8	492
TAK	18.53	64	614.7
APP	-6	67	394

Table 3: DHC-6 NPD Data

L_{AE}					
Distance	TAK1	TAK2	APP	LFO	
				Tour	Cruise
200	97.8	92.3	82.3	82.6	87.6
400	94.5	88.6	77.9	78.6	84.1
630	92.3	86.1	74.7	76.3	81.6
1000	90.0	83.4	71.2	72.7	78.8
2000	86.3	79.2	65.5	67.6	74.1
4000	82.0	74.7	59.2	61.8	68.8
10000	75.2	68.0	50.1	52.9	60.8
25000	66.0	60.1	41.3	43.9	51.4

L_{ASmx}					
Distance	TAK1	TAK2	APP	LFO	
				Tour	Cruise
200	96.8	89.2	77.2	78.3	84.7
400	90.5	82.7	70.0	71.3	78.1
630	86.3	78.4	65.1	67.4	73.6
1000	82.1	74.0	59.9	61.7	68.9
2000	75.4	67.2	51.5	53.9	61.5
4000	68.3	60.1	42.3	45.6	53.8
6300	63.3	55.3	36.2	39.8	48.4
10000	57.7	50.2	30.0	33.6	42.6
16000	51.3	44.6	23.6	27.0	36.3
25000	44.6	38.7	17.9	20.1	29.8

L_{EPN}					
Distance	TAK1	TAK2	APP	LFO	
				Tour	Cruise
200	103.9	99.9	88.0	88.5	92.7
400	100.3	96.1	83.2	84.1	88.9
630	97.7	93.4	79.5	81.2	86.0
1000	95.0	90.4	75.3	76.6	82.6
2000	90.8	85.6	67.6	69.7	77.1
4000	85.7	79.9	58.6	62.3	71.1
6300	82.2	76.0	52.3	56.7	67.1
10000	77.5	71.0	42.8	48.9	60.4
16000	72.2	65.6	28.3	38.4	53.5
25000	66.1	59.4	7.3	25.7	44.4

L_{PNLTmx}					
Distance	TAK1	TAK2	APP	LFO	
				Tour	Cruise
200	112.2	108.0	93.6	95.5	101.3
400	105.7	101.4	86.0	88.0	94.5
630	101.2	96.9	80.5	83.4	89.7
1000	96.6	92.1	74.4	76.6	84.6
2000	89.4	84.7	64.3	67.2	76.1
4000	81.6	76.3	52.8	57.4	67.2
6300	76.2	70.4	45.0	50.3	61.8
10000	69.6	63.9	34.6	41.0	53.3
16000	62.6	56.7	19.6	29.6	45.0
25000	54.9	48.9	6.4	14.1	34.4

Table 4: DHC-6 Reference Conditions

	Angle (°)	Speed (kts)	Altitude (ft)
LFO-Tour	0	94	492
LFO-Cruise	0	125	492
INM TAK 1	15.2	81.5	492
INM TAK 2	14.2	76.4	492
APP	-2.9	78.5	492

U.S. Department
of Transportation

Research and Special Programs Administration

Memorandum

Subject: Technical Note: Helicopter Noise Modeling in Grand Canyon National Park

Date: May 17, 1999

From: Gregg G. Fleming

Reply to Attn. of: DTS-34

To: Jake A. Plante; FAA, AEE-120

This brief technical note was prepared in support of the noise modeling effort performed for the 1999 Environmental Assessment for Grand Canyon National Park (GCNP). The objective of the note is to provide a clear understanding of helicopter noise modeling and related time above (TA) computations within the FAA's Integrated Noise Model (INM).

Figure 1 below presents an example plot of A-weighted sound level as a function of time (i.e., time history plot) for a given aircraft flyover at a given speed v_1. Also shown is a similar time history plot for the same aircraft flyover but at a different speed v_2, such that v_2 is greater than v_1. The maximum A-weighted sound level (L_{ASmx}) along with a threshold sound level (L_{TH}) is also presented.

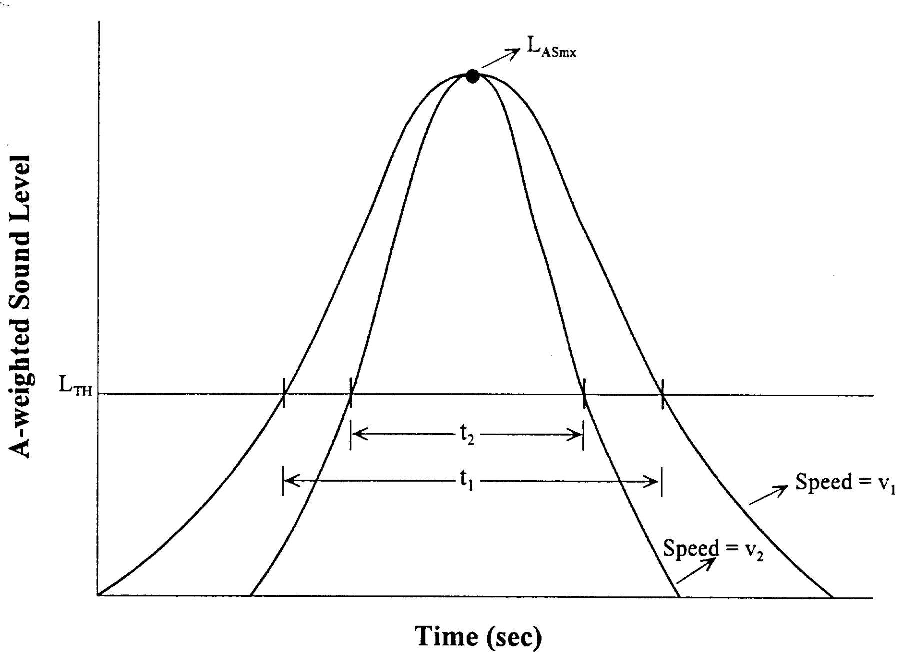


Figure 1. Example Time History Plot

In this example, time above is very simply the time in which the A-weighted sound level is greater than the threshold sound level. As shown, time above is t_1 for the aircraft traveling at v_1, and t_2 for the same aircraft traveling at v_2. Notice in the figure that L_{ASmx} is the same regardless of aircraft speed. It should also be noted that the "skirts" of the time history plot become steeper with increasing aircraft speed. This behavior is somewhat intuitive and basically indicates that the same aircraft flyover is "heard" for a shorter period of time when the it occurs at a higher speed. Another way of looking at this is that the total sound energy, expressed in terms of the A-weighted sound exposure level (L_{AE}) is less for the higher speed.

The relationship between L_{ASmx} and L_{AE} dictates the time above computation within INM. In particular, time above within INM is computed according to the following equation:

$$TA = \frac{4}{\pi}\left[10^{(L_{AE}+L_{ASmx})/10}\right]\left[10^{(L_{ASmx}-L_{TH})/20} - 1\right]^{1/2} \qquad \text{[Eq. 1]}$$

where: TA is the time above in seconds;
L_{AE} is the A-weighted sound exposure level;
L_{ASmx} is the A-weighted maximum sound level; and
$_{L.H.}$ is sound level threshold above which the TA is computed.

As can be seen, the **sole** input variables to time above computations within INM are the L_{ASmx}, the L_{AE}, and the $_{L.H.}$. Time is **not** an explicit variable in the computation. Instead time is implicit in the L_{AE}. In other words, as aircraft speed increases, L_{AE} decreases and the resultant time above a given threshold decreases.

For modeling a helicopter within INM the first step is to establish a set of L_{AE} values as a function of distance for an airspeed considered typical of tour operations within GCNP, i.e., 90 kts. A similar set of L_{ASmx} values as a function of distance also need to be established, but as described above these values are independent of helicopter speed. Given these two sets of noise versus distance relationships (which are established external to INM in a correction manner which is completely consistent with that presented in Federal Aviation Regulation (FAR) Part 36), and a value for $_{L.H.}$, the time above can be computed using Eq. 1 directly.

However, to compute time above within INM an additional step is required. Inherent within INM is the assumption that the noise level data base has been normalized to a speed of 160 kts. For aircraft which deviate from this speed the INM adjusts the L_{AE} according to the following equation:

$$AS_{ADJ} = 10\log_{10}\left(\frac{160}{AS}\right) \qquad \text{[Eq. 2]}$$

where: AS_{ADJ} is the airspeed adjustment to be added to the data in the noise curves; and
AS is the speed of the aircraft.

As described above this adjustment effectively increases the L_{AE} for speeds less than 160 kts and decreases them for speeds greater than 160 kts. Since the noise curves have already been normalized to a speed of 90 kts external to INM, the speed adjustment term presented in Eq. 2 is not applicable. Therefore to effectively offset this term a helicopter speed of 160 kts is input to the INM. The net result is that the INM will use the noise versus distance data as they were established external to the model, and it will compute the correct time above value for a helicopter flyover at 90 kts.

There are no residual negative effects to this approach because the time above computation within INM does not use time as an input variable. Instead time is implicit in the L_{AE} term utilized in Eq. 1 above.

Another important thing to remember is that INM is not a so-called time-step integration model, like many other existing aircraft noise prediction models. In other words, INM computations are independent of where the aircraft is at a particular point in time, i.e., all computations within INM are explicitly independent of time.

APPENDIX E

OPERATIONS DATA

Summary of 1998 GCNP Operational Activities as a Function of Flight Track			
No-Action Alternative			
Track	**Type of Operation**	**Aircraft**	**Operations**
BD0030	Departure	DHC6	19.03
		GASEPV	0.65
		BEC58P	30.00
BD0016	Arrival	BEC58P	1.97
		DHC6	8.07
		GASEPV	0.09
BD,BL1R-A/G0032	Departure	BEC58P	0.66
		GASEPV	0.01
		DHC6	0.41
BDS0061	Departure	GASEPV	0.53
		DHC6	15.57
		BEC58P	1.27
BDS0060	Arrival	DHC6	3.50
		GASEPV	0.09
		BEC58P	0.20
BK,BL,BR0067	Departure	GASEPV	0.34
BK1 (Gunther)0040	Circuit	GASEPV	0.10
		BEC58P	0.05
BK1,40013	Departure	GASEPV	0.03
		GASEPF	0.01
		DHC6	0.00*
BK1,4X0047	Departure	GASEPV	1.82
		GASEPF	0.02
		DHC6	0.28
BK1A0004	Departure	DHC6	8.62
BK1A0004	Circuit	GASEPF	0.15
		GASEPV	11.11
		BEC58P	0.14
BK2,1,1A0050	Arrival	DHC6	0.18
		GASEPV	1.00
BK2,1,40043	Overflight	GASEPV	0.14
		DHC6	0.00*
BK3,10012	Arrival	GASEPV	1.24
		DHC6	0.22
		GASEPF	0.02
BK3,10044	Arrival	BEC58P	0.11
BK5,10048	Arrival	DHC6	0.81
		GASEPV	1.91
		GASEPF	0.04
BK5,1,1A0046	Arrival	GASEPV	0.02
BK5,1,1A,1,40045	Overflight	GASEPV	0.47
		GASEPF	0.05
		DHC6	0.00*
BL,BR0064	Departure	DHC6	0.05
BL,BR0064	Circuit	GASEPV	0.83
BL,BR,BK0065	Departure	GASEPV	0.98
BL1,BD-A/G0018	Arrival	GASEPV	1.88
		BEC58P	33.98
		DHC6	24.75
BL1,BD-A/O0077	Overflight	GASEPV	0.33
		BEC58P	6.19

Summary of 1998 GCNP Operational Activities as a Function of Flight Track			
No-Action Alternative			
Track	**Type of Operation**	**Aircraft**	**Operations**
BL1,BDS-A/O0069	Overflight	DHC6	0.72
		GASEPV	0.30
		BEC58P	0.19
BL1,BL1A,BDS-MNV0075	Overflight	GASEPV	0.15
		DHC6	0.02
		BEC58P	0.10
BL1R,2B,BDS0070	Circuit	GASEPV	0.04
BL2-A/G0071	Overflight	GASEPF	0.28
		GASEPV	1.47
		DHC6	0.69
BL2-A/G0020	Overflight	GASEPV	2.13
		GASEPF	0.15
		BEC58P	0.55
		DHC6	0.17
BL2-A/O0019	Overflight	BEC58P	0.79
		GASEPV	0.64
		DHC6	0.39
BL2-A/O0021	Overflight	GASEPF	2.52
		GASEPV	12.32
		BEC58P	5.68
		DHC6	2.95
GR1-A/O0033	Departure	AS350	2.02
		MD900	0.02
GR1A-A/O0002	Departure	AS350	2.72
		B206	13.00
		MD900	0.02
GR2-A/O0003	Departure	AS350	11.04
		B206	60.18
		MD900	0.07
GR4-A/G0091	Overflight	AS350	11.18
		B206	0.81
GR4-A/G0093	Overflight	AS350	1.63
GR4-A/G0089	Overflight	AS350	1.56
		B206	0.80
GR4-A/O0081	Overflight	AS350	0.90
		B206	0.17
GR4-A/O0026	Overflight	AS350	0.34
		B206	0.19
GR4-A/O0024	Overflight	B206	2.63
		AS350	0.18
BK,BL,BR0062	Arrival	GASEPV	0.34
BK1,4X,6,5,10042	Arrival	GASEPV	0.05
BK6,BK5,BK10066	Arrival	GASEPV	0.98
BK2,1,4X0085	Overflight	GASEPV	0.14
		DHC6	0.02
BL1,BR1A0087	Overflight	DHC6	0.01
Total Operations			**321.78**

* The number of operations for the DHC6 aircraft on each of the tracks 0013, 0043, and 0045 is 0.003 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.003 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

Summary of 2000 GCNP Operational Activities as a Function of Flight Track
No-Action Alternative

Track	Type of Operation	Aircraft	Operations
BD0030	Departure	DHC6	20.30
		GASEPV	0.69
		BEC58P	32.01
BD0016	Arrival	BEC58P	2.10
		DHC6	8.61
		GASEPV	0.10
BD,BL1R-A/G0032	Departure	BEC58P	0.71
		GASEPV	0.01
		DHC6	0.44
BDS0061	Departure	GASEPV	0.57
		DHC6	16.61
		BEC58P	1.36
BDS0060	Arrival	DHC6	3.73
		GASEPV	0.10
		BEC58P	0.21
BK,BL,BR0067	Departure	GASEPV	0.36
BK1 (Gunther)0040	Circuit	GASEPV	0.11
		BEC58P	0.05
BK1,40013	Departure	GASEPV	0.04
		GASEPF	0.01
		DHC6	0.00*
BK1,4X0047	Departure	GASEPV	1.95
		GASEPF	0.02
		DHC6	0.30
BK1A0004	Departure	DHC6	9.20
BK1A0004	Circuit	GASEPF	0.16
		GASEPV	11.86
		BEC58P	0.14
BK2,1,1A0050	Arrival	DHC6	0.20
		GASEPV	1.08
BK2,1,40043	Overflight	GASEPV	0.15
		DHC6	0.00*
BK3,10012	Arrival	GASEPV	1.33
		DHC6	0.23
		GASEPF	0.02
BK3,10044	Arrival	BEC58P	0.11
BK5,10048	Arrival	DHC6	0.87
		GASEPV	2.04
		GASEPF	0.04
BK5,1,1A0046	Arrival	GASEPV	0.02
BK5,1,1A,1,40045	Overflight	GASEPV	0.50
		GASEPF	0.05
		DHC6	0.00*
BL,BR0064	Departure	DHC6	0.06
BL,BR0064	Circuit	GASEPV	0.89
BL,BR,BK0065	Departure	GASEPV	1.05
BL1,BD-A/G0018	Arrival	GASEPV	2.01
		BEC58P	36.26
		DHC6	26.41
BL1,BD-A/O0077	Overflight	GASEPV	0.36
		BEC58P	6.60

Summary of 2000 GCNP Operational Activities as a Function of Flight Track
No-Action Alternative

Track	Type of Operation	Aircraft	Operations
BL1,BDS-A/O0069	Overflight	DHC6	0.77
		GASEPV	0.32
		BEC58P	0.21
BL1,BL1A,BDS-MNV0075	Overflight	GASEPV	0.16
		DHC6	0.02
		BEC58P	0.10
BL1R,2B,BDS0070	Circuit	GASEPV	0.04
BL2-A/G0071	Overflight	GASEPF	0.30
		GASEPV	1.57
		DHC6	0.73
BL2-A/G0020	Overflight	GASEPV	2.27
		GASEPF	0.16
		BEC58P	0.59
		DHC6	0.18
BL2-A/O0019	Overflight	BEC58P	0.84
		GASEPV	0.68
		DHC6	0.42
BL2-A/O0021	Overflight	GASEPF	2.69
		GASEPV	13.14
		BEC58P	6.06
		DHC6	3.15
GR1-A/O0033	Departure	AS350	2.16
		MD900	0.02
GR1A-A/O0002	Departure	AS350	2.90
		B206	13.88
		MD900	0.02
GR2-A/O0003	Departure	AS350	11.78
		B206	64.21
		MD900	0.07
GR4-A/G0091	Overflight	AS350	11.93
		B206	0.86
GR4-A/G0093	Overflight	AS350	1.74
GR4-A/G0089	Overflight	AS350	1.67
		B206	0.85
GR4-A/O0081	Overflight	AS350	0.97
		B206	0.19
GR4-A/O0026	Overflight	AS350	0.36
		B206	0.20
GR4-A/O0024	Overflight	B206	2.81
		AS350	0.19
BK,BL,BR0062	Arrival	GASEPV	0.36
BK1,4X,6,5,10042	Arrival	GASEPV	0.05
BK6,BK5,BK10066	Arrival	GASEPV	1.05
BK2,1,4X0085	Overflight	GASEPV	0.15
		DHC6	0.02
BL1,BR1A0087	Overflight	DHC6	0.01
Total Operations			**343.37**

* The number of operations for the DHC6 aircraft on each of the tracks 0013, 0043, and 0045 is 0.003 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.003 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

Summary of 2003 GCNP Operational Activities as a Function of Flight Track			
No-Action Alternative			
Track	Type of Operation	Aircraft	Operations
BD0030	Departure	DHC6	22.37
		GASEPV	0.76
		BEC58P	35.29
BD0016	Arrival	BEC58P	2.31
		DHC6	9.49
		GASEPV	0.11
BD,BL1R-A/G0032	Departure	BEC58P	0.78
		GASEPV	0.01
		DHC6	0.49
BDS0061	Departure	GASEPV	0.62
		DHC6	18.31
		BEC58P	1.49
BDS0060	Arrival	DHC6	4.12
		GASEPV	0.11
		BEC58P	0.23
BK,BL,BR0067	Departure	GASEPV	0.40
BK1 (Gunther)0040	Circuit	GASEPV	0.12
		BEC58P	0.05
BK1,40013	Departure	GASEPV	0.04
		GASEPF	0.01
		DHC6	0.00*
BK1,4X0047	Departure	GASEPV	2.14
		GASEPF	0.03
		DHC6	0.33
BK1A0004	Departure	DHC6	10.14
BK1A0004	Circuit	GASEPF	0.17
		GASEPV	13.06
		BEC58P	0.16
BK2,1,1A0050	Arrival	DHC6	0.21
		GASEPV	1.19
BK2,1,40043	Overflight	GASEPV	0.16
		DHC6	0.00*
BK3,10012	Arrival	GASEPV	1.46
		DHC6	0.25
		GASEPF	0.02
BK3,10044	Arrival	BEC58P	0.12
BK5,10048	Arrival	DHC6	0.96
		GASEPV	2.24
		GASEPF	0.04
BK5,1,1A0046	Arrival	GASEPV	0.02
BK5,1,1A,1,40045	Overflight	GASEPV	0.55
		GASEPF	0.05
		DHC6	0.00*
BL,BR0064	Departure	DHC6	0.06
BL,BR0064	Circuit	GASEPV	0.98
BL,BR,BK0065	Departure	GASEPV	1.16
BL1,BD-A/G0018	Arrival	GASEPV	2.21
		BEC58P	39.96
		DHC6	29.12
BL1,BD-A/O0077	Overflight	GASEPV	0.39
		BEC58P	7.28

Summary of 2003 GCNP Operational Activities as a Function of Flight Track			
No-Action Alternative			
Track	**Type of Operation**	**Aircraft**	**Operations**
BL1,BDS-A/O0069	Overflight	DHC6	0.85
		GASEPV	0.35
		BEC58P	0.23
BL1,BL1A,BDS-MNV0075	Overflight	GASEPV	0.18
		DHC6	0.02
		BEC58P	0.12
BL1R,2B,BDS0070	Circuit	GASEPV	0.04
BL2-A/G0071	Overflight	GASEPF	0.33
		GASEPV	1.73
		DHC6	0.81
BL2-A/G0020	Overflight	GASEPV	2.50
		GASEPF	0.18
		BEC58P	0.64
		DHC6	0.20
BL2-A/O0019	Overflight	BEC58P	0.93
		GASEPV	0.75
		DHC6	0.46
BL2-A/O0021	Overflight	GASEPF	2.97
		GASEPV	14.48
		BEC58P	6.67
		DHC6	3.47
GR1-A/O0033	Departure	AS350	2.38
		MD900	0.02
GR1A-A/O0002	Departure	AS350	3.19
		B206	15.30
		MD900	0.02
GR2-A/O0003	Departure	AS350	12.99
		B206	70.78
		MD900	0.08
GR4-A/G0091	Overflight	AS350	13.15
		B206	0.95
GR4-A/G0093	Overflight	AS350	1.92
GR4-A/G0089	Overflight	AS350	1.84
		B206	0.94
GR4-A/O0081	Overflight	AS350	1.06
		B206	0.20
GR4-A/O0026	Overflight	AS350	0.40
		B206	0.22
GR4-A/O0024	Overflight	B206	3.09
		AS350	0.21
BK,BL,BR0062	Arrival	GASEPV	0.40
BK1,4X,6,5,10042	Arrival	GASEPV	0.06
BK6,BK5,BK10066	Arrival	GASEPV	1.16
BK2,1,4X0085	Overflight	GASEPV	0.16
		DHC6	0.02
BL1,BR1A0087	Overflight	DHC6	0.01
Total Operations			**378.50**

* The number of operations for the DHC6 aircraft on each of the tracks 0013, 0043, and 0045 is 0.003 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.003 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

Summary of 2008 GCNP Operational Activities as a Function of Flight Track			
No-Action Alternative			
Track	**Type of Operation**	**Aircraft**	**Operations**
BD0030	Departure	DHC6	26.31
		GASEPV	0.90
		BEC58P	41.51
BD0016	Arrival	BEC58P	2.72
		DHC6	11.16
		GASEPV	0.13
BD,BL1R-A/G0032	Departure	BEC58P	0.92
		GASEPV	0.01
		DHC6	0.57
BDS0061	Departure	GASEPV	0.74
		DHC6	21.54
		BEC58P	1.76
BDS0060	Arrival	DHC6	4.84
		GASEPV	0.13
		BEC58P	0.27
BK,BL,BR0067	Departure	GASEPV	0.47
BK1 (Gunther)0040	Circuit	GASEPV	0.14
		BEC58P	0.07
BK1,40013	Departure	GASEPV	0.05
		GASEPF	0.01
		DHC6	0.00*
BK1,4X0047	Departure	GASEPV	2.52
		GASEPF	0.03
		DHC6	0.38
BK1A0004	Departure	DHC6	11.93
BK1A0004	Circuit	GASEPF	0.21
		GASEPV	15.37
		BEC58P	0.19
BK2,1,1A0050	Arrival	DHC6	0.25
		GASEPV	1.40
BK2,1,40043	Overflight	GASEPV	0.19
		DHC6	0.00*
BK3,10012	Arrival	GASEPV	1.72
		DHC6	0.30
		GASEPF	0.03
BK3,10044	Arrival	BEC58P	0.14
BK5,10048	Arrival	DHC6	1.13
		GASEPV	2.64
		GASEPF	0.05
BK5,1,1A0046	Arrival	GASEPV	0.02
BK5,1,1A,1,40045	Overflight	GASEPV	0.64
		GASEPF	0.07
		DHC6	0.00*
BL,BR0064	Departure	DHC6	0.07
BL,BR0064	Circuit	GASEPV	1.15
BL,BR,BK0065	Departure	GASEPV	1.36
BL1,BD-A/G0018	Arrival	GASEPV	2.61
		BEC58P	47.02
		DHC6	34.25
BL1,BD-A/O0077	Overflight	GASEPV	0.46
		BEC58P	8.56

Summary of 2008 GCNP Operational Activities as a Function of Flight Track			
No-Action Alternative			
Track	**Type of Operation**	**Aircraft**	**Operations**
BL1,BDS-A/O0069	Overflight	DHC6	0.99
		GASEPV	0.41
		BEC58P	0.27
BL1,BL1A,BDS-MNV0075	Overflight	GASEPV	0.21
		DHC6	0.02
		BEC58P	0.14
BL1R,2B,BDS0070	Circuit	GASEPV	0.05
BL2-A/G0071	Overflight	GASEPF	0.39
		GASEPV	2.04
		DHC6	0.95
BL2-A/G0020	Overflight	GASEPV	2.95
		GASEPF	0.21
		BEC58P	0.76
		DHC6	0.23
BL2-A/O0019	Overflight	BEC58P	1.09
		GASEPV	0.88
		DHC6	0.54
BL2-A/O0021	Overflight	GASEPF	3.49
		GASEPV	17.04
		BEC58P	7.85
		DHC6	4.08
GR1-A/O0033	Departure	AS350	2.80
		MD900	0.03
GR1A-A/O0002	Departure	AS350	3.76
		B206	17.99
		MD900	0.02
GR2-A/O0003	Departure	AS350	15.28
		B206	83.26
		MD900	0.10
GR4-A/G0091	Overflight	AS350	15.46
		B206	1.11
GR4-A/G0093	Overflight	AS350	2.26
GR4-A/G0089	Overflight	AS350	2.16
		B206	1.10
GR4-A/O0081	Overflight	AS350	1.25
		B206	0.24
GR4-A/O0026	Overflight	AS350	0.47
		B206	0.26
GR4-A/O0024	Overflight	B206	3.64
		AS350	0.25
BK,BL,BR0062	Arrival	GASEPV	0.47
BK1,4X,6,5,10042	Arrival	GASEPV	0.07
BK6,BK5,BK10066	Arrival	GASEPV	1.36
BK2,1,4X0085	Overflight	GASEPV	0.20
		DHC6	0.02
BL1,BR1A0087	Overflight	DHC6	0.01
Total Operations			**445.21**

* The number of operations for the DHC6 aircraft on each of the tracks 0013, 0043, and 0045 is 0.004 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.004 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

Summary of 1998 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
BD0061	Departure	DHC6(high)	16.30
		DHC6(low)	2.88
		GASEPV(low)	1.18
		BEC58P(high)	25.71
		BEC58P(low)	4.54
BD0060	Arrival	BEC58P(high)	12.35
		BEC58P(low)	2.18
		DHC6(high)	14.64
		DHC6(low)	2.58
		GASEPV(low)	0.78
BDS0063	Departure	DHC6(high)	15.83
		BEC58P(high)	1.69
BDS0062	Arrival	DHC6	19.09
		GASEPV	1.28
		BEC58P	21.61
BK10040	Departure	DHC6	8.68
BK10040	Circuit	GASEPV	13.26
		GASEPF	0.15
		BEC58P	0.14
BK1/BK20044	Circuit	GASEPV	0.10
		BEC58P	0.04
BK2/BK40041	Departure	GASEPV	0.03
		GASEPF	0.01
		DHC6	0.00*
BK2/BK2X/BK5E/BK5/BK10047	Departure	GASEPV	1.82
		GASEPF	0.02
		DHC6	0.28
BK2S/BK10050	Arrival	DHC6	0.40
		GASEPV	2.25
		BEC58P	0.11
		GASEPF	0.02
BK2S/BK1/BK40043	Overflight	GASEPV	0.14
		DHC6	0.00*
BK5/BK10046	Arrival	DHC6	0.81
		GASEPV	1.93
		GASEPF	0.04
BK5/BK1/BK1/BK40045	Overflight	GASEPV	0.47
		GASEPF	0.05
		DHC6	0.00*
BL20069	Overflight	GASEPV	15.90
		BEC58P	13.49
		DHC6	4.25
		GASEPF	2.67
BL2/BL2E0071	Overflight	GASEPF	0.28
		GASEPV	1.47

Summary of 1998 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
		DHC6	0.69
GR10080	Departure	AS350	4.74
		B206	13.00
		MD900	0.04
GR20086	Departure	AS350	11.04
		B206	60.18
		MD900	0.07
GR4 w/pads0091	Overflight	AS350	11.18
		B206	0.81
GR4 w/pads0093	Overflight	AS350	1.63
GR4 w/pads0089	Overflight	AS350	1.56
		B206	0.80
GR40081	Overflight	AS350	0.90
		B206	0.17
GR40087	Overflight	AS350	0.52
		B206	2.82
BK5/BK10054	Arrival	GASEPV	0.05
BK2S/BK2/BK2X0051	Overflight	GASEPV	0.14
		DHC6	0.02
Total Operations			**321.78**

* The number of operations for the DHC6 aircraft on each of the tracks 0041, 0043, and 0045 is 0.003 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.003 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

Summary of 2000 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
BD0061	Departure	DHC6(high)	17.39
		DHC6(low)	3.07
		GASEPV(low)	1.27
		BEC58P(high)	27.43
		BEC58P(low)	4.84
BD0060	Arrival	BEC58P(high)	13.21
		BEC58P(low)	2.33
		DHC6(high)	17.12
		DHC6(low)	3.02
		GASEPV(low)	0.87
BDS0063	Departure	DHC6(high)	16.89
		BEC58P(high)	1.80
BDS0062	Arrival	DHC6	20.38
		GASEPV	1.36
		BEC58P	23.06
BK10040	Departure	DHC6	9.26
BK10040	Circuit	GASEPV	14.16
		GASEPF	0.16
		BEC58P	0.15
BK1/BK20044	Circuit	GASEPV	0.11
		BEC58P	0.04
BK2/BK40041	Departure	GASEPV	0.04
		GASEPF	0.01
		DHC6	0.00*
BK2/BK2X/BK5E/BK5/BK10047	Departure	GASEPV	1.95
		GASEPF	0.02
		DHC6	0.30
BK2S/BK10050	Arrival	DHC6	0.43
		GASEPV	2.41
		BEC58P	0.11
		GASEPF	0.02
BK2S/BK1/BK40043	Overflight	GASEPV	0.15
		DHC6	0.00*
BK5/BK10046	Arrival	DHC6	0.87
		GASEPV	2.06
		GASEPF	0.04
BK5/BK1/BK1/BK40045	Overflight	GASEPV	0.50
		GASEPF	0.05
		DHC6	0.00*
BL20069	Overflight	GASEPV	16.97
		BEC58P	14.40
		DHC6	4.53
		GASEPF	2.85
BL2/BL2E0071	Overflight	GASEPF	0.30
		GASEPV	1.57

Summary of 2000 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
		DHC6	0.73
GR10080	Departure	AS350	5.06
		B206	13.88
		MD900	0.04
GR20086	Departure	AS350	11.78
		B206	64.21
		MD900	0.07
GR4 w/pads0091	Overflight	AS350	11.93
		B206	0.86
GR4 w/pads0093	Overflight	AS350	1.74
GR4 w/pads0089	Overflight	AS350	1.67
		B206	0.85
GR40081	Overflight	AS350	0.97
		B206	0.19
GR40087	Overflight	AS350	0.55
		B206	3.01
BK5/BK10054	Arrival	GASEPV	0.05
BK2S/BK2/BK2X0051	Overflight	GASEPV	0.15
		DHC6	0.02
Total Operations			**343.37**

* The number of operations for the DHC6 aircraft on each of the tracks 0041, 0043, and 0045 is 0.003 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.003 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

Summary of 2003 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
BD0061	Departure	DHC6(high)	19.17
		DHC6(low)	3.38
		GASEPV(low)	1.39
		BEC58P(high)	30.24
		BEC58P(low)	5.34
BD0060	Arrival	BEC58P(high)	14.56
		BEC58P(low)	2.57
		DHC6(high)	18.87
		DHC6(low)	3.33
		GASEPV(low)	0.96
BDS0063	Departure	DHC6(high)	18.62
		BEC58P(high)	1.98
BDS0062	Arrival	DHC6	22.46
		GASEPV	1.50
		BEC58P	25.41
BK10040	Departure	DHC6	10.21
BK10040	Circuit	GASEPV	15.60
		GASEPF	0.17
		BEC58P	0.17
BK1/BK20044	Circuit	GASEPV	0.12
		BEC58P	0.05
BK2/BK40041	Departure	GASEPV	0.04
		GASEPF	0.01
		DHC6	0.00*
BK2/BK2X/BK5E/BK5/BK10047	Departure	GASEPV	2.14
		GASEPF	0.03
		DHC6	0.33
BK2S/BK10050	Arrival	DHC6	0.47
		GASEPV	2.64
		BEC58P	0.12
		GASEPF	0.02
BK2S/BK1/BK40043	Overflight	GASEPV	0.16
		DHC6	0.00*
BK5/BK10046	Arrival	DHC6	0.96
		GASEPV	2.26
		GASEPF	0.04
BK5/BK1/BK1/BK40045	Overflight	GASEPV	0.55
		GASEPF	0.05
		DHC6	0.00*
BL20069	Overflight	GASEPV	18.69
		BEC58P	15.86
		DHC6	5.00
		GASEPF	3.14
BL2/BL2E0071	Overflight	GASEPF	0.33
		GASEPV	1.73
		DHC6	0.81

Summary of 2003 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
GR10080	Departure	AS350	5.58
		B206	15.30
		MD900	0.04
GR20086	Departure	AS350	12.99
		B206	70.78
		MD900	0.08
GR4 w/pads0091	Overflight	AS350	13.15
		B206	0.95
GR4 w/pads0093	Overflight	AS350	1.92
GR4 w/pads0089	Overflight	AS350	1.84
		B206	0.94
GR40081	Overflight	AS350	1.06
		B206	0.20
GR40087	Overflight	AS350	0.61
		B206	3.32
BK5/BK10054	Arrival	GASEPV	0.06
BK2S/BK2/BK2X0051	Overflight	GASEPV	0.16
		DHC6	0.02
Total Operations			**378.50**

Summary of 2008 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	Type of Operation	Aircraft	Operations
BD0061	Departure	DHC6(high)	22.55
		DHC6(low)	3.98
		GASEPV(low)	1.64
		BEC58P(high)	35.57
		BEC58P(low)	6.28
BD0060	Arrival	BEC58P(high)	17.13
		BEC58P(low)	3.02
		DHC6(high)	22.20
		DHC6(low)	3.92
		GASEPV(low)	1.13
BDS0063	Departure	DHC6(high)	21.90
		BEC58P(high)	2.33
BDS0062	Arrival	DHC6	26.42
		GASEPV	1.77
		BEC58P	29.89
BK10040	Departure	DHC6	12.01
BK10040	Circuit	GASEPV	18.35
		GASEPF	0.21
		BEC58P	0.19
BK1/BK20044	Circuit	GASEPV	0.14
		BEC58P	0.06
BK2/BK40041	Departure	GASEPV	0.05
		GASEPF	0.01
		DHC6	0.00*
BK2/BK2X/BK5E/BK5/BK10047	Departure	GASEPV	2.52
		GASEPF	0.03
		DHC6	0.38
BK2S/BK10050	Arrival	DHC6	0.55
		GASEPV	3.11
		BEC58P	0.14
		GASEPF	0.03
BK2S/BK1/BK40043	Overflight	GASEPV	0.19
		DHC6	0.00*
BK5/BK10046	Arrival	DHC6	1.13
		GASEPV	2.67
		GASEPF	0.05
BK5/BK1/BK1/BK40045	Overflight	GASEPV	0.64
		GASEPF	0.07
		DHC6	0.00*
BL20069	Overflight	GASEPV	22.00
		BEC58P	18.67
		DHC6	5.88
		GASEPF	3.70
BL2/BL2E0071	Overflight	GASEPF	0.39
		GASEPV	2.04
		DHC6	0.95

Summary of 2008 GCNP Operational Activities as a Function of Flight Track

Alternative One

Track	**Type of Operation**	**Aircraft**	**Operations**
GR10080	Departure	AS350	6.56
		B206	17.99
		MD900	0.05
GR20086	Departure	AS350	15.28
		B206	83.26
		MD900	0.10
GR4 w/pads0091	Overflight	AS350	15.46
		B206	1.11
GR4 w/pads0093	Overflight	AS350	2.26
GR4 w/pads0089	Overflight	AS350	2.16
		B206	1.10
GR40081	Overflight	AS350	1.25
		B206	0.24
GR40087	Overflight	AS350	0.72
		B206	3.90
BK5/BK10054	Arrival	GASEPV	0.07
BK2S/BK2/BK2X0051	Overflight	GASEPV	0.20
		DHC6	0.02
Total Operations			**445.21**

* The number of operations for the DHC6 aircraft on each of the tracks 0041, 0043, and 0045 is 0.004 operations, which converts to 0.00 operations when rounded to two decimal places. The 0.004 operations for the DHC6 on each of these tracks is included as part of the total aircraft operations.

APPENDIX F

SUPPLEMENTAL ANALYSIS

SUPPLEMENTAL ANALYSES

As part of this noise study, four supplemental analyses were conducted. Rather than using all of the yearly data from the Activity Report, as is done in the main analysis, the supplemental analysis examines the projected noise environment in GCNP for four shorter time periods. Each of the analyses was done assuming that the Preferred Alternative (Alternative 2) is implemented. Selection of one Alternative for this sensitivity analysis provides a representative comparison for all of the Proposed Alternatives and the No Action Alternative.

The first supplemental analysis models operations on a typical summer day, the second models a typical 'shoulder' season day, the third models a day of high aircraft activity, and the last models the peak hour of aircraft activity on the typical summer day.

The NPS defined the summer season as the five month period from May 1 through September 30, and the shoulder season as the four months, two in the spring and two in the fall, on both sides of the summer season. Shoulder season months are March, April, October, and November. The high activity day also was chosen by the NPS.

Average activity levels during these seasons were represented in the modeling by a typical day that most closely matched the seasonal average. The summer day used was June 6, 1997, the shoulder day was November 19, 1997, and the high activity day was August 11, 1997. The fourth analysis for peak hour used the typical summer day again, June 6, 1997, from 1:00 to 1:59 p.m.

For the summer and shoulder seasons, the average number of operations per day was determined by taking the total number of air tour routes flown in the season and dividing by the number of days in the season. As an effective surrogate for operations and the most readily available statistic in the FAA Activity Report, it should be noted that the number of routes flown does not equate with the number of INM operations. The number of routes flown is always a higher number than the number of INM operations, as explained in Section 4.1.3.

Specifically, the summer average for 1997 was 579 routes flown per day. The shoulder season average for 1997 was 346 routes flown per day. The typical days for these periods were June 6 for the summer season with 578 routes flown and November 19 for the shoulder season with 345 routes flown. The corresponding number of INM operations is 429 for June 6 and 289 for November 19.

The high activity day of August 11 contained 816 routes flown, representing 653 INM operations. The peak hour of operations on June 6 was chosen by examining the number of routes flown in each hour of the day. The peak hour experienced 97 routes flown, significantly more than the next most frequently used hour (10:00 to 10:59 a.m., with 69 routes flown). The scaled number of daily INM operations during the peak hour is 765.

As with the main analysis, both the L_{Aeq12h} and $\%TA_{12h}$ metrics were computed for this supplemental analysis of the study area. A discussion of these two metrics follows.

<u>L_{Aeq12h} Analysis</u>

Review of the L_{Aeq12h} results show that the 30 and 40 dB levels contain the most useful information on the variation of noise within the study periods. These levels contain the greatest area of exposure above the ambient levels. In comparison, the 20 dB levels are below the ambient in many areas of the Park, while the 50 and 60 dB levels do not encompass a significant area of the Park. The total area in square miles for each of these contours, both over the entire study area and the area within GCNP, are presented in Table **F.1**. The L_{Aeq12h} contours are presented in Figures **F-1** through **F-4**.

The percentage of GCNP within the 30 dB L_{Aeq12h} level varies from 38.2 and 39.2 for the high activity day and the peak hour, respectively, to 31.7 for the typical summer day and 24.8 for the typical shoulder season day. For the higher levels, the areas drop off significantly. 11.6 percent of GCNP experienced an L_{eq12h} level of 40 dB or higher on August 11, 13.2 percent of the Park experienced this level during the peak hour. On the typical summer day, 7.9 percent of the Park was within the 40 dB L_{eq12h} level; 4.8 percent was within the 40 dB level on the typical shoulder day. These percentages are found by dividing the appropriate entries in Table **F.1** by the total area of GCNP (1886.78 square miles).

While the $\%TA_{12h}$ metric tends to correlate linearly with the number of operations, the L_{Aeq12h} metric tends to be less sensitive to operations due to its acoustic-energy basis foundation. For example, assuming that all other factors (such as track loading and aircraft types) remain constant for a given measurement location, doubling the number of operations will double the $\%TA_{12h}$ compared with increasing the L_{Aeq12h} by 3 dB. For this reason, the L_{Aeq12h} levels for the four periods show less variation than the $\%TA_{12h}$ levels described below.

$\%TA_{12h}$ Analysis

The high number of operations during August 11 and the peak hour probably make the $\%TA_{12h}$ metrics for these periods less meaningful than the other analysis days. For example, on the peak day, there are 184 operations on Green 2. This is an average, over the 12 hour activity period, of about 15 operations an hour, or one operation every four minutes. At these high levels of activity, noise from consecutive operations will almost certainly overlap, particularly during the peak activity periods of the day. The INM calculates the $\%TA_{12h}$ metric for each event independently, then sums the time for all the events, so the INM reported $\%TA_{12h}$ will always be equal or greater than a $\%TA_{12h}$ metric that accounts for overlapping operations. This effect is not as pronounced at lower levels of operations, where the probability of noise events overlapping is relatively low.

Table **F.2** presents the areas of the $25\%TA_{12h}$ contours for both the entire study area and the area within GCNP. This Table also shows the percentage of GCNP that experiences natural quiet during each study period. The Table also includes the Alternative 1 average annual day results for easy comparison. The $25\%TA_{12h}$ contours are presented in Figures **F-5** through **F-8**.

The summer and shoulder average day analyses show similar $\%TA_{12h}$ levels under the Blue Direct transit routes and in the Sanup Plateau region, but significantly less noise in the mid-Canyon and North Rim regions on the shoulder day. For these two particular days, the difference in $\%TA_{12h}$ in the mid-Canyon and North Rim regions is due to the difference in number of operations. In particular, the Green 2 route (the Dragon Corridor helicopter route) experienced 109 operations on June 6 compared to 21 operations on November 19.

Similarly, 38 operations occurred on Green 1A and Black 1A (the loops around the Bright Angel FFZ) on June 6, and only 14 operations on November 19. For comparison, there were 81 operations on Green 1A and Black 1A on August 11, the peak day. On November 19, the majority of operations flown were transit routes; on June 6, operations were distributed throughout the GCNP area. These differences may not exist for other days in the two seasons.

Operations on August 11, like June 6, were equally distributed through the Park. The high number of operations everywhere on August 11 leaves only the southern tip of Sanup, the northwest tip of the Kanab Plateau, and Marble Canyon in natural quiet. The lower number of June 6 operations leaves more of the three areas mentioned above in natural quiet and also provides some areas on the North Rim which have relatively high ambient levels (i.e., the conifer forests not under the flight paths) in natural quiet.

Using the same impact criteria described in Section 4.1.1, the percent of the park where Natural Quiet existed during August 11 (19.0 percent) and during the peak hour of June 6 (18.4 percent) were relatively low. These numbers may be lower than actually experienced due to the overlap effect discussed above and in Section 4.1.5. Over the day of June 6, 31.3 percent of the Park experienced Natural Quiet. The analysis for November 19 indicts that Natural Quiet existed in 53.7 percent of the Park.

Figures **F-9** and **F-10** illustrate the 1997 peak day compared to the 1998 annual average day noise contours for Leq12h and the aircraft audible more than 25 percent of the time, respectively.

The results presented in this Appendix apply only for the particular days or time under study. The individual air tour routes in use on any day will greatly influence which parts of the Park are exposed to aircraft noise and the level of that exposure.

Table F.1

Square Mile Area for L_{Aeq12h} Contours (20-60)
(Based on Preferred Alternative)

Analysis	Contour Level (dB)	Average Day 1998	Shoulder Day November 19, 1997	Summer Day June 6, 1997	Peak Day August 11, 1997	Peak Hour June 6, 1997 (1:00 – 1:59 pm)
WIDE	20	3722.39	3593.80	4059.49	4847.98	4757.85
	30	1632.01	1578.52	1834.84	2195.55	2186.21
	40	455.40	470.42	592.76	758.79	807.60
	50	10.04	18.22	27.12	60.05	59.68
	60	8.64	3.09	4.66	6.36	5.94
GCNP	20	1110.72	1006.69	1172.65	1282.84	1299.73
	30	558.02	467.23	598.92	721.58	739.51
	40	120.53	90.89	149.43	219.01	248.94
	50	2.44	0.32	3.94	9.98	12.25
	60	0.00	0.00	0.00	0.06	0.08

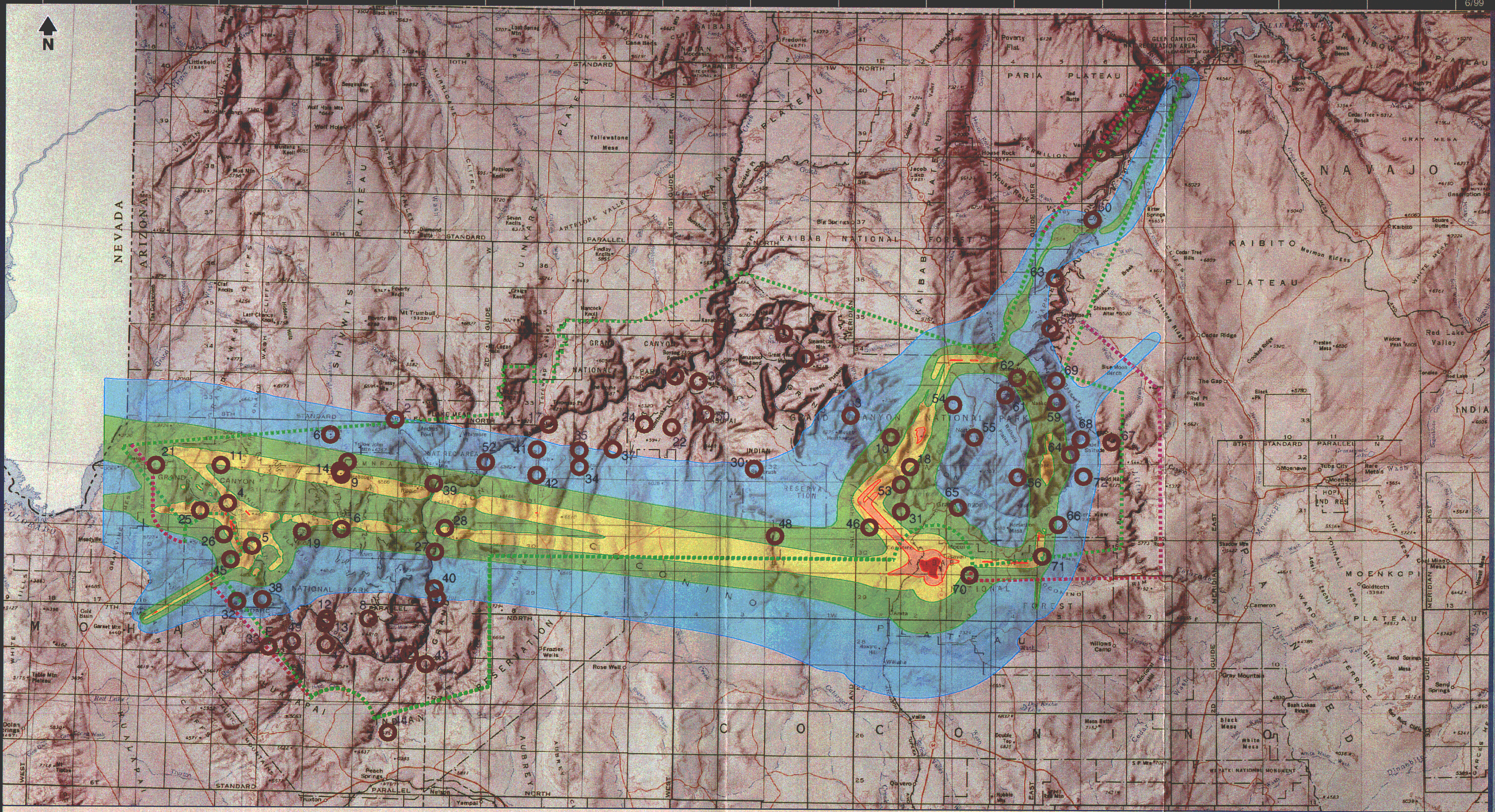
Table F.2

Square Mile Area for $25\%TA_{12h}$ Contour
(Based on Preferred Alternative)

Analysis	Annual Day 1998	Shoulder Day November 19, 1997	Summer Day June 16, 1997	Peak Day August 11, 1997	Peak Hour June 6, 1997 (1:00 – 1:59 pm)
WIDE	2568.46	2517.32	3115.79	3727.50	3708.49
GCNP	1107.11	1069.38	1295.81	1529.09	1539.25
% Restored	41.3	53.7	31.3	19.0	18.4

Supplemental Environmental Assessment
June 6, 1997 Leq$_{12h}$ Contours

FIGURE F-1



Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Representative Locations

Leq12h Level in dB Contour Color: 20, 30, 40, 50, 60

10 STATUTE MILES

6/99

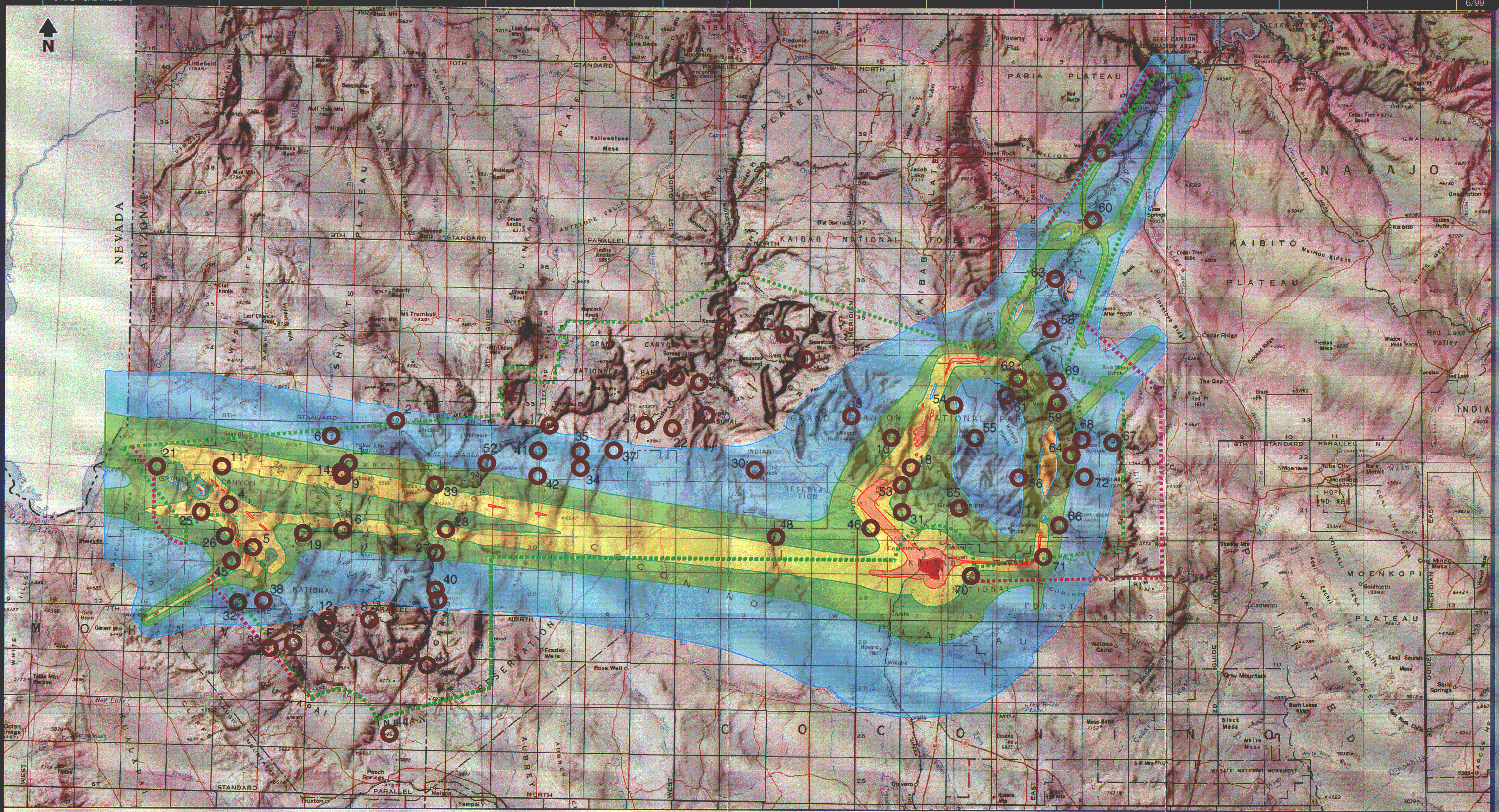
BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Supplemental Environmental Assessment

August 11, 1997 Leq_{12h} Contours

FIGURE F-2



Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Representative Locations

Leq_{12h} Level in dB	20	30	40	50	60
Contour Color	blue	green	yellow	light red	red

10 STATUTE MILES

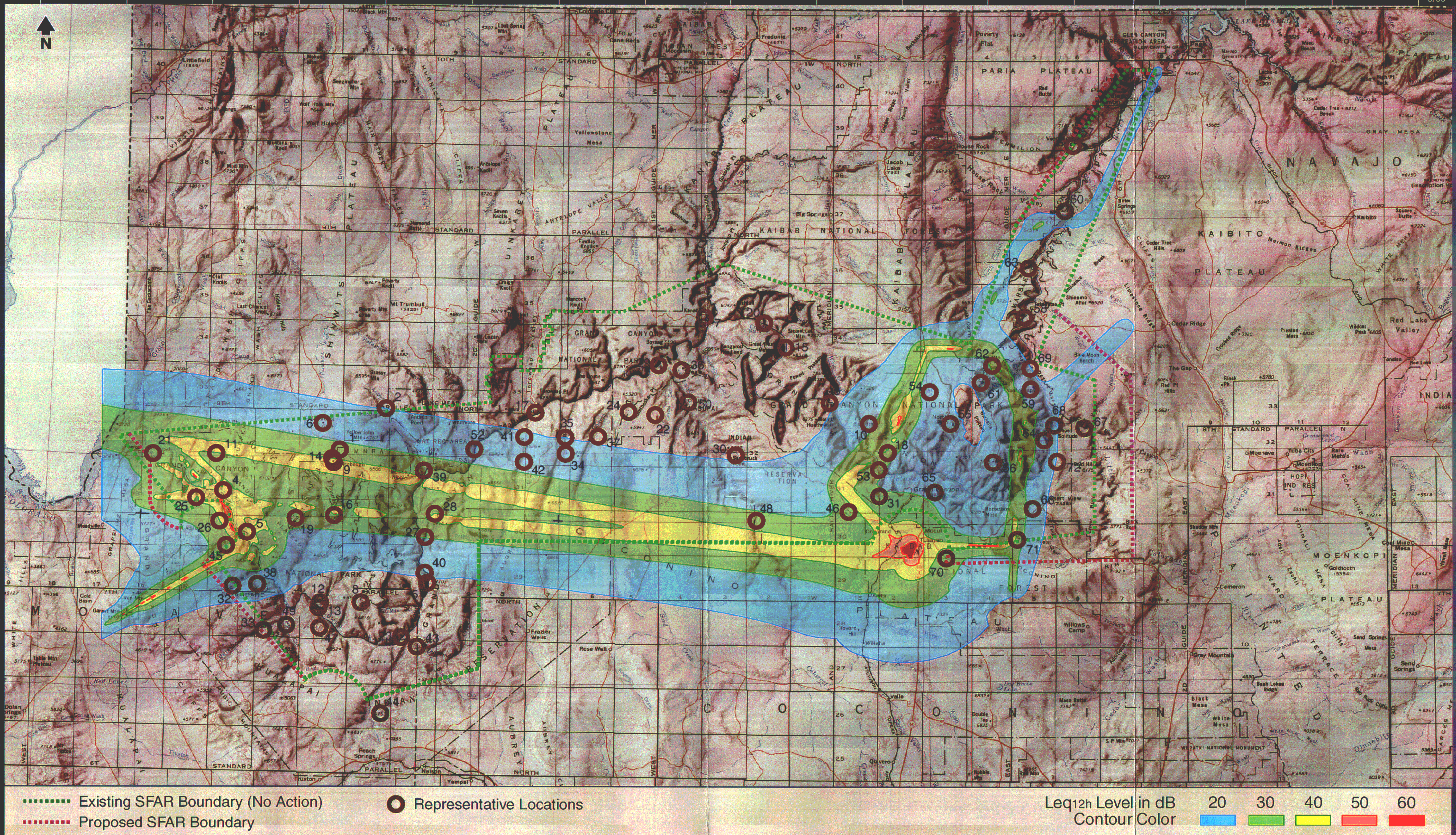
BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Supplemental Environmental Assessment

November 19, 1997 Leq_{12h} Contours

FIGURE F-3

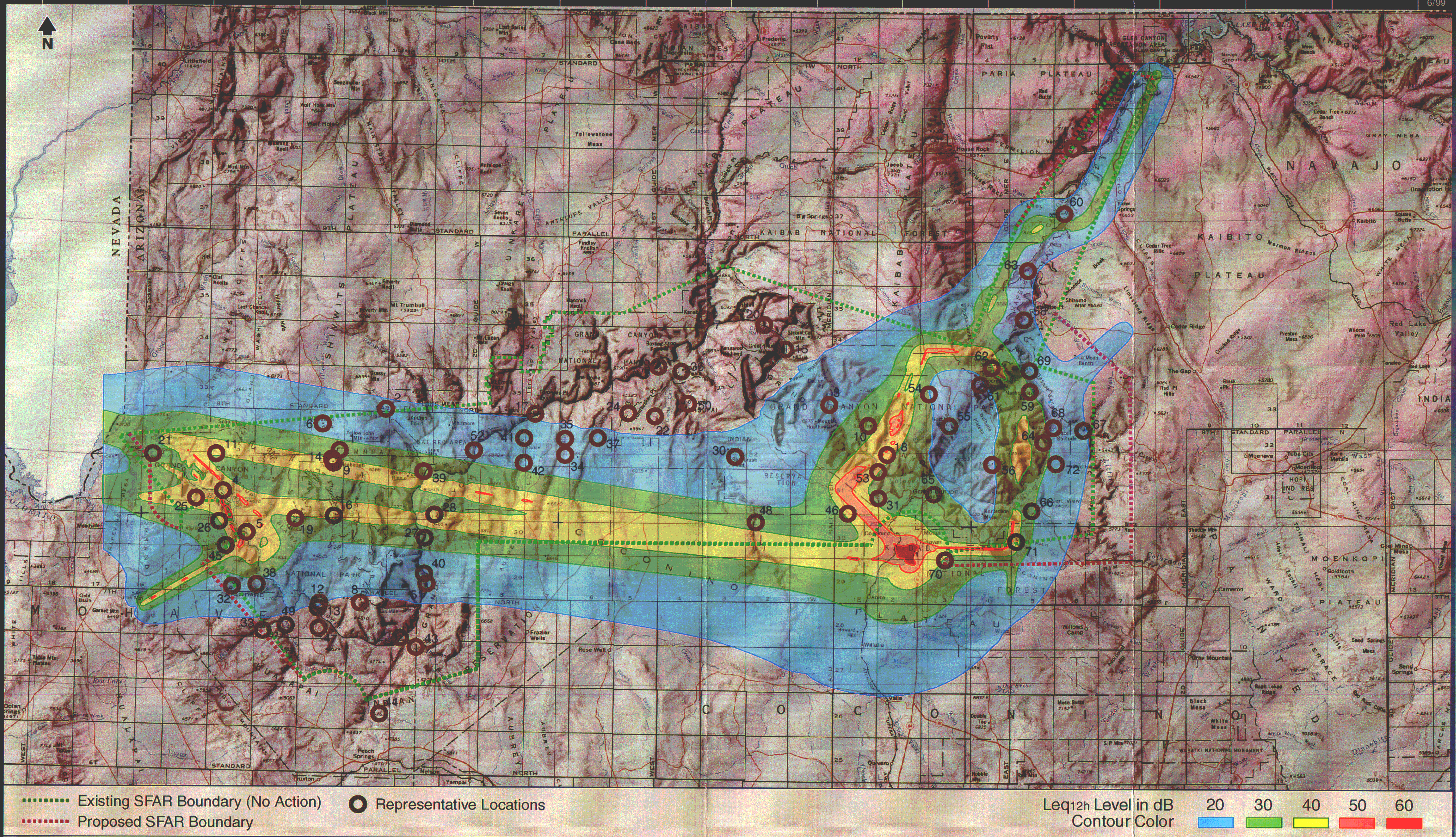


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

FIGURE F-4

1997 Peak Hour Leq_{12h} Contours

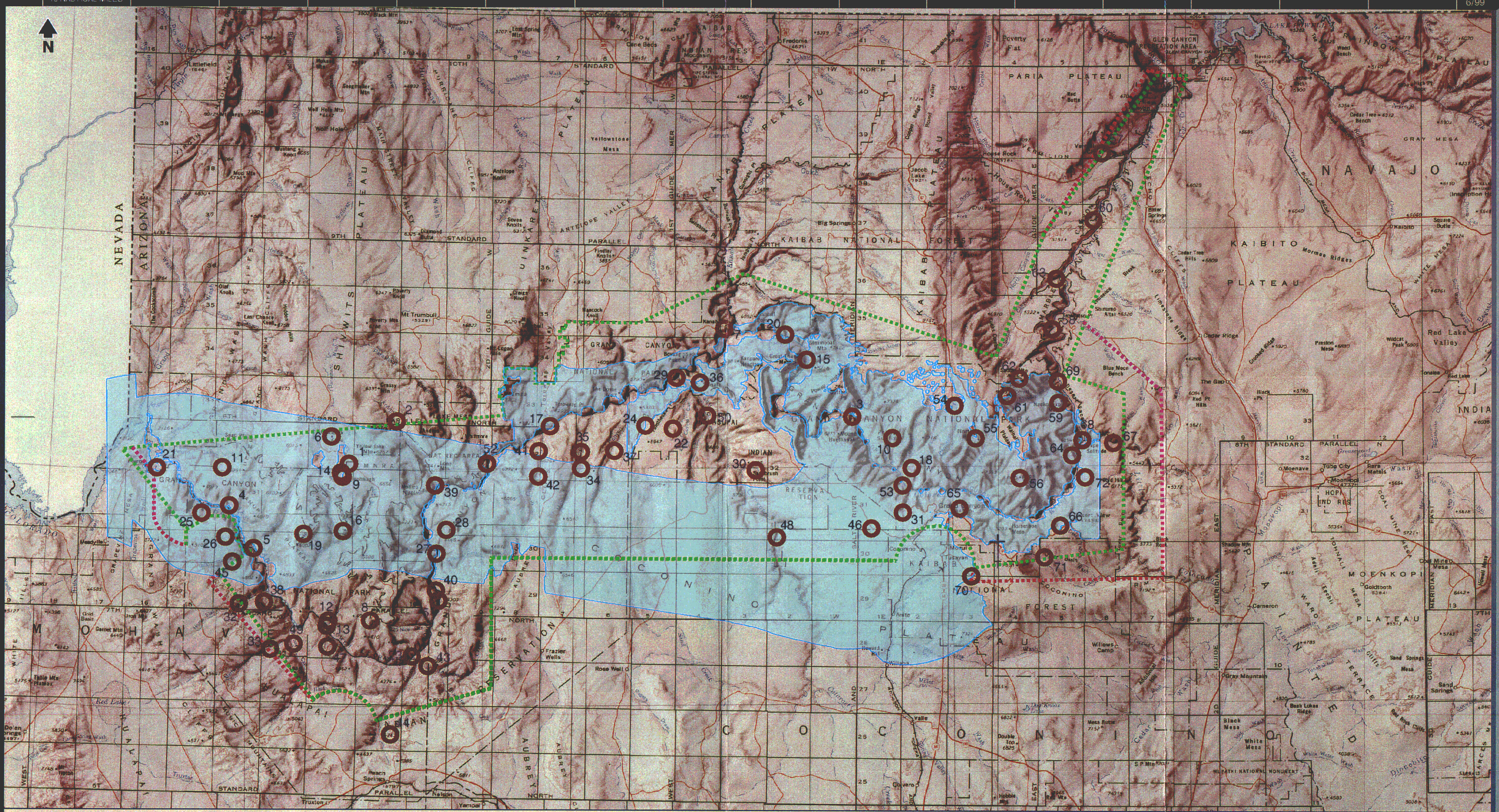


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

FIGURE F-5

June 6, 1997
Aircraft Audible More than 25% of Time Contours

6/99



Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Representative Locations

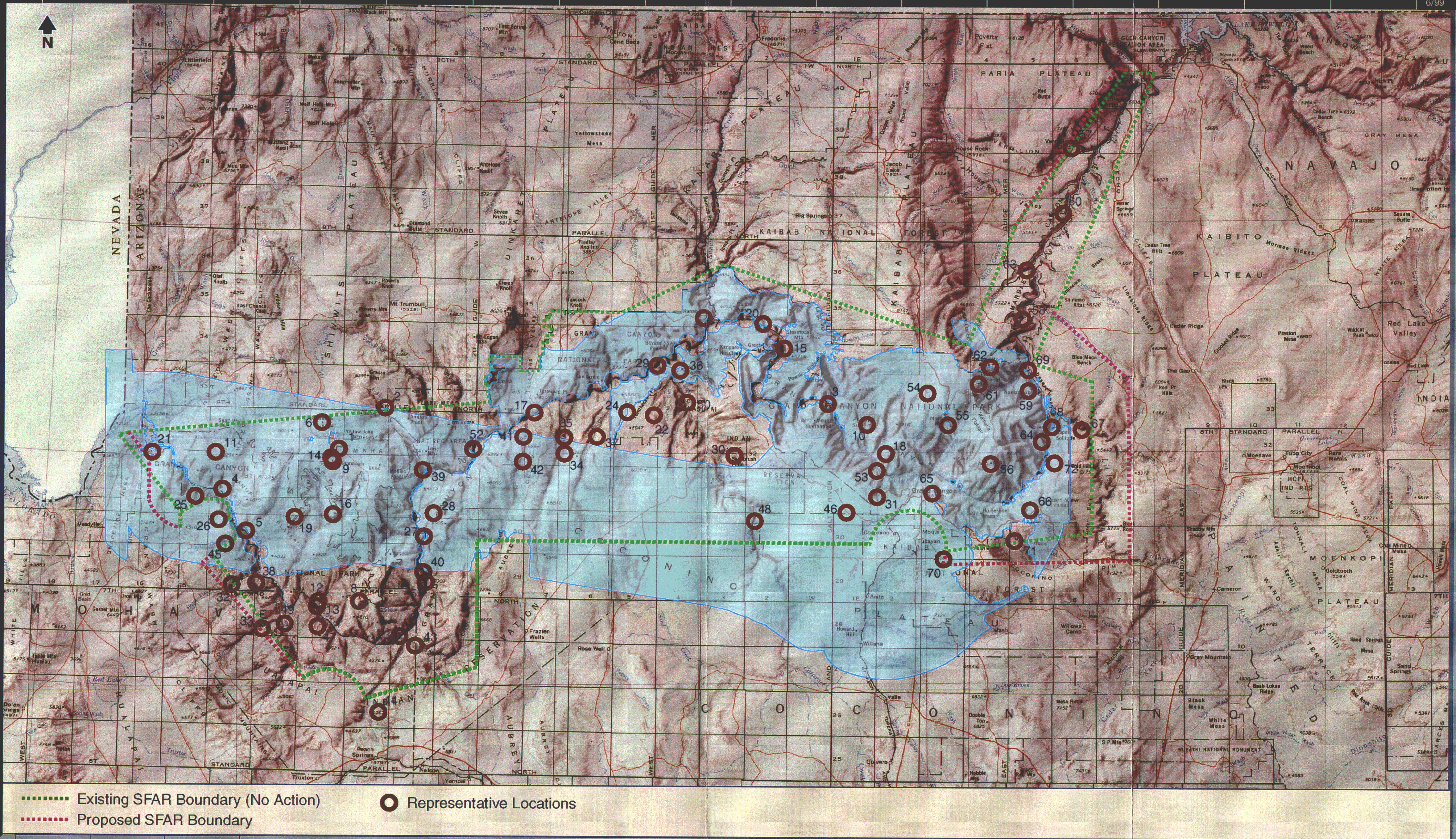
BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

Supplemental Environmental Assessment

August 11, 1997
Aircraft Audible More than 25% of Time Contours

FIGURE F-6



BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

November 19, 1997
Aircraft Audible More than 25% of Time Contours

FIGURE F-7

Existing SFAR Boundary (No Action)

Proposed SFAR Boundary

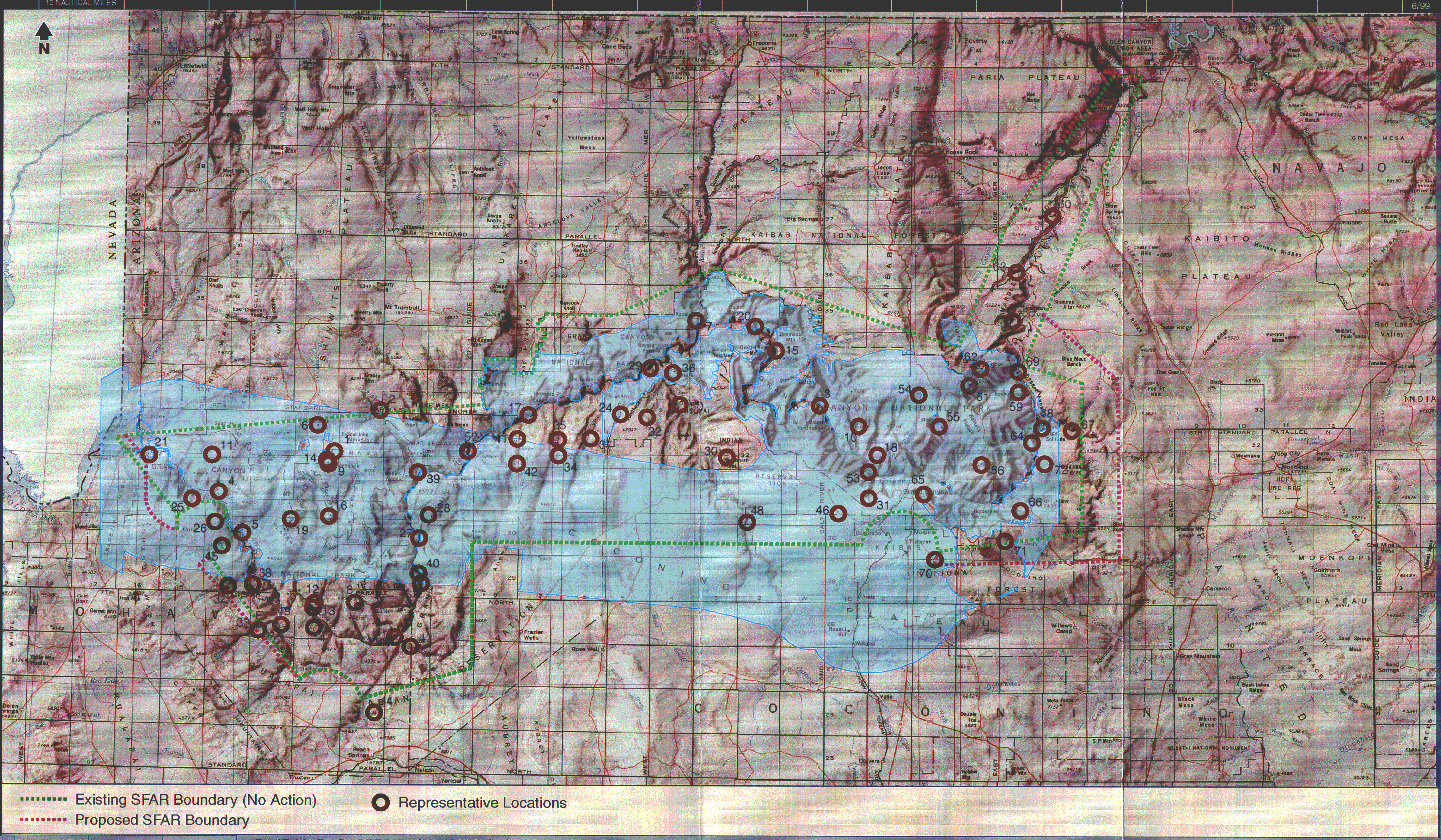
Representative Locations

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

1997 Peak Hour Aircraft Audible More than 25% of Time Contours

FIGURE F-8

6/99

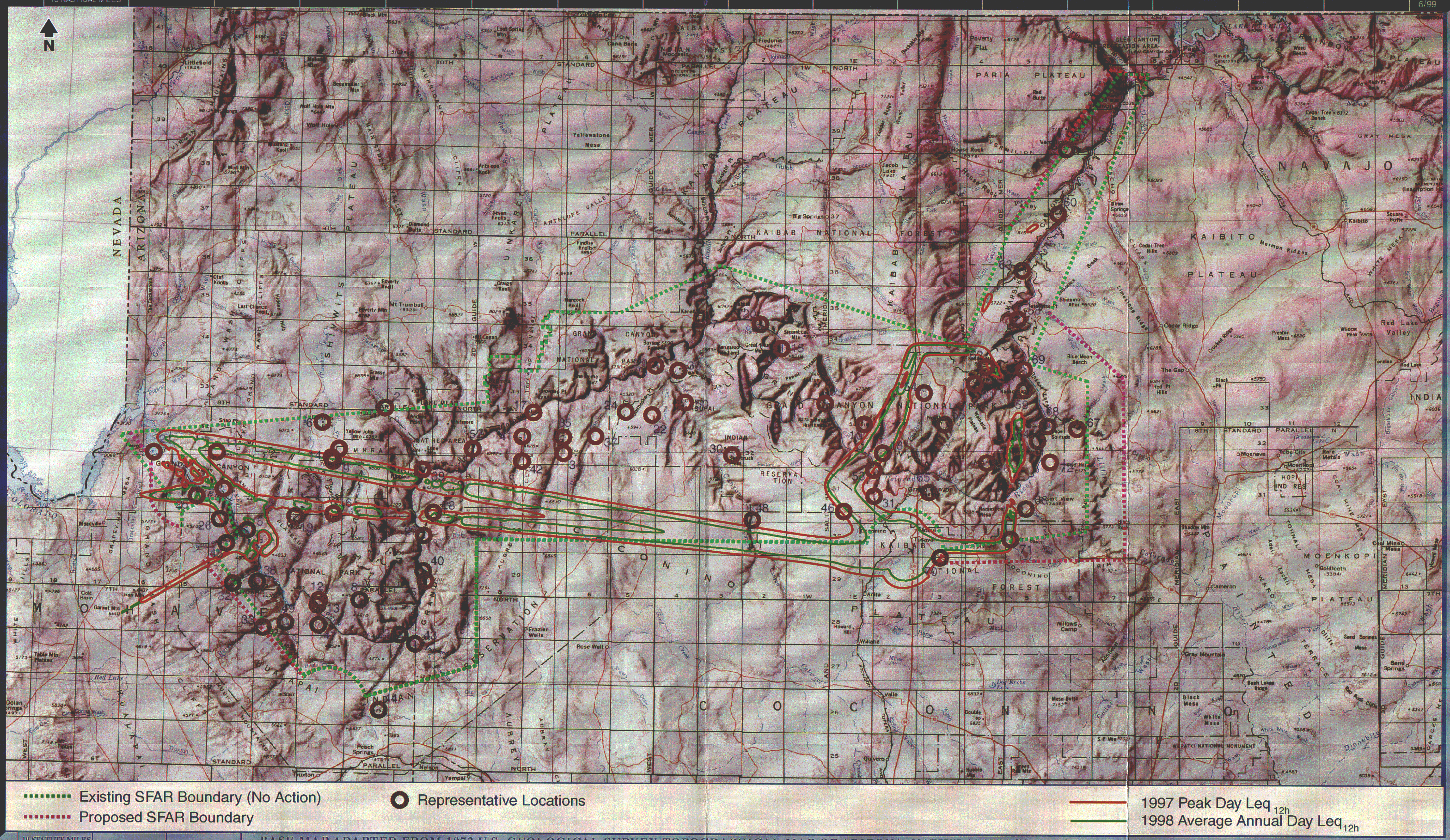


BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

1997 Peak Day Compared to 1998 Average Annual Day Leq_{12h} 40 dB Contours Using the Preferred Alternative Routes

FIGURE F-9



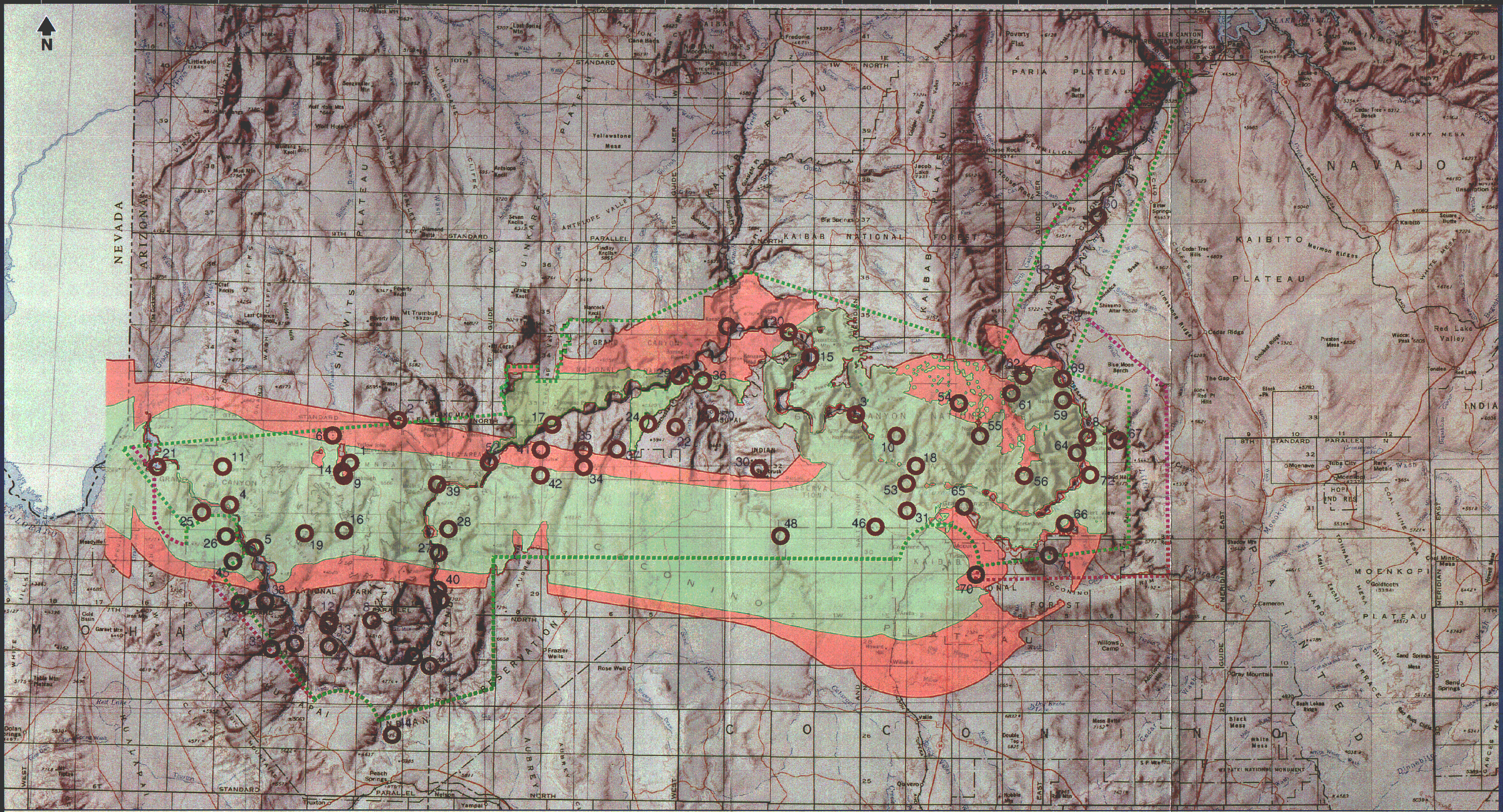
BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

Supplemental Environmental Assessment

1997 Peak Day Compared to 1998 Average Annual Day Aircraft Audible More Than 25% of Time Contours Using the Preferred Alternative Routes

FIGURE F-10

6/99



Existing SFAR Boundary (No Action)
Proposed SFAR Boundary
Representative Locations
1997 Peak Day - Aircraft Audible More Than 25% of the Time
1998 Average Annual Day - Aircraft Audible More Than 25% of the Time

BASE MAP ADAPTED FROM 1972 U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL MAP OF ARIZONA. NATIVE AMERICAN RESERVATION BOUNDARIES UPDATED BY HNTB ANALYSIS.

PROPOSED REVISION TO SFAR 50-2 • SPECIAL FLIGHT RULES IN THE VICINITY OF GRAND CANYON NATIONAL PARK

APPENDIX G

SCOPING COMMENTS

Summary of Comments Received in Response to Scoping

COMMENTER
Grand Canyon Trust Tom Robinson Director of Government Affairs February 26, 1999

1 Object to the dog legging of the Dragon Corridor because of the impacts it will have on the Shinumo backcountry, Pt. Sublime and Havasupai Pt.

2 Recommend Zuni Corridor be shortened to protect the Nankoweap Basin, Point Imperial, and the Nankoweap trail as these points are heavily impacted from helicopter noise.

3 FAA and NPS should assess noise impacts over the proposed Shiviwits National Monument north of the Sanup FFZ.

Drake Seaman February 23, 1999

1

Do not expand Desert View Flight Free Zone.

James M. McCarthy February 28, 1999

1 Limitation on the number of operations is absolutely integral to any plan that will substantially restore natural quiet.

2 The current definition of "substantial restoration of natural quiet" is flawed. The NPS should evaluate the definition of these important words.

United States Air Tour Association Steve Bassett March 4, 1999

1 A viable and safe air tour route between Las Vegas and GCNP that provides for approximately 30 to 60 minutes to view unsurpassed scenic vistas around the east and west end of the Canyon without requiring aircraft land at GCNP Airport also allowing a bad weather relief tour route is required.

2 The air tour and environmental communities along with the FAA and NPS must negotiate in good faith to achieve substantial progress.

3 It is wholly unfair and impractical for the cap interpretation to be anything other than that which was originally intended and, for a number of legitimate reasons, it would be equally unfair and impractical for the FAA to issue a new cap regulation in the Grand Canyon limiting operations.

Sierra Club Robert Smith, Southwest Staff Director March 4, 1999

1

Elimination of Blue One and other air tour routes which fly along the Colorado River may simply displace noise further south and west. Parallel routes spreads the noise out even more than concentrating it along one corridor.

2 The Blue Direct South route means that the Sanup FFZ is not going to be noise free.

COMMENTER	
3	Two alternative routes should be considered and modeled: 1) Vegas-Tusayan Dogleg and 2) Vegas-Truxton-Tusayan.
4	Request that the Burnt Springs area, a heron rookery, and similar sites be protected from air tour noise by moving routes away from these areas.
5	Include noise impact analysis for the area proposed for inclusion into a Shivwits National Monument north of the Sanup Plateau on BLM land.
6	Oppose creating a new air tour route over the Saddle Mountain Wilderness north of the North Rim of the Canyon.
7	Develop alternatives which emphasize the fundamental that the FAA should regulate aircraft to reduce noise over GCNP not to accommodate commercial air tour industry as well as the Congressional guidance provided in the National Park Organic Act and the Wilderness Act.
Air Vegas Airlines Jim Petty March 4, 1999	
1	A viable and safe air tour route between Las Vegas and GCNP that provides for approximately 30 to 60 minutes to view unsurpassed scenic vistas around the east and west end of the Canyon without requiring aircraft land at GCNP Airport also allowing a bad weather relief tour route is required.
2	A cap on the number of flights an operator may conduct in the SFAR would be difficult at best to enforce and puts a company such as Air Vegas at extreme economic and competitive disadvantage.
Papillon Airways, Inc. Elling Halvorson, Chairman March 5, 1999	
1	The proposed direct route from Las Vegas does not allow the public to enjoy a scenic air tour.
2	Expansion of the SFAR to the east is an unnecessary usurpation of airspace.
3	NPS stated that the new study would be reviewed and approved by peers in the acoustic field, the air tour industry should approve selection of peer reviews.
4	Quiet technology aircraft incentives must be implemented (e.g. preferential altitudes, routes and one earlier in the morning and one hour later afternoon departure times from the present curfew limits.
5	Oppose a cap on operations based on 1997 movements.
Friends of Grand Canyon Dennis Brownridge March 5, 1999	
1	Object to proposed new route over the Sanup FFZ. Propose two acceptable routes: 1) south near Truxton, bypassing the SFRA, Hualapai, and Havasupai lands entirely; or, 2) doglegged version of Blue Direct, crossing the Colorado River at right angles at about river mile 193 to minimize impacts on the park.
2	Minimum changes that must be made in the eastern Canyon: 1) Dragon Corridor must be closed; and 2) Zuni Corridor must be substantially shortened to protect the Nandoweap Basin, and the Nankoweap Trail, Saddle Mountain, and as much of the permanent springs and streams as possible.

COMMENTER	
3	Other recommendation: 1) Apply existing curfews to all routes, 2) Establish a one-week long, all-day curfew for Tusayan-based operators in early October, 3) phase in the quietest available aircraft technology, 4) limit and reduce the number of flights on each route, and 5) move the jet routes away from the Canyon

Nordhaus Haltom Taylor Taradash & Frye, LLP
Teresa Isabel Leger
March 5, 1999

1 Opposes tour routes on the western end of the Grand Canyon that would bring noise and intrusion onto the ancestral homelands of the Hualapai Tribe.

2 Remove western end air tours, or at a minimum move any western end air tour at least five miles away from Grand Canyon West.

3 Place a cap on the number of flights allowed on any single route.

4 The Blue Direct routes would impact the Tribe's economic development at Grand Canyon West and would impact sacred sites as well.

5 The EA should utilize the same criteria for determining impacts on the Hualapai reservation as it does for determining impact on the GCNP.

Cutler & Stanfield, L.L.P.
John E. Putnam
March 5, 1999

1 EA must at a minimum: 1) address the noise modeling concerns that Clark County has raised in prior comments; 2) conduct validation of the audibility modeling that FAA and the NPS have acknowledged is necessary; 3) make the noise modeling data and soft ware available to the public for technical peer review and comment; and 4) consider the effects of the proposed rule on air quality, traffic congestion, waste disposal and other resources caused by a potential increase in ground visitation to GCNP.

2 FAA must provide a detailed defense of the adequacy of its noise model.

3 FAA must validate its noise model before undertaking new rulemaking.

AirStar Helicopters
Ron W. Williams, Chairman
March 4, 1999

1 Extending the SFAR on the eastern end of the Canyon is contrary to Public Law 100-91.

2 The Government is spending huge sums of monies on a non-problem and persecuting numerous small businesses in the process.

3 Government needs to set quiet technology standards, goals and timeframes for aircraft manufacturers.

Grand Canyon Air Tour Council (GCATC)
David A. Young, President
March 8, 1999

1 The GCATC is strongly opposed to any changes to the current air tour routes designated as SFAR-50-2.

2 The GCATC is strongly opposed to any changes to the current caps.

Summary of Comments Received in Response to Scoping

COMMENTER
Scenic Airlines at McCarran International Airport Cliff Evarts, President and CEO March 8, 1999

1 Scenic Airlines is strongly opposed to any changes to the current air tour routes designated as SFAR-50-2.

2 Scenic Airlines is strongly opposed to any changes to the current caps.

U.S.D.O.I. Robert R. McNichols, Superintendent March 5, 1999

1 The routes proposed over the Hualapai Reservation are not acceptable for economic and environmental reasons.

2 The Hualapai Tribe has proposed that the routes be shifted to the north side of the Colorado River on the Sanup Plateau, the FAA has refused to model these alternative routes.

3 The flight lines are too close to the ground and the intrusion of aircraft will be significant to people on the ground.

Rothstein, Donatelli, Hughes, Dahlstrom, Cron & Schoenburg Michael C. Shiel March 4, 1999

1 Consider evaluating and modeling for noise purposes relocating the new transportation route which appeared in "magenta" on the chart provided by the FAA south of the park and south of the Hualapai Reservation.

Scenic Airlines at McCarran International Airport Clifford P. Evarts, CEO March 5, 1999

1 Opposed to new caps. The original intent of the existing caps would have accomplished the desired goal if only it had been enforced as intended.

Lake Mead Air Art Gallenson March 4, 1999

1 Re-align the Dragon Corridor with either the dog-leg or move it to the west to avoid the Hermit Basin.

Grand Canyon Airlines (GCA) Alan R. Stephen, Vice President March 4,1999

1 Take into account benefits derived from operations of aircraft like Vistaliners which meet Category C quiet airplane standards.

2 There is a need for incentives in each FAA notice regarding airspace management at GCNP.

3 GCA opposes a cap on operations as unjustified and unwarranted rulemaking.

4 GCA opposes expanding the SFRA order to expand the size of the Desert View FFZ.

Papillon Grand Canyon Brenda Halvorson, President/CEO March 4, 1999

1 Settle restoration of natural quiet requirements through a negotiated process , not through a supplemental environmental assessment.

Summary of Comments Received in Response to Scoping

COMMENTER
Eugene Allen Citizen February 28, 1999

1 The only way to see the Canyon is on the ground, natural quiet is extremely important.

APPENDIX H

CONSULTATION

FEDERAL AVIATION ADMINISTRATION (FAA)
NATIVE AMERICAN CONSULTATION
as of April 1999

The following listing is a record of consultation relating to the Native American Tribes and/or Nations having traditional cultural ties to the Grand Canyon. These consultations were conducted in accordance the National Environmental Policy Act and the National Historic Preservation Act, Section 106 requirements. They addressed the proposed modifications in the airspace, commercial air tour routes, and procedures utilized in Special Federal Aviation Regulation Number 50-2 (SFAR 50-2) in the vicinity of Grand Canyon National Park (GCNP). These modifications were contained in Federal Aviation Administration (FAA) Notice of Proposed Rulemaking (NPRM) documents.

The consultations included representatives from: (1) the Havasupai Tribe; (2) the Hopi Tribe; (3) the Hualapai Tribe; (4) the Kaibab Paiute Tribe; (5) the Navajo Nation at Window Rock; (6) the Navajo Nation Gap/Bodaway Chapter; (7) the Navajo Nation Cameron Chapter; (8) the Paiute Tribe of Utah; (9) the Pueblo of Zuni Tribe; and, (10) the San Juan Southern Paiute Tribe.

The Hualapai Tribe and the Navajo Nation have an official Tribal Historic Preservation Office (THPO). In addition to tribal representatives, the remaining Tribes were also represented by the Arizona State Historic Preservation Office (SHPO).

<u>1996</u>

February 22, 1996 - Letter to the Native Americans inviting participation in the environmental assessment (EA) process.

March 18, 1996 - Meeting with Hualapai Tribal representatives in the Department of Transportation (DOT) Secretary's office, also in attendance was the FAA's Assistant Administrator for Policy, Planning and International Aviation (API).

March 25 - Letter to the Hualapai Tribe regarding a meeting with the DOT Secretary.

March 29 - Letter from the Hualapai Tribe Chairman to the DOT Secretary, requesting among other things that SFAR 50-2 and any proposed changes be removed from the airspace over Hualapai lands.

April 3 - Letter from the Hualapai Tribe.

April 4 - Letter from the Hualapai Chairman to the DOT Secretary, requesting compensation and involvement in the EA and NPRM process for SFAR 50-2. The Tribe also requested to enter into a Memorandum of Agreement (MOA) to participate in the conduction of the EA and a socio-economic impact study on the proposed changes.

April 5 - Letter from the FAA Western-Pacific Regional Office (AWP-530) advising of four tribes connected to GCNP, that the Nations were now independent and would want to be contacted individually. Also advising who the Bureau of Indian Affairs (BOIA) Phoenix Area Office contact point was.

April 8 - Telephone call from AWP-530 advising that the Hualapai Tribe would be most concerned. This according to the BOIA Truxton Canyon Agency representative.

April 9 - Telephone call with the Hualapai Tribe and the BOIA Truxton Canyon Agency.

April 9 - FEDEX copy of the draft EA to the Hualapai Tribe.

April 16 - Letter from the Hualapai Tribe regarding the telephone call of April 9.

April 17 - Letter from the Havasupai Tribe to the DOT Secretary concerning SFAR 50-2.

April 24 - Letter from the Hualapai Tribe to President Clinton, advising that the Department of Interior (DOI) and DOT were not honoring the commitment to work on a government-to-government basis with the Tribe.

May 3 - Letter from the Hualapai Tribe to API, questioning why the Tribe was not invited to participate in the meeting Thursday, May 2, in the Old Executive Office Building with representatives from the air tour industry, National Park Service (NPS), the Grand Canyon Trust, and the FAA discussing flight restrictions over the Hualapai reservation.

May 3 - Letter from the Hualapai Tribe requesting cooperating agency status.

May 10 - Telephone call with the BOIA Truxton Canyon Agency representative regarding the Havasupai Tribe.

May 10 - Telephone call with the Hualapai Tribe Chairman regarding funding for a socio-economic impact study, the comment period on the NPRM and draft EA, and the upcoming meeting.

May 16 - Meeting between the FAA and the Hualapai Tribe in Peach Springs, Arizona (AZ).

May 23 - Letter to the Hualapai Tribe regarding the Grand Canyon NPRM.

June 3 - Letter from the Hualapai Tribe commenting on EA.

June 6 - Courtesy copy for FAA of a letter to the Hualapai Tribe from the Environmental Protection Agency (EPA), Region IX, advising that EPA will be also reviewing and commenting on the draft EA and NPRM.

June 7 - Letter from the White House to the Hualapai Tribe advising that concerns were passed to the DOI and DOT Secretaries.
June 12 - Telephone call with the Governor of the Pueblo of Zuni Tribe.

June 14 - Courtesy copy for FAA of a letter from the Pueblo of Zuni Tribe to BOIA Phoenix Area Office requesting cooperating status.

June 17 - Meeting with the Hualapai and Havasupai Tribes in Peach Springs, AZ.

June 18 - Meeting between the FAA, BOIA and Native Americans in Phoenix, AZ.

June 27 - Letter from the Kaibab Paiute Tribe to the DOT Secretary concerning SFAR 50-2.

June 28 - Telephone call with the Navajo Nation Gap/Bodaway representative.

July 3 - Telephone calls with the Navajo Nation at Window Rock, the Paiute of Utah, the Hualapai, and the Pueblo of Zuni Tribes advising that the Flagstaff meeting was being postponed.

July 3- Letter from the Kaibab Paiute Tribe requesting cooperating status.

July 31 - Copies of the NPRM mailed to Tribes.

August 1 - Telephone calls with the Havasupai, the Paiute of Utah, the Pueblo of Zuni, the Kaibab Paiute, and the Hopi Tribes.

August 2 - Telephone calls with the Attorney for the Havasupai, the Paiute of Utah, and the Attorney for the Hualapai Tribe.

August 5 - Telephone call with the Navajo Nation Historic Preservation Officer.

August 7 - Letter faxed to the Native Americans inviting them to participate in meetings in Flagstaff, AZ on August 27 and 28. August 7 - Telephone call to and fax to the BOIA Phoenix Area Office regarding the Flagstaff meetings.

August 12 - Telephone call to BOIA Phoenix Area Office regarding comments on the Memorandum of Understanding (MOU) from the BOIA and the Havasupai Tribe.

August 12 - Telephone call with the San Juan Southern Paiute Tribe regarding the Flagstaff meetings.

August 13 - Telephone call with the Paiute Tribe of Utah regarding the Flagstaff meetings.

August 13 - Telephone call with the Kaibab Paiute Tribe regarding the Flagstaff meetings.

August 16 - Letter from the Hualapai Tribe advising acceptance of invitation to Flagstaff meeting and questioning non-receipt of funding for socio-economic impact study.

August 16 - Telephone call with the Hualapai Tribe regarding attendance at Flagstaff meetings.

August 19 - Telephone call with the Paiute Tribe of Utah regarding the Flagstaff meetings.

August 19 - Telephone call with the Navajo Nation at Window Rock regarding the Flagstaff meetings.

August 19 - Telephone call with the Pueblo of Zuni Tribe regarding Flagstaff meetings.

August 19 - Telephone call with the Hopi Tribe regarding the Flagstaff meetings.

August 20 - Telephone call with the Attorney for the Havasupai Tribe regarding the Flagstaff meetings.

August 20 - Telephone call with the Hopi Tribe regarding Flagstaff meetings.

August 20 - Telephone call with the Navajo Nation EPA Office regarding Flagstaff meetings.

August 20 - Telephone call with the Pueblo of Zuni Tribe regarding the Flagstaff meetings.

August 22 - Telephone call with the Navajo Nation Gap/Bodaway Chapter regarding Flagstaff meetings.

August 22 - Telephone call with the Hopi Tribe regarding Flagstaff meetings.

August 22 - Telephone call with the Pueblo of Zuni Tribe regarding the Flagstaff meetings.

August 27 and 28 - Meeting in Flagstaff, AZ with the Tribes and Nations hosted by the FAA. Among topics discussed were the cooperating agency status and the matter of funding for conduction of the socio-economic impact study. Draft copies of the MOU were distributed for Native American review and comment.

September 11 - Faxed letter containing the draft minutes from the August Flagstaff meetings to the attendees for review and comment.

September 16 - Telephone call with the Pueblo of Zuni regarding public meetings.

September 16 - Telephone call with the Hualapai Tribe regarding public meetings.

September 16 through 20 - Public meetings in Las Vegas, NV and Scottsdale, AZ.

September 17 - Telephone call with the Hualapai Tribe regarding public meetings.

September 17 - Letter from the Hualapai Tribe to DOI and DOT Secretaries, and the DOI Solicitor listing concerns of the Tribe regarding the proposal to shift flights from GCNP to Hualapai tribal lands.

September 18 - Meeting at the BOIA Phoenix Area Office in with Native Americans.

September 19 - Mailed the documents requested by the Native Americans at the August Flagstaff meetings.

September 24 - Telephone call with the Kaibab Paiute Tribe regarding the Flagstaff meetings.

October 7 - Faxed letter to the Native Americans containing a signed copy of the minutes from the Flagstaff August 27 and 28 meetings.

October 7 - Received a letter identifying the official Hualapai Tribal Preservation Office representative.

October 7 - Telephone call with the Hualapai Tribe.

October 7 - Telephone call with the Pueblo of Zuni Tribe.

October 7 - Telephone call with the Navajo Nation at Window Rock EPA office.

October 7 - Telephone call with the Attorney for the Hopi Tribe.

October 7 - Telephone call with the Havasupai Tribe.

October 7 - Telephone call with the Kaibab Paiute Tribe.

October 8 - Telephone call with the Pueblo of Zuni Tribe.

October 8 - Telephone call with the San Juan Southern Paiute Tribe.

October 8 - Telephone call with the Attorney for the Hopi Tribe.

October 8 - Telephone call with the Paiute Tribe of Utah.

October 8 - Telephone call with the Navajo Nation EPA at Window Rock.

October 9/10, 1996 - Participated with Senator McCain in the public hearing in Phoenix, AZ.

October 10 - Telephone call with the San Juan Southern Paiute Tribe.

October 14 - Meeting in Window Rock, AZ between FAA and Navajo Nation representatives. In attendance was David Kelly, Navajo Air Quality/NNEPA representative.

October 15 - Meeting in Zuni, New Mexico, between FAA and the Pueblo of Zuni Tribe. In attendance were representatives from the Heritage Historic Preservation Office.

October 16 - Meeting in Flagstaff, AZ, between FAA, the Hopi Tribe and their Attorney.
October 17 - Meeting in Fredonia, AZ, between FAA and the Kaibab Paiute tribal council members.

October 21 - Meeting in Supai, AZ, between the FAA, BOIA, the Havasupai Tribe Chairman, Vice-Chairman, Attorney, and tribal council members.

October 21 - Meeting in Peach Springs, AZ with the Hualapai Tribe Historic Preservation Officer, the Tribe Attorney, and tribal council members.

October 22 - Meeting in Cedar City, Utah, between the FAA and Paiute Tribe of Utah Historic representative.

October 23 - Meeting in Phoenix, AZ, between the FAA, the Hualapai Tribe representatives and the Hualapai Attorney.

October 23 - Received a copy of a Draft Cooperating Management Agreement between the NPS and the Hualapai Tribe.

October 28 - Letter from the Havasupai Tribal Council to FAA advising of their decision not to enter into a MOU.

October 31 - Letter to the Hualapai Tribe granting cooperating agency status.

November 6 - Letter to the Hualapai Tribe regarding environmental justice and the NPRM.

December 11 - Letter from the Hualapai regarding helicopter operations at Grand Canyon West.

December 20 - Letter from the Hualapai THPO regarding the EA.

1997

January 2 - Mailed copies of the Final EA, the NPRM and Draft EA relating to the Noise Limitations for Aircraft Operations in the Vicinity of GCNP, and the Notice of Route Determination via Federal Express (all except San Juan Southern Paiute - no FEDEX address available).

January 9 - Letter from the Navajo Nation THPO regarding the consultation under Section 106.

January 13 - Letter advising of FAA's intent to fund travel costs for two representatives from each tribe to attend meetings in Las Vegas, NV and Phoenix, AZ during the week of February 3.

January 14 - Telephone call with the Attorney for the Havasupai Tribe.

January 16 - Telephone call with the Paiute Tribe of Utah.

January 16 - Letter to the Navajo Nation THPO regarding Section 106 consultation.

January 23 - Telephone call with the Navajo Nation THPO.

January 27 - Telephone call with the Hopi Tribe Attorney.

January 27 - Telephone call with the Hualapai Tribe.

January 28 - Telephone call with the Kaibab Pauite Tribe.

January 28 - Telephone call with the Havasupai Tribe.

January 28 - Telephone call with the Pueblo of Zuni Tribe.

January 30 - Received comments from the Hualapai Tribe on the December 1996 Rulemaking and environmental documents.

February 3 & 4 - Meeting with following Native American representatives in Las Vegas:

Havasupai Tribe - Lester Crooke, Roland Manakaja, and Mike Shiel.
Hopi Tribe - Franklin Hoover and Leigh Jenkins.
Hualapai Tribe - Cisney Havatone, Earl Havatone, Everett Manakaja, Jr., Edgar Walema, and Rob Yoxall.
Kaibab Paiute tribe - Brenda Drye and Laura Rae Perez.
Navajo Nation - Greg Bowen.
Paiute Tribe of Utah - Eleanor Tom.

February 4 - Letter from the Hualapai THPO regarding traditional cultural properties (TCPs).

February 6 - Meeting with the Pueblo of Zuni Tribe in Phoenix, AZ.

February 7 - Letter from the Havasupai Attorney regarding Freedom of Information Act (FOIA) request for copies of all written comments by tour operators in response to the Noise Limitations NPRM.

February 14 - Telephone call with the Havasupai Tribe

February 14 - Letter from the Navajo Nation Gap/Bodaway Chapter regarding the appointment of Official Liaisons between the Chapter, NPS and other Federal Agencies in discussions of regional management issues.

February 19 - Meeting with the Havasupai Tribal council members in Supai Village.

February 19 - Mailed via Federal Express FOIA documentation to the Havasupai Attorney.

February 25 - Received confirmation from the Hualapai THPO regarding attendance at the meeting in Washington, D.C.

March 4 - Meeting with Hualapai Tribe representatives and the Tribe Attorney in Washington, D.C. Discussed Section 106 consultation and other issues.

March 4 - Received comments from the Havasupai Tribe on FAA's proposed air tour routes for GCNP.

March 4 - Letter to the Navajo Nation Gap/Bodaway Chapter regarding consultation.

March 6 - Participated in Inter Tribal Council of Arizona, Inc., Cultural Resources Working Group meeting in Tucson, AZ.

March 17 - Letter from the Hualapai Tribe Attorney concerning Section 106 and air tour routes.

March 24 - Telephone call with the Navajo Nation Cameron Chapter.

March 24 - Telephone call with the Havasupai Attorney.

March 26 - Telephone call with the Hualapai Attorney.

March 26 - Faxed response letter to the Hualapai Attorney concerning Section 106, the proposed re-route of commercial air tour routes and a proposed meeting April 9 in Flagstaff, AZ.

March 26 - Faxed letter to the Havasupai Tribe and their Attorney regarding the proposed meeting of April 9, in Flagstaff, AZ for additional Section 106 consultation.

April 8 - Meeting with the Navajo Nation representatives from Window Rock, Gap/Bodaway Chapter and Cameron Chapters in Flagstaff, AZ regarding Section 106 and the proposed commercial air tour routes.

April 8 - Meeting with the Pueblo of Zuni Historic Preservation Officer in Flagstaff, AZ regarding Section 106 and proposed air tour routes.

April 8 - Letter to DOT Secretary from the Hualapai Attorney forwarding comments on Section 106.

April 9 (morning) - Meeting with Havasupai Tribe and BOIA representatives in Flagstaff, AZ regarding Section 106 and the proposed commercial air tour routes.

April 9 (afternoon) - Meeting with Hualapai Tribe and BOIA representative in Flagstaff, AZ regarding Section 106 and the proposed commercial air tour routes.

May 7 - Meeting and flight on the proposed commercial air tour routes over Hualapai lands by FAA, NPS and Hualapai Tribe representatives.
May 9 - Letter from the Hualapai Attorney to FAA Dockets memorializing the meeting of April 9, between the Hualapai Tribe and FAA representatives.

May 14 - Letter from the Hualapai Attorney regarding a list of studies requested by the Hualapai Tribe.

May 23 - Letter from the Hualapai Tribe regarding comments on the commercial air tour routes.

May 28 - Letter from the Hualapai Attorney to FAA Dockets regarding the meeting and overflight of Tribal lands on May 7.

June 3 - Received the Hualapai Scope of Work for a Cultural Resources study.

June 20 - Letter form the Hualapai Attorney regarding information needed to assess the NPRM.

June 20 - Letter to the Hualapai THPO agreeing to fund an Ethnographic/Archeological Study to identify TCPs.

June 24 - Meeting in Peach Springs, AZ with FAA, DOI and Hualapai Tribe representatives.

June 27 - Letter from the Hualapai Attorney regarding the proposed commercial air tour routes.

July 8 - Letter from the Hualapai Tribe forwarding some 1986 documents.

July 10 - Letter from the Hualapai Attorney regarding the TCP study.

July 23 - Letter to the Hualapai Attorney forwarding some current Grand Canyon charts.

August 5 - Letter to the FAA Docket from the Havasupai Tribe regarding a revised commercial air tour route through National Canyon.

August 12 - Letter to the Hualapai Tribe regarding the formal Section 106 study.

August 12 - Letter to the Hualapai THPO forwarding proposed revisions to Statement of Work (SOW) for the TCP study.

August 26 - Mailed the No Adverse Effect Determination letters to all Native Americans except the Hualapai Tribe.

August 26 - Received a courtesy copy of the Hualapai Tribe testimony before the Senate Aviation Subcommittee on the National Parks Overflights Act.

September 5 - Letter from the Hualapai THPO forwarding changes to the SOW.

September 17 - Telephone call with the Hualapai Attorney.

September 22 - Meeting with the Hualapai Tribe representatives in Washington, D.C.

September 26 - Letter to the Hualapai THPO regarding the meeting on September 22.

September 30 - Letter to the Hualapai Attorney forwarding 5 (five) copies of the proposed commercial air tour routes.

October 24 - Letter from the Hualapai Attorney requesting information needed for the October 28/29 meetings.

October 27 - Letter from the Hualapai Office of Cultural Resources (OCR) regarding comments on the SOW.

October 28 and 29 - Meeting in Las Vegas, NV with FAA, DOI, NPS, GCNP, BOIA and Hualapai representatives.

October 30 (morning) - Meeting in Las Vegas, NV with FAA, GCNP and Navajo Nation Window Rock, Gap/Bodaway and Cameron Chapter representatives.

October 30 (afternoon) - Meeting in Las Vegas, NV with FAA, GCNP and Arizona SHPO representatives.

December 5 - Letter (via fax) to the Hualapai OCR and Attorney forwarding the latest draft of the SOW.

December 16 - Informal meeting with the Hualapai OCR and their contractor regarding the SOW.

December 22 - Letter from the Hualapai OCR containing the revised Phase I budget and schedule for the SOW.

December 24 - Letter forwarded from the Department of Justice regarding concerns of the Havasupai Tribe relating to overflights of the Grand Canyon.

1998

January 13 - Letter from the Hualapai Tribe transmitting comments on the December 17, 1997 Rule.

January 16 - Letter from the Hualapai Attorney containing revisions to the SOW.

January 21 - Meeting in Flagstaff, AZ with FAA, NPS, BOIA, and Hualapai Tribe representatives.

January 23 - Meeting in Flagstaff, AZ with representatives from the FAA, NPS, BOIA, Havasupai, Hopi and Zuni Tribes, and the Arizona SHPO.

January 24 - Meeting in Gap, AZ with FAA, GCNP and Navajo Nation Gap/Bodaway Chapter representatives.

January 28 - Letter from the Hualapai Attorney regarding the SOW and proposed contract.

January 29 - Letter (via fax) to the Hualapai OCR and Attorney regarding the SOW.

February 5 - Letter to the Hualapai Tribe regarding the September 1997 meeting and Hualapai sensitive canyons.

February 25 - Letter from the Hualapai Attorney regarding Section 106 studies.

March 3 - Letter from the Hualapai Attorney regarding funding of the SOW.

March 13 - Letter to FAA Southwest Regional Office (ASO) from the Pueblo of Zuni Tribe regarding a no flight designation for the Zuni Indian Reservation.

March 19 - Letter from the Hualapai Tribal Council regarding a resolution authorizing the signing of the SOW for conduction and FAA funding of the Ethnographic-Archeological Study.

March 20 - Letter from the Hualapai Attorney forwarding the revised subcontract between the Hualapai Tribe and PRC Inc.

March 24 - FAA signed the SOW with the Hualapai Tribe.

March 24 - Letter to the Hualapai Attorney forwarding the signed SOW.

March 25 - Letter (via fax) to the Hualapai Attorney forwarding the signed SOW.

April 17 - Letter to the Pueblo of Zuni Tribe from ASO regarding their request for a no flight zone designation for the Zuni Indian Reservation.

April 28/29 - Meeting in Flagstaff, AZ with FAA, NPS, Native Americans, Environmentalists, and Tour Operators.

May 15 - FAA assisted the Hualapai Tribe in getting the Hualapai Airport changed from a Private to Public Use facility.

May 28 - Letter from the Hualapai Attorney advising that relations between the Tribe and FAA are now proceeding consistent with Executive Order, dated May 14, 1998, on Consultation and Coordination with Indian Tribal Governments.

July 15 - Meeting with Hualapai Tribe representatives in Peach Springs, AZ regarding the proposed commercial air tour routes on the west end of GCNP.

July 23 - Letter from the Hualapai OCR transmitting the status report on the Study.

July 29 - Meeting with the Navajo Nation THPO representative in San Diego, CA.

September 9 - Letter to the Hualapai Attorney regarding the commercial air tour route proposals and the July meeting.

September 11 - Letter from the Hualapai Attorney regarding the Hualapai response to the proposed commercial air tour routes on the west end.

September 15 - Courtesy copy for FAA of a letter from the Hualapai Attorney regarding the August 20 meeting between the Hualapai Tribe and the Air Tour Operators.

October 22 - Letter to the Hualapai Attorney regarding the Hualapai proposed commercial air tour route structure.

November 5 - Letter from the Hualapai OCR transmitting the preliminary list of Traditional Cultural Properties from the Ethnographic Study.

November 13 - Letter (via e-mail) to Arizona SHPO and the Advisory Council on Historic Preservation representatives regarding the status of GCNP rulemaking actions.

November 16 - Letter from the Hualapai Tribe to the DOT Secretary requesting a meeting.

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