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Southwestern
Region

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2005**

Final Environmental Impact Statement for Arizona Snowbowl Facilities Improvements

Volume 1

Coconino National Forest
Coconino County, Arizona

Legal Description:

Northeast corner of section 1, Township 22 North, Range 6 East
Southeast corner of section 36, Township 23 North, Range 6 East
Southern half of section 31, Southwestern corner of section 32, Township 23 North, Range 7 East
Northern portion of section 6, Northwestern portion of section 5, Township 22 North, Range 7 East

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FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE

ARIZONA SNOWBOWL
FACILITIES IMPROVEMENTS PROPOSAL

COCONINO NATIONAL FOREST
COCONINO COUNTY, ARIZONA

FEBRUARY 2005

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Abstract: This Final Environmental Impact Statement (FEIS) has been prepared to analyze and document the environmental effects of a proposal to provide a consistent/reliable operating season through snowmaking and to enhance the overall recreational experience at the Arizona Snowbowl ski area. The Arizona Snowbowl is located on the Coconino National Forest in Coconino County, Arizona and operates in accordance with the terms and conditions of a Ski Area Term Special Use Permit issued by the US Forest Service. The Proposed Action includes installation of snowmaking infrastructure to support approximately 205.2 acres of season-long snow coverage; realignment and/or lengthening of the Sunset, Hart Prairie, and Aspen lifts; installation of one new chairlift and four surface lifts; development of new skiing terrain, increasing skiable acreage within the SUP area from approximately 138 acres to approximately 204 acres; development of a snowplay/tubing area, with associated surface lifts, parking, and guest service facilities; the creation of a halfpipe; and improvement of service facilities and ski

area infrastructure. Forest Plan Amendment #21 is incorporated to allow for changed circumstances within the SUP area and to relate to the Master Development Plan based on NEPA analysis and approvals. This FEIS discusses the purpose and need for the Proposed Action; alternatives to the Proposed Action; potential direct, indirect, and cumulative impacts of implementing each alternative; and mitigation measures. Three alternatives are analyzed in the EIS. The Decision Maker's selected alternative is documented in the accompanying Record of Decision (ROD).

Appeals: The decision documented in the ROD is subject to appeal pursuant to 36 CFR 215.11. Any appeal of this decision must be fully consistent with 36 CFR 215.14, "Content of Notice of Appeal," and it must be received within 45 days of the date of publication of the legal notice in the Arizona Daily Sun.

The written Notice of Appeal must be sent to:

Appeal Deciding Officer
USDA Forest Service
Region 3, Southwestern Region
333 Broadway SE
Albuquerque, NM 87102

EXECUTIVE SUMMARY

Coconino National Forest
Peaks Ranger District

EXECUTIVE SUMMARY

INTRODUCTION

A Draft Environmental Impact Statement (DEIS) for the Arizona Snowbowl Facilities Improvements proposal was released to the public in February 2004. In response to the DEIS, a total of 9,887 comments were submitted by various mediums, including: letters; form letters; faxes, emails; phone calls; and petitions. The total number of commentors totaled 5,716. The Forest Service has prepared this Final EIS (FEIS) - Volume 1 - which includes updates to the original analysis, as based on substantive comments received. Numerous changes have been incorporated into the analysis between DEIS and FEIS, with the most substantial changes occurring in the Environmental Justice analysis contained in Section 3N. The Response to Comments (RTC) submitted on the DEIS is contained in Volume 2 of the FEIS. Finally, a Record of Decision (ROD) has been prepared and accompanies volumes 1 and 2. The ROD documents the Decision Maker's Selected Alternative and rationale for the decision.

The Arizona Snowbowl (hereinafter referred to as "Snowbowl") is owned and operated by Arizona Snowbowl Resort Limited Partnership. The Snowbowl is located entirely on the Coconino National Forest (CNF) on the western flank of the San Francisco Peaks. The ski area is operated under a 777-acre Forest Service-issued Special Use Permit (SUP), which is renewed on a 40-year basis. Snowbowl is approximately 15 miles north of Flagstaff, one of the four largest metropolitan areas in Arizona (refer to Figure 1-1). Snowbowl is surrounded on three sides by the 18,963-acre Kachina Peaks Wilderness, which was designated by the U.S. Congress in 1984.

Skiers[1] have been using the Snowbowl since 1938, when the ski area's original base area was established in Hart Prairie. In addition to wintertime skiing and snowboarding, the Snowbowl offers summertime scenic chairlift rides on the (Sky ride program) Agassiz Chairlift. Guided horseback rides, banquets and restaurant facilities are also available.

PURPOSE AND NEED FOR THE PROPOSED ACTION

The Forest Service and Snowbowl cooperatively determined general categories important for improving the Snowbowl's facilities. From these categories, a list of proposed projects was created, and the Proposed Action ultimately emerged. The Proposed Action responds to the goals and objectives outlined in the Forest Plan,[2] and helps move the project area towards desired conditions described in it.

The overall Purpose and Need for these projects responds to two broad categories: 1) to provide a consistent/reliable operating season, and 2) to improve safety, skiing conditions, and

[1] At ski areas, one may see people using Alpine, snowboard, telemark, cross-country, and other specialized ski equipment, such as that used by disabled or other skiers. Accordingly, the terms "ski, skier, and skiing" in this document encompass all lift-served sliding sports typically associated with a winter sports resort.
[2] USDA Forest Service, 1987

recreational opportunities by bringing terrain and infrastructure into balance with existing demand.

SUMMARY OF THE ALTERNATIVES ANALYZED IN THE FEIS

All alternatives include a provision by where a new Master Development Plan (MDP) would be developed for Arizona Snowbowl to provide for operation and maintenance of existing facilities into the future. The reader is referred to Table 2-4 for a comparison of alternative components.

FOREST PLAN AMENDMENT

In addition, Alternatives 1, 2 and 3 include amending the Coconino Forest Plan with a non-significant amendment[3] clarifying the direction in Management Area 15 – Developed Recreation Sites. Page 188 of the Forest Plan makes reference to the 1979 FEIS as guidance for the management of the Snowbowl ski area. This management direction necessitates being updated to reference the Arizona Snowbowl's Master Development Plan based on NEPA analyses and subsequent approvals. The original management emphasis did not allow for the changed circumstances that may initiate a new environmental analysis of the ski area operations. The reader is referred to Appendix B for more information.

ALTERNATIVE 1 - NO ACTION

As required by NEPA, a No Action Alternative has been included in this analysis for review alongside the action alternatives.[4] The No Action Alternative reflects a continuation of existing management practices without changes, additions, or upgrades. Therefore, no new facilities, trail improvements, or snowmaking would occur under the No Action Alternative and the Snowbowl would continue to operate at its existing Comfortable Carrying Capacity (CCC) of 1,880 skiers-at-one-time. The No Action Alternative provides a baseline for comparing the effects of the Proposed Action and Alternative 3.

ALTERNATIVE 2 - THE PROPOSED ACTION

In response to the purpose and need, the following Proposed Action was assembled by Snowbowl and the Forest Service. Because Forest Plan direction for management of the Snowbowl SUP area does not specifically allude to amenities such as snowtubing and snowmaking, a non-significant Forest Plan amendment is included as a portion of the Proposed Action in order to allow the Forest Service and Snowbowl to respond to key portions of the Purpose and Need.

Snowmaking

- Approximately 205 acres of snowmaking coverage throughout the SUP area utilizing Class A reclaimed water as a source

[3] Regulations at 36 CFR 219.10(f) direct the Forest Service to consider whether a proposed amendment to a forest plan would be considered a significant change.
[4] 40 CFR 1502.14(d)

- A 10 million-gallon snowmaking water reservoir near the top terminal of the existing Sunset Chairlift, and catchment pond below the Hart Prairie Lodge
- Construct a reclaimed water pipeline between Flagstaff and the Snowbowl with booster stations and pumphouses
- Construct a 3,000 to 4,000 square foot snowmaking control building in the vicinity of the existing maintenance shop

Snowplay/Tubing Facility

- A professionally designed and managed snowplay/tubing facility at the base area including sculpted lanes, lifts and a lodge

Lifts/Uphill Capacity

- Replace of the Sunset Chairlift with a high speed, detachable chair
- Relocate the existing Sunset Chairlift as the Humphreys Chairlift, accessing a pod of proposed ski trails
- Upgrade and extension of the Hart Prairie Chairlift with a high-speed, detachable lift
- Upgrade and realignment of the Aspen Chairlift
- Install three surface conveyors in the area north of the Hart Prairie Lodge
- Install a handle tow is proposed to service a halfpipe and terrain park

Terrain

- Additional terrain, bring total skiable acreage at the Snowbowl to approximately 204 acres
- Approximately 47 acres of thinning to created improved glades
- Approximately 87 acres of terrain improvements (grading/stumping and smoothing)
- Create a dedicated teaching area near the Hart Prairie Lodge
- Construct a halfpipe

Guest Service Facilities

- Enlarge the Hart Prairie Lodge by approximately 6,000 square feet to a *total* of 24,900 square feet
- Construct a new 10,000 square foot guest services facility adjacent to the Agassiz Lodge[5]
- Construct a 2,500 square foot Native American cultural and education center constructed in or near the Agassiz Lodge
- Replace existing on-mountain ski team buildings

Summer Trails

- Construct a hiking trail from the existing Agassiz Chairlift mid-station to the top terminal
- Construct an Americans with Disabilities Act (ADA) compliant summer access trail into Hart Prairie from the parking lot near Agassiz Lodge

[5] Facilities in both the Hart Prairie and Agassiz lodges would be brought into ADA compliance.

Infrastructure and Utilities

- Construct a 14.8-mile pipeline to transport reclaimed water from Flagstaff to Snowbowl
- Install snowmaking pipelines buried within existing and proposed trails
- Redesign the entrance circle, which would have signs directing guests to parking lots, day lodges, and snowplay parking
- Construct a 400-space parking area to service the proposed tubing facility
- Combine parking lots #1 and #2 by re-grading and leveling them
- Develop approximately 1,110 feet of additional on-mountain access road
- Reconstruct approximately 3,650 feet of existing two-track mountain access road
- Decommission approximately 3,050 feet of existing two-track mountain access road
- Install buried 10,000-gallon water storage tanks at each of the lodges and at the snowplay building to facilitate the use of reclaimed water
- Construct a pedestrian underpass

ALTERNATIVE 3 - NO SNOWMAKING OR SNOWPLAY

By excluding all snowmaking infrastructure and the associated use of reclaimed water on the San Francisco Peaks, Alternative 3 was designed to respond to tribal and public concerns over effects to cultural and spiritual values as well as effects to water quality within the watershed. Alternative 3 also responds to cultural issues related to scarring of the San Francisco Peaks with reduced ground and vegetation disturbance. When compared to the Proposed Action, Alternative 3 reduces permanent and temporary ground disturbance. Alternative 3 includes all components as described in the Proposed Action with the exception of snowmaking, the snowtubing facility, and the realignment of the Aspen Chairlift or associated vegetation clearing in the northwestern portion of Hart Prairie.

ALTERNATIVES CONCEPTS CONSIDERED BUT NOT ANALYZED IN DETAIL

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not analyzed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternative methods for achieving the established project purpose and need. Some of these alternatives may have been outside the scope of the proposal, duplicative of the alternatives considered in detail, or determined to be components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered but eliminated from detailed consideration. Refer to Chapter 2 for a more detailed description of these alternatives considered but eliminated from the EIS.

- Remove the Ski Area
- Night Lighting
- Reduced Development of Additional Skiable Terrain - Humphreys Pod
- Reduced Snowmaking Coverage
- Alternative On-Site and Nearby Water Sources
- Additional / Alternative Summer Recreational Opportunities
- Alternative Snowmaking Water Pipeline Alignments

PUBLIC INVOLVEMENT

PUBLIC SCOPING AND COMMENTS ON THE DEIS

On September 23, 2002, a scoping notice describing the Forest Service's Proposed Action was mailed to approximately 350 community residents, interested individuals, public agencies, and other organizations. This notice was designed to elicit comments, concerns, and issues pertaining to the Proposed Action. A press release and legal notice were distributed to key local and regional media. On October 7, 2002, the Forest Service published a required Notice of Intent (NOI) to prepare an EIS in the Federal Register. In addition, two public open houses were held at the Flagstaff High School on October 10, and 26, 2002 to formally introduce the Proposed Action. Approximately 1,200 comment letters were received by the Forest Service by the end of the comment period. Based upon the responses received during scoping, the Forest Service Interdisciplinary Team (ID Team) prepared a list of resource issues and areas to be analyzed within DEIS.

As previously indicated, the DEIS was released to the public in February 2004. Substantive comments were extracted and responded to, either individually or "thematically" in the Response to Comments contained in Volume 2 of the FEIS

TRIBAL SCOPING AND CONSULTATION

The Forest has been consulting with approximately 13 tribes or chapters - representing the Hopi, Navajo, Zuni, Acoma, Apache, Hualapai, Havasupai, Yavapai, and Southern Paiute - about the cultural significance of the San Francisco Peaks since the 1970's. The Forest Service initiated tribal consultation on the Proposed Action in June 2002 with a formal letter from the Forest Supervisor to 13 tribal leaders. Also in June 2002, the District Ranger contacted tribal representatives from Cultural Preservation Offices of 13 formally recognized tribes to discuss the Snowbowl proposal and suggest pre-proposal meetings. Phone contacts between the District Archaeologist and several tribal Cultural Preservation Officers (Hopi, Navajo, Hualapai, San Carlos Apache, Yavapai-Apache) were made during the months of June-December 2002. In addition, follow-up phone calls to interested tribes were made by the District Archaeologist to ensure receipt of letters. Overall, numerous phone calls and letters have been sent to tribes and the tribal public requesting input.

Two formal public meetings were held on the Hopi and Navajo Indian Reservations (Tuba City and Kykotsmovi) on Monday, December 9, 2002. The emphasis of these two public meetings was to explain the Proposed Action to tribal members and to elicit comment/concerns on behalf of individuals and the tribe. Throughout the Tribal consultation process specific to the Proposed Action, the Forest Service estimates that approximately 205 phone calls were made, 41 meetings were held and 245 letters were exchanged.

ISSUES, RESOURCES REQUIRING ADDITIONAL ANALYSIS, AND INDICATORS

Based on the results of internal and public scoping, the Forest Service identified specific areas (resources) of concern. The two issues that emerged from the scoping process were related to heritage resources. These issues warranted the creation of an additional alternative. Beyond

these two issues, 17 additional "resources requiring additional analysis and disclosure" were identified. Issues and resources requiring additional analysis and disclosure have been assigned indicators for use in addressing them. While some indicators are necessarily qualitative in nature, every effort was made to use indicators that are quantitative, measurable, and predictable. The project record includes all comments letters that were submitted during the scoping period, as well as a synthesis comments which was used by the Forest Service ID Team to identify issues. A summary of the issues and resources requiring additional analysis follows. Indicators used for the analysis of each resources area can be found in Chapter 1 and their effects throughout Chapter 3.

HERITAGE RESOURCES

Issue #1 - *The installation and operation of snowmaking infrastructure as described in the Proposed Action, and the use of reclaimed wastewater as a water source, may impact cultural and spiritual values associated with the San Francisco Peaks (Issue).*

Issue #2 - *Proposed ground disturbances and vegetation removal may result in permanently evident, visible alterations (i.e., "scarring") of the San Francisco Peaks' landscape (Issue).*

Some people feel the effects of the Proposed Action cannot be adequately described until the significant qualities of the San Francisco Peaks are identified as part of the National Register nomination process (Resource requiring additional analysis).

NOISE

The proposed snowmaking system may increase noise levels potentially disturbing residents, recreationists, and/or wildlife (Resource requiring additional analysis).

TRAFFIC AND ACCESS

The Proposed Action may affect traffic volumes and/or congestion on U.S. Highway 180 and/or the Snowbowl Road (Resource requiring additional analysis).

AESTHETIC IMPACTS

Proposed ground disturbance and vegetation removal within the SUP may incrementally affect the aesthetic quality of the west face of the San Francisco Peaks (Resource requiring additional analysis).

SOCIO-ECONOMICS

Implementation of the Proposed Action may have social and economic effects on Flagstaff and Coconino County (Resource requiring additional analysis).

RECREATIONAL OPPORTUNITIES AND EXPERIENCES

The Proposed Action may affect the quality, distribution, and opportunity for winter and summer recreational experiences within the SUP area (Resource requiring additional analysis).

WILDERNESS VALUES

Implementation of the Proposed Action may affect the experience of wilderness users within the surrounding Kachina Peaks Wilderness (Resource requiring additional analysis).

SKI AREA INFRASTRUCTURE AND UTILITIES

The Proposed Action may affect ski area infrastructure and supporting utilities within and beyond the SUP area (Resource requiring additional analysis).

WATERSHED RESOURCES

The application of Class A reclaimed water for snowmaking within the SUP area may affect water quality within the receiving subwatersheds (Resource requiring additional analysis).

Use of reclaimed water for snowmaking purposes between November and February of each year may affect aquifer recharge (Resource requiring additional analysis).

SOILS AND GEOLOGY

The Proposed Action has potential to change soil chemistry and moisture due to the application of machine produced snow (Resource requiring additional analysis).

VEGETATION

Plant communities (including T, E and S plant species, and regionally important plants) within the SUP area may be altered as a result of the proposed projects (Resource requiring additional analysis).

The Proposed Action has potential to change vegetation composition within the SUP area due to the application of machine-produced snow (Resource requiring additional analysis).

WILDLIFE

The Proposed Action may result in the alteration and/or removal of habitat for terrestrial wildlife species within the SUP (Resource requiring additional analysis).

Proposed snowmaking activities may result in a longer-duration snowpack and additional water storage for wildlife in the SUP area (Resource requiring additional analysis).

GEOTECHNICAL ANALYSIS

Geotechnical feasibility and associated hazards associated with construction of the proposed snowmaking impoundment on the ridge above the Sunset Chairlift must be analyzed (Resource requiring additional analysis).

AIR RESOURCES

Snowplay activities at Snowbowl may increase vehicular traffic and may negatively impact air quality in the region (Resource requiring additional analysis).

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

A useful description of the affected environment and environmental consequences for each resource area analyzed in Chapter 3 not appropriate for a summary. The reader is referred to Table 2-5.

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Coconino National Forest
Peaks Ranger District

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LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AF	Acre-feet
AMSL	Above Mean Sea Level
APP	Aquifer Protection Permit
APS	Arizona Public Service
APU	Auxiliary Power Unit
ATR	Automatic Traffic Recorder
ADT	Average Daily Traffic
A&W	Aquatic and Wildlife
A&Wedw	Aquatic and Wildlife for effluent-dependent water
AZPDES	Arizona Pollutant Discharge Elimination System
BA	Biological Assessment
BBB	Bed, Board, & Booze
BBS	Breeding Bird Survey
BE	Biological Evaluation
BOD	Biological Oxygen Demand
BMP	Best Management Practice
CAA	Clean Air Act
CCC	Comfortable Carrying Capacity
CEQ	Council on Environmental Quality
CFM	Cubic Feet per minute
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CNF	Coconino National Forest
CO	Carbon Monoxide
COE	US Army Corps of Engineers
CPI	Consumer Price Index
CWA	Clean Water Act
DBA	Noise
DB	Decibel
DBP	Disinfection By-Products
DBH	Diameter at Breast Height
DDT	Dichloro Diphenyl Trichloroethane
DEM	Digital Elevation Model
DEQ	Department of Environmental Quality
DMR	Discharge Monitoring Report
DWS	Drinking Water Source
EA	Environmental Assessment
EDCs	Endocrine Disrupting Compounds
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FBC	Full-Body Contact
FC	Fish Consumption

FICON	Federal Interagency Committee on Noise
FPS	Feet per Second
FS	Forest Service
FSH	Forest Service Handbook
FSM	Forest Service Manual
FTE	Full-time Equivalents
GIS	Geographic Information System
GMU	Game Management Unit
GPD	Gallons per Day
GPM	Gallons per Minute
GPS	Global Positioning System
HUD	US Housing and Urban Development Department
IBA	Important Bird Areas
IDT	Interdisciplinary Team
IF	Isolated Find
IRA	Inventoried Roadless Area
kV	Kilovolt
Ldn	Day Night Average Sound Level
LRMP	Land and Resource Management Plan
MA	Management Areas
MCE	Maximum Credible Earthquake
MGD	Million Gallons per Day
mg/l	Milligrams per liter
MIS	Management Indicator Species
MSA	Metropolitan Statistical Area
MSO	Mexican Spotted Owl
NAAQS	National Ambient Air Quality Standards
NASB	Northern Arizona Seismic Belt
NAU	Northern Arizona University
NDIS	Natural Diversity Information System
NEPA	National Environmental Policy Act
NFS	National Forest System
NHPA	National Historic Preservation Act
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxide
NOI	Notice of Intent
NRHP	National Register of Historic Places
NPDES	National Pollutant Discharge Elimination System
O_3	Ozone
OFE	Overland Flow Elements
PAC	Protected Activity Centers
Pb	Lead
PBC	Partial-Body Contact
PFA	Post-fledgling Family Areas
$PM_{2.5}$	Particulate Matter under 2.5 microns
PM_{10}	Particulate Matter under 10 microns
PMF	Probable Maximum Flood
PPCP	Pharmaceuticals and Personal Care Products

PRISM	Parameter Elevation Regressions on Independent Slopes Model
PSD	Prevention of Significant Deterioration
RGL	Regulatory Guidance Letter
ROD	Record of Decision
SAOT	Skiers-At-One-Time
SD	Standard Deviation
SFE	Single-Family Equivalent
SH	State Highway
SIL	Scenic Integrity Level
SIP	State Implementation Plan
SIU	Significant Industrial User
SMRF	Self-Monitoring Report Forms
SMS	Scenery Management System
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SUP	Special Use Permit
TCP	Traditional Cultural Property
TDS	Total Dissolved Solids
TES	Threatened, Endangered, and Sensitive species
TLA	Three Letter Acronym
TIN	Triangulated Irregular Network
TOC	Total Organic Carbon
TRC	Total Residual Chlorine
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
$\mu g/m^3$	Micrograms per cubic meter
USC	United States Code
USCA	United States Code Annotated
USDA	United States Department of Agriculture
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
VMS	Visual Management System
VQO	Visual Quality Objective
VOC	Volatile Organic Compound
WEPP	Water Erosion Prediction Project
WET	Whole Effluent Toxicity
WRENSS	Water Resources Evaluation of Non-Point Silvicultural Sources
WRP	Water Reclamation Plant
WWTP	Wildcat Hill Wastewater Treatment Plant

CHAPTER 1
PURPOSE AND NEED

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Coconino National Forest
Peaks Ranger District

1. PURPOSE AND NEED

INTRODUCTION

A Draft Environmental Impact Statement (DEIS) for the Arizona Snowbowl Facilities Improvements proposal was released to the public in February 2004. The comment period extended through April 13, allowing the public 60 days to review the document and submit comments to the Forest Service. The number of commentors on the DEIS totaled 5,716, received by various mediums, including: letters; form letters; faxes, emails; phone calls; and petitions (the reader will note that this number accounts for people who submitted multiple forms of comments). The reader is referred to Volume 2 – Response to Comments (RTC) for more information on the DEIS comment period.

The Forest Service has prepared this Final EIS (FEIS) - Volume 1 - which includes updates to the original analysis, as presented in the DEIS, as based on substantive comments received. Numerous changes have been incorporated into the analysis between DEIS and FEIS, however, the majority of them are considered minor and do therefore do not change overall conclusions. The exception is the Environmental Justice analysis contained in Section 3N, which has undergone a wholesale revision since the DEIS was published. The RTC is contained in Volume 2 of this FEIS. Finally, a Record of Decision (ROD) has been prepared and accompanies volumes 1 and 2 of this FEIS. The ROD documents the Decision Maker's Selected Alternative and rationale for the decision.

DOCUMENT STRUCTURE

The proposed projects analyzed in this document constitute a federal action (i.e., a decision), which has the potential to affect the quality of the human environment on public lands administered by the Forest Service. Therefore, the action must be analyzed pursuant to the National Environmental Policy Act (NEPA). Under NEPA, Federal Agencies must carefully consider environmental concerns in the decision making process and provide relevant information to the public for review and comment.

This FEIS discloses the direct, indirect, and cumulative environmental impacts anticipated to result from implementation of the Proposed Action and alternatives. Volume 1 of the FEIS is organized into five Chapters and five technical appendices:

- Chapter 1 - Purpose and Need: includes information on the history of the project proposal, the purpose of and need for the project, and the proposal for achieving that purpose and need. Chapter 1 also details how the Forest Service informed the public of the proposal and how the public responded.

- Chapter 2 – Description of Alternatives: provides a detailed description of the Proposed Action as well as alternatives that were formed in response to issues raised. This discussion also includes alternatives considered but eliminated from further analysis and mitigation

measures. Finally, Chapter 2 provides a summary table of the environmental consequences anticipated with each alternative.

- Chapter 3 - Affected Environment and Environmental Consequences: provides a description of the affected environment (i.e., existing conditions) according to resources area and describes the environmental effects of implementing the Proposed Action and other alternatives. Chapter 3 is organized by resource topic.

- Chapter 4 – Preparers and Contributors: provides a list of preparers and contributors during the development of this EIS.

- Chapter 5 – Agencies, Organizations and Persons Who Received Copies of the FEIS

- Technical appendices:
  (A) Conceptual Snowmaking Water Impoundment Design
  (B) Proposed Forest Plan Amendment
  (C) Cumulative Effects Table
  (D) Memorandum of Agreement between the USDA Forest Service, Advisory Council on Historic Preservation, and the Arizona State Historic Preservation Officer

Additional documentation, including more detailed analyses of project area resources, may be found in the project administrative record located on the Coconino National Forest (CNF).

BACKGROUND

The San Francisco Volcanic Field covers approximately 1,800 square miles in northern Arizona. The field lies along the southern perimeter of the Colorado Plateau, defined by the Mogollon Rim to the south of Flagstaff. The most prominent peak within the field is Humphreys Peak, which at 12,633 feet is the highest point in Arizona. Collectively, Humphreys Peak, Agassiz Peak (12,356 feet), Doyle Peak (11,460), and Fremont Peak (11,696 feet) are identified on USGS maps as the San Francisco Mountain. However the mountain is more commonly referred to as the San Francisco Peaks by the local population and for the purpose of this analysis shall be hereafter referred to as such.

The Arizona Snowbowl (hereinafter referred to as “Snowbowl”) is owned and operated by Arizona Snowbowl Resort Limited Partnership. Snowbowl is located entirely on the CNF on the western flank of the San Francisco Peaks. The ski area is operated under a 777-acre Forest Service-issued Special Use Permit (SUP), which is renewed on a 40-year basis. Snowbowl is approximately 15 miles north of Flagstaff, one of the four largest metropolitan areas in Arizona (refer to Figure 1-1). Snowbowl is surrounded on three sides by the 18,960-acre Kachina Peaks Wilderness, which was designated by the U.S. Congress in 1984.

Skiers[1] have been using the Snowbowl since 1938, when the ski area's original base area was established in Hart Prairie. The foundation of the base lodge (which was destroyed by fire in 1952) can still be seen just above the first tower of the Hart Prairie Chairlift. Originally a dirt road, the Snowbowl Road was constructed by the Civilian Conservation Corps. A rope tow, powered by a car engine, was the only means of uphill transport. In 1954 the road was extended to the site of the Agassiz Lodge and in 1956 the Agassiz Lodge was constructed. A Poma surface lift was installed in 1958 and part of that lift line is now the *Blackjack* (trail #17). The original Agassiz Chairlift was installed by the Riblet Corporation in 1962. Relatively little activity was seen until the 1970's when Summit Properties purchased the area with plans for a base village, however, a land use plan issued in 1971 restricted development to the existing permit area. In 1977 the area was purchased by Northland Recreation and a Master Concept Plan was filed with the Forest Service. This plan was tested in the courts and the US Supreme Court refused to hear the case, effectively upholding the decision of the US Court of Appeals.. In 1982 the Hart Prairie Chairlift was built. Fairfield Communities purchased the ski area in November of that same year and began an improvement program in 1983, including construction of the Hart Prairie Lodge, Sunset Chairlift and transfer of the rope tow back to Hart Prairie. In 1985 parking lots #5 and #6 were completed along with a new maintenance shop. In 1986 a new CTEC triple chairlift was installed on the site of the original Agassiz Chairlift; the rope tow and the Poma were removed and the Aspen Chairlift was installed in Hart Prairie. A two-year Snowbowl Road improvement and paving project began in 1988.

Arizona Snowbowl Resort Limited Partnership purchased the ski area in December 1992 and proceeded to make immediate improvements to the facilities and ski trails. Hart Prairie Lodge was expanded by constructing a new guest service office, rental shop, and children's ski school. *Logjam* (trail #25) was widened and new trails – *Lava* (trail #43c) and *Volcano* (trail #43a) were constructed.

In addition to wintertime skiing and snowboarding, the Snowbowl offers summertime scenic chairlift rides on the (Sky ride program) Agassiz Chairlift. Guided horseback rides, banquets, and restaurant facilities are also available.

RELATIONSHIP OF THE CURRENT PROPOSAL TO PREVIOUS NEPA ANALYSIS AND APPROVALS

In 1979 a master plan for upgrading Snowbowl was produced, which provided for the installation of new lifts, trails, and facilities. These projects were analyzed in the 1979 Arizona Snowbowl Ski Area Proposal Final Environmental Statement (1979 Environmental Statement) and ultimately approved via an associated Record of Decision (ROD). Two of the approved lifts were subsequently installed – Hart Prairie and Sunset. In addition, the Hart Prairie Lodge and new parking were added in accordance with the 1979 Environmental Statement.

Many of the projects analyzed in this current EIS are consistent with the 1979 Master Plan. However, because of the length of time that has passed since the approval of the 1979 Master

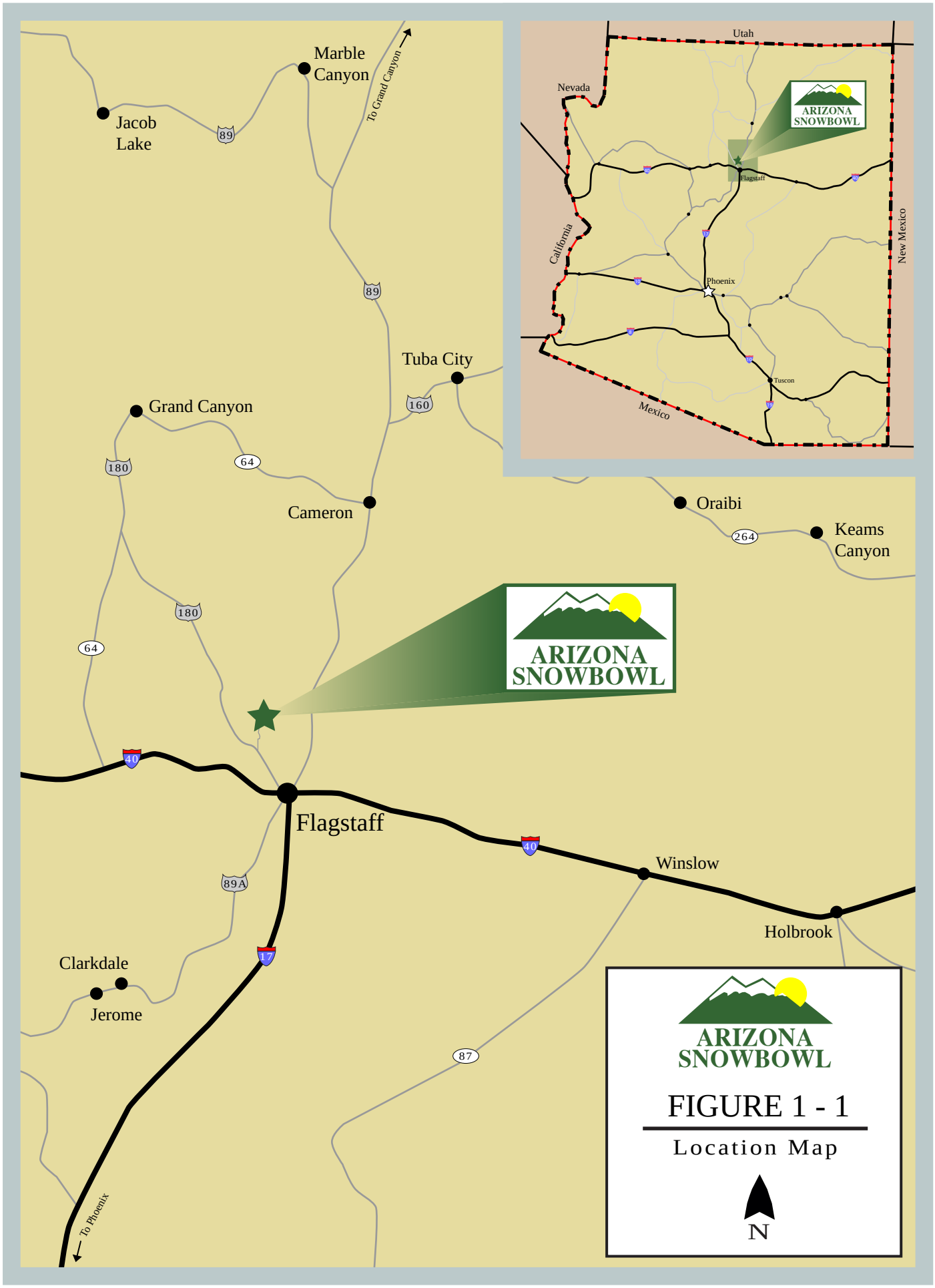
[1] At ski areas, one may see people using Alpine, snowboard, telemark, cross-country, and other specialized ski equipment, such as that used by disabled or other skiers. Accordingly, the terms "ski, skier, and skiing" in this document encompass all lift-served sliding sports typically associated with a winter sports area.

Plan, the advent of new procedural requirements, and potentially changed conditions, these approvals are no longer valid without additional site-specific environmental analysis. Currently proposed projects that were not specifically approved in the 1979 ROD have been designed to remain within the contextual scope of the 1979 decision. From the selected alternative identified in the 1979 ROD, this analysis carries forward the size of the ski area (777 acres) and the comfortable carrying capacity (CCC)[2] of 2,825.

The 1987 CNF Forest Plan[3] (hereinafter referred to as "the Forest Plan") adopted the 1979 Environmental Statement into its management direction for Management Area 15, which provides direction for developed recreation areas, including the SUP area. Throughout the Forest Plan, the Arizona Snowbowl is referred to as the Fairfield Snowbowl.

[2] CCC is defined as the number of guests that can be comfortably accommodated by a ski area at any point in time. It provides for a pleasant recreational experience by not overburdening a ski area's facilities (including, but not limited to, parking, restaurant seating, restrooms, and uphill/downhill capacity). CCC is used by ski area planners and the Forest Service as a planning tool and *does not constitute a cap on visitation*. Facilities are typically designed to accommodate 125 percent of a ski area's CCC in order to preserve the guest experience on peak visitation days, which are anticipated periodically throughout the season.

[3] USDA Forest Service, 1987 as amended


Marble Canyon
To Grand Canyon
Jacob Lake
89
89
Tuba City
160
Grand Canyon
180
64
Cameron
Oraibi
264
Keams Canyon
180
64
ARIZONA SNOWBOWL
40
Flagstaff
40
Winslow
89A
Holbrook
17
Clarkdale
Jerome
87
To Phoenix
Utah
Nevada
California
New Mexico
Mexico
Flagstaff
Phoenix
Tuscon
ARIZONA SNOWBOWL
FIGURE 1 - 1
Location Map
N

PURPOSE AND NEED FOR THE PROPOSED ACTION

The Forest Service and Snowbowl cooperatively determined general categories important for improving the Snowbowl's facilities. From these categories, a list of proposed projects was created, and the Proposed Action ultimately emerged. The Proposed Action responds to the goals and objectives outlined in the Forest Plan,[4] and helps move the project area towards desired conditions described in it.

The overall Purpose and Need for these projects responds to two broad categories: 1) to provide a consistent/reliable operating season, and; 2) to improve safety, skiing conditions, and recreational opportunities by bringing terrain and infrastructure into balance with existing demand.

PURPOSE #1:

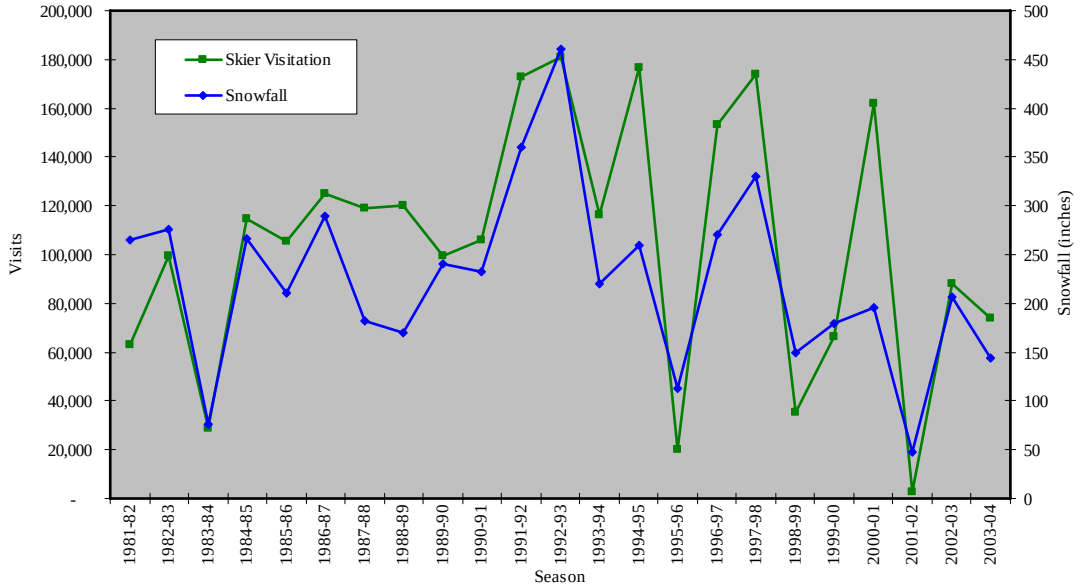
To ensure a consistent and reliable operating season, thereby maintaining the economic viability of the Snowbowl, and stabilizing employment levels and winter tourism within the local community.

Existing Condition:

Inconsistent annual snowfall has historically led to a sporadic operating season and therefore broad fluctuations in annual visitation. This has created unstable employment levels at the ski area and has greatly affected local winter tourism. Snowbowl's ability to maintain or improve its current level of service and endure the business conditions caused by unreliable snowfall is questionable. Figure 1-2 correlates annual snowfall (inches) with annual visitation for the past 22 seasons at Snowbowl:

[4] USDA Forest Service, 1987

Figure 1-2
Comparison of Natural Snowfall and Skier Visits
(1981/82 through 2003/04)



Need:

The installation and operation of snowmaking infrastructure would provide a reliable and consistent operating season helping to stabilize Snowbowl's investment, increase local employment levels, and boost winter tourism within the community.

PURPOSE #2:

To improve safety, skiing conditions, and recreational opportunities, bringing terrain and infrastructure into balance with current use levels.

Existing Condition:

Currently, areas of intermediate and beginner terrain are inadequately sized to accommodate the public's demand for terrain of these ability levels on peak days. This lack of terrain often results in significant use of the existing terrain and high skier densities on peak days. This creates safety issues because of overcrowded ski runs. When compared to ski industry norms (and guest expectations), Snowbowl exhibits a deficit of intermediate and beginner level terrain and a surplus of novice level terrain as shown in Table 1-1.

Need:

Improve the quantity and distribution of beginner and intermediate (including low intermediate and advanced intermediate) terrain and skier safety by developing additional terrain within the existing SUP area.

Table 1-1
Existing Terrain Distribution

Skier/Rider Ability Level	Total Skiable Terrain (acres)	Terrain Capacity by Ability Level (guests)	Skier Distribution Across Terrain (percent)	Typical Skier Market Distribution Across Terrain (percent)	Difference
Beginner	0.5	15	1%	5%	-4
Novice	44.0	790	44%	15%	+29
Low Intermediate	31.3	438	25%	25%	0
Intermediate	38.1	381	22%	35%	-13
Adv. Intermediate	15.4	108	6%	15%	-9
Expert	9.4	28	2%	5%	-3
Total	***138.6***	***1,760***	***100%***	***100%***	

Existing Condition:

Public demand at Snowbowl has grown significantly in the past 20 years, increasing from 63,000 annual visits in 1981/82 to 162,175 during the 2000/01 season, an increase of 157 percent. The inadequate size and limited conditions of on-mountain facilities have resulted in a crowded, undesirable guest experience in many areas, such as in the lodges and on the chairlifts. Additionally, Snowbowl frequently experiences peak demand days which significantly exceed the current CCC of the existing facilities and infrastructure.

Need:

To increase the capacities of the day lodges, chairlifts, and other ski area infrastructure, bringing it into proper balance with *current* use levels, while remaining within the ski area's previously approved CCC of 2,825 skiers.

Existing Condition:

Approximately 30,000 visitors ride the summer Scenic Sky ride annually. Although numerous summer visitors express interest, guests are not allowed to hike down the mountain due to the steep grades and cobbled surface.

Need:

To allow guests to hike from the top back to the base area by providing an established hiking trail from the top of the Agassiz Chairlift. Additionally, this trail would allow Snowbowl lift maintenance personnel to periodically access the top terminal of the Agassiz Chairlift using all terrain vehicles during the summer.

Existing Condition:

In the past, numerous snowplayers illegally parked along the Snowbowl Road and at the ski area to sled, slide, and saucer in existing openings off the edge of the road and at the ski area. This unmanaged, dispersed use often leads to injuries, traffic management issues, garbage, and sanitation problems. In 2002 the Forest Service prohibited parking along the Snowbowl road which eliminated these unmanaged snowplay activities. This action relocated the displaced

snowplayers to other unmanaged areas on the forest, primarily along Highway 180, but has produced numerous management challenges associated with widespread, unregulated snowplay.

Need:

To develop a managed and professionally designed snowplay/tubing facility at the ski area to fill the demonstrated public demand for snowplay. The facility should provide restrooms, a warming building, ticketing, concessions, parking, and trash receptacles.

SUMMARY OF THE PROPOSED ACTION

In response to the purpose and need, the following Proposed Action was assembled by Snowbowl and the Forest Service. A detailed description of the Proposed Action is provided in Chapter 2.

SNOWMAKING

- Approximately 205 acres of snowmaking coverage throughout the SUP area utilizing Class A reclaimed water as a source
- A 10 million-gallon snowmaking water reservoir near the top terminal of the existing Sunset Chairlift, and catchment pond below the Hart Prairie Lodge
- Construct a reclaimed water pipeline between Flagstaff and the Snowbowl with booster stations and pumphouses
- Construct a 3,000 to 4,000 square foot snowmaking control building in the vicinity of the existing maintenance shop

SNOWPLAY/TUBING FACILITY

- A professionally designed and managed snowplay/tubing facility at the base area including sculpted lanes, lifts, and a lodge

LIFTS/UPHILL CAPACITY

- Replace of the Sunset Chairlift with a high speed, detachable chair
- Relocate the existing Sunset Chairlift as the Humphreys Chairlift, accessing a pod of proposed ski trails
- Upgrade and extension of the Hart Prairie Chairlift with a high-speed, detachable lift
- Upgrade and realignment of the Aspen Chairlift
- Install three surface conveyors in the area north of the Hart Prairie Lodge
- Install a handle tow is proposed to service a halfpipe and terrain park

TERRAIN

- Approximately 66 acres of new trails
- Approximately 47 acres of thinning to created improved glades
- Approximately 87 acres of terrain improvements (grading/stumping and smoothing)
- Create a dedicated teaching area near the Hart Prairie Lodge
- Construct a halfpipe

GUEST SERVICE FACILITIES

- Enlarge the Hart Prairie Lodge by approximately 6,000 square feet to a *total* of 24,900 square feet
- Construct a new 10,000 square foot guest services facility adjacent to the Agassiz Lodge[5]
- Construct a 2,500 square foot Native American cultural and education center constructed in or near the Agassiz Lodge
- Replace existing on-mountain ski team buildings

SUMMER TRAILS

- Construct a hiking trail from the existing Agassiz Chairlift mid-station to the top terminal
- Construct an Americans with Disabilities Act (ADA) compliant summer access trail into Hart Prairie from the parking lot near Agassiz Lodge

INFRASTRUCTURE AND UTILITIES

- Construct a 14.8-mile pipeline to transport reclaimed water from Flagstaff to Snowbowl
- Install snowmaking pipelines buried within existing and proposed trails
- Redesign the entrance circle, which would have signs directing guests to parking lots, day lodges, and snowplay parking
- Construct a 400-space parking area to service the proposed tubing facility
- Combine parking lots #1 and #2 by re-grading and leveling them
- Develop approximately 1,110 feet of additional on-mountain access road
- Reconstruct approximately 3,650 feet of existing two-track mountain access road
- Decommission approximately 3,050 feet of existing two-track mountain access road
- Install 10,000-gallon buried water storage tanks at each of the lodges and at the snowplay building to facilitate the use of reclaimed water
- Construct a pedestrian underpass

DECISION FRAMEWORK

This FEIS is not a decision document. Its primary purpose is to disclose the environmental consequences which are anticipated to occur through implementation of the alternatives under consideration. The Selected Alternative is documented in the ROD. The Selected Alternative provides the framework for a new master development plan (MDP), which will guide the future development of the Snowbowl.

PUBLIC INVOLVEMENT

PUBLIC SCOPING AND COMMENTS ON THE DEIS

On September 23, 2002, a scoping notice was mailed to approximately 350 community residents, interested individuals, public agencies, and other organizations. This notice was designed to elicit comments, concerns, and issues pertaining to the Proposed Action. A press release and legal notice were distributed to key local and regional media. On October 7, 2002, the Forest Service published a Notice of Intent (NOI) to prepare an EIS in the Federal Register. In addition,

[5] Facilities in both the Hart Prairie and Agassiz lodges would be brought into ADA compliance.

two public open houses were held at the Flagstaff High School on October 10, and 26, 2002. Forest Service representatives and members of the consultant team were present to answer questions and collect comments. In response to public and tribal scoping (described below), including the open houses, approximately 1,200 comment letters were received. Based upon the responses received during scoping, the Forest Service Interdisciplinary Team (ID Team) prepared a list of resource issues and areas to be analyzed within DEIS.[6]

The DEIS was released to the public in February 2004. On February 25, a public open house was held at the Flagstaff High School (302 people signed in). As indicated in the Introduction, 5,716 people submitted comments during the 60-day DEIS comment period. Substantive comments were extracted and responded to, either individually or "thematically" in the RTC. The total number of substantive comments was 9,887. Volume 2 of the FEIS not only provides responses to all substantive comments received, but also includes a table with the names and general comments themes of all commentors. The reader is referred to Volume 2 of the FEIS for additional clarification on how substantive comments were extracted, grouped, and responded to.

TRIBAL SCOPING AND CONSULTATION

The Forest has been consulting with approximately 13 tribes or chapters - representing the Hopi, Navajo, Zuni, Acoma, Apache, Hualapai, Havasupai, Yavapai, and Southern Paiute - about the cultural significance of the San Francisco Peaks since the 1970's. The Forest Service initiated tribal consultation on the Proposed Action in June 2002 with a formal letter from the Forest Supervisor to 13 tribal leaders. Also in June 2002, the District Ranger contacted tribal representatives from Cultural Preservation Offices of 13 affiliated tribes to discuss the Snowbowl proposal and suggest pre-proposal meetings. Phone contacts between the District Archaeologist and several tribal Cultural Preservation Officers (Hopi, Navajo, Hualapai, San Carlos Apache, Yavapai-Apache) were made during the months of June-December 2002. In addition, follow-up phone calls to interested tribes were made by the District Archaeologist to ensure receipt of letters. Overall, numerous phone calls and letters have been sent to tribes and the tribal public requesting input.

Two formal public meetings were held on the Hopi and Navajo Indian Reservations (Tuba City and Kykotsmovi) on Monday, December 9, 2002. The emphasis of these two public meetings was to explain the Proposed Action to tribal members and to elicit comment/concerns on behalf of individuals and the tribe.

Throughout the Tribal scoping process, specific to the Snowbowl's Proposed Action, the Forest Service estimates that approximately 205 phone calls were made, 41 meetings were held and 245 letters were exchanged.[7] Meetings that took place between Forest Service representatives, tribes and consultants are indicated below.[8]

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[6] The scoping comment disposition analysis is available in the project file.

[7] 115 of these phone calls, meetings and letters are estimated to have occurred in a manner that is consistent with government-to-government relationship.

[8] "*" denotes meetings that were of a government-to-government nature.

*July 18, 2002	Pre-proposal CRATT (Cultural Resource Advisory Task Team) meeting at Hopi
August 6, 2002	Forest Service, Shereen Lerner, and representatives from Yavapai-Apache (all Apache tribes invited; only Camp Verde attended)
August 18, 2002	Heather Cooper and Mae Franklin (Navajo liaison) set up information booth at Tuba City Flea Market as part of the Western Navajo Fair
August 21, 2002	Forest Service, Shereen Lerner, and Hopi Land Team
September 19, 2002	Forest Service, Shereen Lerner and Hopi Cultural Resource Advisory Team
October 3, 2002	Snowbowl public meeting – Flagstaff
October 8, 2002	Mae Franklin attended Gap/Bodaway Chapter House meeting on Navajo Reservation and collects comments regarding Snowbowl proposal
October 13, 2002	Mae Franklin attended Cameron Chapter House meeting and collects comments regarding Snowbowl proposal
October 16, 2002	Cooper (CNF) and Franklin (Navajo Liaison) meet in Cameron to discuss Snowbowl Proposal and consultation plan/public outreach for Navajo.
October 26, 2002	Snowbowl public meeting – Flagstaff
October 23, 2002	Shereen Lerner, Forest Service and representatives from the Hopi Tribe
November 13, 2002	Franklin (Navajo Liaison) attends 2 Chapter House Meetings: Cameron and Bodaway/Gap
November 23, 2002	Mae Franklin and Heather Cooper attended Leupp Chapter House meeting and collect comments regarding Snowbowl proposal
November 26, 2002	Heather Cooper presents "Collaborative Management of the San Francisco Peaks" to the Hopi Cultural Resources Advisory Team
*December, 4 2002	Waldrip, Cooper, Jacobs (CNF) meet with Talayumptewa and Morgart from Hopi to discuss details of Tribal public meetings
December 9, 2002	Tribal meeting held at Tuba City High School. Representatives include: Forest Service personnel (including Forest Supervisor Jim Golden and Peaks District Range Gene Waldrip); SE GROUP; Shereen Lerner; and members of the Hopi Tribe and Navajo Nation
December 9, 2002	Tribal meeting held at Kykotsmovi Community Center. Representatives include: Forest Service personnel (including Forest Supervisor Jim Golden and Peaks District Range Gene Waldrip); SE GROUP; Shereen Lerner; and members of the Hopi Tribe

December 14, 2002	Mae Franklin, Gene Waldrip, and Heather Cooper attend Western Navajo Agency Council meeting, requesting comments on Snowbowl proposal
*November 19, 2003	Pilles, Rasure and Waldrip (CNF) meet Kuwanwisiwma at Hopi for CRATT presentation – CRATT does not show up because they were not correctly informed
December 08, 2003	Rasure, Waldrip, Cooper, and other CNF staff meet with the Save The Peaks Coalition to discuss the DEIS
January 15, 2004	Cooper (CNF) meets with Franklin (Navajo Liaison) to discuss release of DEIS and what information we're looking for during comment period
*February 12, 2004	Morgart (Hopi) stops by Peaks RD to get one box of DEISs and drop off press release which states Hopi's opposition to the preferred alternative
February 12, 2004	Franklin (Navajo Liaison) stops by Peaks RD to get one box of DEISs
February 25, 2004	Public Meeting at Flagstaff High School. Several tribal members attend, in addition to Save the Peaks Coalition, and discuss cultural issues with Pilles and Cooper (CNF)
*March 12, 2004	Rasure, Waldrip, Cooper (CNF) meet with Chairman Taylor (Hopi), Kuwanwisiwma, and Morgart at the Chairman's office in Flagstaff to discuss the DEIS and MOA
March 25, 2004	Cooper (CNF) meets with Franklin (Navajo Liaison) and Thomas (Navajo translator) in Cameron to discuss the Cameron public meeting
*April 16, 2004	Morgart (Hopi CPO) visited Cooper (CNF) at the Peaks RD to talk about DEIS and the Hopi response to that document
April 16, 2004	Franklin (Navajo Liaison) visits Cooper (CNF) at Peaks RD and leaves documentation of her Chapter House visits
April 30, 2004	Public Meeting in Cameron to discuss DEIS and gather comments
May 23, 2004	DEIS public meeting at the Veteran's Center on Second Mesa (Hopi)
June 30, 2004	Rasure, Waldrip and Cooper (CNF) meet with Richard Begay and Timothy Begay (Navajo Cultural Preservation Office) at the CNF Supervisor's Office to discuss the DEIS and MOA
*August 06, 2004	Rasure, Waldrip, Pilles and Cooper (CNF) meet with Hualapai Chairman, Vice Chairman, Cultural Preservation Officer and traditional healer in Peach Springs to discuss DEIS and MOA

ISSUES, RESOURCES REQUIRING ADDITIONAL ANALYSIS AND INDICATORS

Based on the results of internal and public scoping, the Forest Service identified specific areas (resources) of concern. The two issues that emerged from the scoping process were related to heritage resources. Both of these issues warranted the creation of an additional alternative. Beyond these two issues, 17 additional "resources requiring additional analysis and disclosure" were identified. Issues and resources requiring additional analysis and disclosure have been assigned indicators for use in addressing them. While some indicators are necessarily qualitative in nature, every effort was made to use indicators that are quantitative, measurable, and predictable. The project record includes all comments letters that were submitted during the scoping period, as well as a synthesis comments which was used by the Forest Service ID Team to identify issues.

THE HUMAN ENVIRONMENT

Heritage Resources

The San Francisco Peaks are central to the cultures and religious practices of many Native American tribes. In 2000, the Peaks were determined eligible for nomination to the National Register of Historic Places (the Register) for their traditional cultural values. In analyzing alternatives, 36 CFR 800 requires that the potential effect of a proposed undertaking be evaluated against the qualities that make a cultural property eligible for the Register. Consequently, in discussions to date with representatives from various tribes, it is evident that the Proposed Action will adversely affect cultural values. Issues raised in response to identified (potential) cultural impacts include the following.

Issue #1: ***The installation and operation of snowmaking infrastructure as described in the Proposed Action, and the use of reclaimed wastewater as a water source, will impact cultural and spiritual values associated with the San Francisco Peaks.***

Background:

The region's Indian Tribes are opposed to the concept of creating snow by an artificial means, particularly through the use of reclaimed water. Although the reclaimed water proposed for use in making snow meets both the EPA and ADEQ water quality standards, the tribes believe the water to be impure which would negatively affect the spiritual values of the Peaks. Any negative effects that occur to the Peaks will be reflected by the plants, animals, water, and soil of the entire mountain. Additionally, the tribes are opposed to snowmaking because it is a disruption of natural processes.

Study Area:

- Direct: SUP area
- Indirect: San Francisco Peaks

Indicator:

- Qualitative discussion of the cultural values of the San Francisco Peaks and the potential for incremental change as a result of implementation of the Proposed Action

Issue #2: ***Proposed ground disturbances and vegetation removal may result in permanently evident, visible alterations (i.e., "scarring") of the San Francisco Peaks' landscape.***

Background:

Ground disturbances associated with grading, vegetation clearing, and snowmaking pipeline installation, could alter the landscape of the San Francisco Peaks – both permanently and temporarily. From the Native American perspective, ground disturbing activities within the SUP could "scar" the sacred landscape/mountain which is believed to be a living entity. The more extensive the disturbance, the greater the adverse effect to cultural values.

Study Area:

- Direct: SUP area
- Indirect: San Francisco Peaks

Indicators:

- Narrative description of existing and historic vegetation and ground disturbance within the SUP area
- Quantification of existing and additional proposed temporarily and permanently evident vegetation disturbances/removals
- Quantification of existing and additional proposed temporary and permanently evident ground disturbances
- Qualitative discussion of the cultural significance of proposed ground and vegetative disturbances and removal within the SUP area

Some people feel the effects of the Proposed Action cannot be adequately described until the significant qualities of the San Francisco Peaks are identified as part of the National Register nomination process.

Background:

The Coconino National Forest has committed to completing the National Register nomination of the Peaks for its traditional cultural values. Analysis and potential approval of the Proposed Action is considered to be independent of the National Register nomination and potential designation processes. Additionally, completion of the nomination/designation processes is not considered to be prerequisite for the analysis or potential approval of the Proposed Action. Since the Peaks have already been determined eligible for National Register nomination for its traditional cultural values, various alternatives may be evaluated according to how they affect traditional values, even if the nomination process has not been completed.

Study Area:

- San Francisco Peaks

Indicators:

- Narrative discussion why the Proposed Action is not dependent upon completion of the National Register nomination/designation processes
- Narrative discussion of the ability for the proposed projects to coexist with a National Register designation if nomination is approved

Noise

The proposed snowmaking system would increase noise levels potentially disturbing residents, recreationists, and/or wildlife.

Background:

There were concerns that noise emissions from single or multiple snowmaking guns and operation of the pumping stations may be audible from Hart Prairie, Thorpe Park, Mars Hill, Observatory Mesa, Fort Valley, or the Kachina Wilderness, potentially disturbing residents, recreationists, and/or wildlife.

Study Area:

- Audible area

Indicators:

- Modeled analysis of snowmaking-related noise emissions above ambient background levels (decibels)
- Modeled analysis of noise dispersion to define audible areas

Traffic and Access

The Proposed Action could affect traffic volumes and/or congestion on U.S. Highway 180 and/or the Snowbowl Road.

Background:

Although daily skier visitation is not proposed to increase as a result of the Proposed Action, the proposed snow tubing facility has potential to increase daily traffic volumes and/or the frequency of congested periods on U.S. Highway 180 and the Snowbowl Road.

Study Area:

- U.S. Highway 180 between Flagstaff and Snowbowl Road, Snowbowl Road

Indicators:

- Historic and projected traffic counts for U. S. Highway 180
- Comparison of anticipated winter traffic volumes with existing winter traffic volumes and the design capacities of U.S. Highway 180 and the Snowbowl Road
- Relative comparison of existing and anticipated winter traffic with current summer traffic volumes

Aesthetic Impacts

Proposed ground disturbance and vegetation removal within the SUP may incrementally affect the aesthetic quality of the west face of the San Francisco Peaks.

Background:

Removal of forested vegetation and ground disturbing activities within the SUP area associated with the proposed projects would be evident in the foreground, middle ground, and background views from various locations. Additionally, there was concern that construction of the proposed water transmission line could result in removal of trees for a new utility corridor affecting aesthetic qualities of the area.

Study Area:

- Foreground, middle ground, and background views[9] of Snowbowl's SUP area.

Indicators:

- The incremental aesthetic effects of the proposed projects compared to historic landscape alterations within the SUP area
- Visual simulations, from identified representative viewpoints, of the proposed landscape alterations as compared to the existing condition. Viewpoints modeled are:
  - Hart Prairie (151 Rd) – Summer
  - U. S. Highway 180 at the Nordic Center– Summer
  - Humphreys Trail (Wilderness area) - Summer
  - Interstate 40 East of Williams - Winter

Socio-Economics

Implementation of the Proposed Action may have social and economic effects on Flagstaff and Coconino County.

Background:

A correlation exists between the consistent operation of the ski area and the Flagstaff/Coconino County economy. This correlation encompasses: seasonal tourism; employment and income levels; and tax revenues. The strength of this correlation needs to be assessed and disclosed.

Socially, Snowbowl provides a source of wintertime recreation for a large number of people in northern and central Arizona. The relative importance of this local source of wintertime recreation needs to be assessed.

Study Area:

- City of Flagstaff/Coconino County

[9] Foreground, middle ground and background, as defined by the Forest Service, are detailed in Chapter 3, Section D.

Indicators:

- Discussion of the potential for the Proposed Action to affect a change in key local economic indicators (population; long- and short-term employment, housing, and tax revenues)
- Analysis of the correlation between Snowbowl annual skier visitation and annual retail and Bed, Board and Booze (BBB) and tax revenues
- Narrative description of the recreational/social function which Snowbowl serves
- The effects of dry roads/fair weather on tourism in Flagstaff and the BBB
- Presentation of historical data analyzing the relationship between winter tourism levels for the City of Flagstaff, with annual snowfall, and annual skier visitation at Snowbowl
- The percentage of the total economy represented by winter tourism
- Financial viability of the ski area under all alternatives

Recreational Opportunities and Experiences

The effects of the Proposed Action on the quality, distribution, and opportunity for winter and summer recreational experiences within the SUP area.

Background:

Snowbowl has provided a source of winter and summer recreational activities since 1938, when the ski area's original base area was established in Hart Prairie. Since that time, an expanding population in the state of Arizona has led to increased pressure on Snowbowl. Inconsistent snowfall in northern Arizona and coupled with increased demand has reduced the ski area's ability to provide a consistent skiing/riding product. As a result, local and regional skiers have expressed a desire for a more reliable and consistent snowpack at Snowbowl.

The Proposed Action would increase skiable terrain and allow the area to meet the CCC of 2,825, and would improve recreational opportunities. By increasing the consistency of the snow pack even through dry winters, the Proposed Action is intended provide more opportunities for skiers in an environment of increasing recreational demand. Summertime hiking opportunities would also be added.

Study Area:

- San Francisco Peaks and SUP area

Indicators:

- Comparison of historic winter and summer recreation visitation versus that anticipated under the Proposed Action
- Narrative description of the quality of winter and summer recreational opportunities under all alternatives.

Wilderness Values

Implementation of the Proposed Action may affect the experience of wilderness users within the surrounding Kachina Peaks Wilderness.

Background:

The Proposed Action would increase use and noise levels within the SUP area during the winter operating season. This could affect the experience of the public recreating within the Kachina Peaks Wilderness.

Study Area:

- San Francisco Peaks and SUP area

Indicators:

- Quantification of seasonal Wilderness use and visitation
- Narrative discussion of the anticipated effects of the Proposed Action to Wilderness users

Ski Area Infrastructure and Utilities

Effects of the Proposed Action on ski area infrastructure and supporting utilities within and beyond the SUP area.

Background:

The Proposed Action necessitates additions to Snowbowl's existing infrastructure, including parking, buildings, power, water, and sanitation, as well as installation of a 14 mile pipeline connecting the ski area to the City of Flagstaff's reclaimed water system.

Study Area:

- SUP area and proposed reclaimed water pipeline corridor

Indicators:

- Disclosure of current versus anticipated requirements for: guest seating, power, domestic water supply, and wastewater treatment.

THE PHYSICAL AND BIOLOGICAL ENVIRONMENT

Watershed Resources

The application of Class A reclaimed water for snowmaking within the SUP area may affect water quality within the receiving subwatersheds.

Background:

Snowbowl's proposed snowmaking operations would use reclaimed water from the City of Flagstaff's Rio de Flag Water Reclamation Plant (WRP), which would differ in water quality characteristics than sources currently present within the receiving watershed area. Although the

reclaimed water proposed for use meets both EPA and ADEQ water quality standards and has been approved by the ADEQ for snowmaking use, concerns were raised that the water may contain low levels of unregulated and unmeasured residual constituents (e.g. pathogens, pharmaceuticals, or hormones) which may cause health problems in humans and wildlife.

Study Area:

- Primary watersheds: Hart Prairie Watershed and Agassiz Subwatershed
- Snowbowl Sub-area (consisting of four subwatersheds - Snowbowl, Sunset, Hart Prairie, and Humphreys) each includes snowmaking coverage

Indicators:

- Description of the certification process for allowing Class A water to be used for snowmaking
- Literature search on use of reclaimed water for various recreational and municipal purposes uses
- Literature search and narrative description of the potential presence of pharmaceuticals, pathogens, and hormones in Class A reclaimed water
- Documentation of compliance with State and Federal water quality standards regarding Class A wastewater and its purposes
- Analysis of potential water quality effects of using reclaimed water in the snowmaking system to down gradient users

Use of reclaimed water for snowmaking purposes between November and February of each year could affect aquifer recharge.

Background:

Concerns were raised regarding the appropriateness of using reclaimed water for snowmaking purposes. The use of reclaimed water for snowmaking could potentially affect recharge to the regional aquifer due to reduced discharges into the Rio de Flag. Additionally, concern was expressed that the use of the reclaimed water for snowmaking would limit its availability to other users in the community.

Study Area:

- Primary watersheds: Hart Prairie Watershed and Agassiz Subwatershed
- Snowbowl Sub-area (consisting of four subwatersheds - Snowbowl, Sunset, Hart Prairie, and Humphreys) each includes snowmaking coverage

Indicators:

- Quantification of anticipated snowmaking water use in average dry, median, and wet years
- Description and quantification of the Rio de Flag WRP's historic seasonal discharges
- Description and quantification of current uses of reclaimed water within the City of Flagstaff by season
- Discussion of existing water rights and the ability to implement the proposed snowmaking with or without procuring additional water rights

- Narrative description of both the City of Flagstaff's well field and reclaimed water uses and their hydrologic relationship to the regional aquifer
- Discussion of the applicability of the Rio de Flag Water WRP NPDES permit to the proposed snowmaking application
- Quantification of anticipated total consumptive water losses (i.e., evaporation, evapotranspiration, sublimation) resulting from proposed snowmaking

Soils and Geology

The Proposed Action has potential to change soil chemistry and moisture due to the application of machine produced snow.

Background:

The proposed application of machine-produced snow may have the effect of increasing total water availability, potentially leading to an increase in the duration, intensity, and/or quantity of total annual snowmelt.

Study Area:

- Eight sub-watersheds in the vicinity of the SUP area having potential to change under the Proposed Action[10]

Indicators:

- Anticipated volume of machine-produced snow applied under various scenarios: dry year, average year, and wet year
- Modeled anticipated changes in the duration and intensity of annual snowmelt compared to historic natural variation
- Modeled (WEPP) anticipated changes in erosion/sedimentation due to predicted changes in total snowpack
- WEPP modeling to include all proposed areas of ground disturbance
- Analysis of potential changes to soil chemistry due to anticipated increases in soil moisture consistency and nutrient loading

Vegetation

Plant communities (including T, E, and S plant species, and regionally important plants) within the SUP area may be altered as a result of the proposed projects.

Background:

The Proposed Action would necessitate impacts to vegetation communities within the SUP area. Mixed conifer forests occupy a small percent of the State, and are rare in the higher elevations of northern Arizona. Snowbowl includes the upper reaches of the largest contiguous patch of montane grassland on the San Francisco Peaks. Additionally, the San Francisco groundsel (*Senecio franciscanus*) is found on the San Francisco Peaks. In addition, the construction and operation of the proposed projects may cause disturbance to federally threatened and endangered as well as regionally sensitive plants (T, E, and S plants) and/or their habitats.

[10] Defined in Chapter 3, Section I

Study Area:

- Area of potential effects from proposed construction activities

Indicators:

- Acres of mixed conifer forest on the San Francisco Peaks, within the SUP, and potentially effected by the Proposed Action
- Potential impacts to montane grasslands within the SUP as a proportion of total grasslands on the San Francisco Peaks
- Disclosure of effects to potentially occurring T, E, and S plant species or potential habitat

The Proposed Action has potential to change vegetation composition within the SUP area due to the application of machine-produced snow.

Background:

The application of machine-produced snow may artificially increase total annual snowpack depth. Machine-produced snow typically has a higher moisture content on a percentage basis. These factors may lead to a slower melting of the snowpack and a corresponding acceleration or delay in the greening of vegetation on the ski trails.

In addition, reclaimed water may contain elevated levels of nitrogen, which could raise pH levels, making soil more acidic and less productive for vegetation. Nitrogen is mobile and with coarser textured soils, has the ability to move fairly deep into the soil profile.

Study Area:

- SUP area

Indicators:

- Description of likely snowmaking scenarios for dry, wet, and average snow years
- Analysis of potential changes to botanical composition due to anticipated increases in soil moisture consistency and/or delayed snowpack desiccation
- Description of the certification process for allowing Class A water to be used for snowmaking
- Literature search on use of reclaimed water for various recreational and municipal purposes uses
- Documentation of compliance with State and Federal water quality standards regarding Class A wastewater and its uses
- Description of nitrogen constituents of Class A wastewater

Wildlife

The Proposed Action may result in the alteration and/or removal of habitat for terrestrial wildlife species within the SUP.

Background:

Modification or removal of habitat may impact terrestrial and/or T, E, and S wildlife species.

Study Area:

- SUP area (varies by species)

Indicators:

- Identification of any T, E, and S; MIS[11]; and other wildlife species and habitats present within the SUP area and along the pipeline corridor
- Disclosure/quantification of anticipated effects to those species and habitats present within the SUP area and along the pipeline corridor

Proposed snowmaking activities may result in a longer-duration snowpack and additional water storage for wildlife in the SUP area.

Background:

Snowmaking and the proposed water impoundment may create improved spring foraging habitat for grazing ungulates. Although this may be beneficial to certain wildlife species, wildlife may congregate in the area due to the increased presence of moisture, particularly during drought conditions.

Study Area:

- SUP area

Indicators:

- Acreage of proposed snowmaking coverage
- Comparison of natural snowpack duration with the extended snowpack due to snowmaking
- Effects of both longer-duration snowpack and water storage (impoundment) on wildlife in the analysis area

[11] MIS, or "management indicator species" are defined in the Forest Plan in accordance with National Forest Management Act (NFMA) – 36 CFR 219.19.

Geotechnical Analysis

Geotechnical feasibility and associated hazards associated with construction of the proposed snowmaking impoundment on the ridge above the Sunset Chairlift must be analyzed.

Background:

Ten million gallons of capacity in the proposed impoundment equates to approximately 30 acre feet of water, which could classify it as a Forest Service Class D dam. The ultimate design of the impoundment and its orientation on the ridge will dictate the hazard rating according to Forest Service standards. For example, it would be a classified as a high hazard if analysis shows that a breach would result in draining towards the Hart Prairie Lodge and Snowbowl Road and, most likely a moderate hazard if it were to drain to the south away from the Hart Prairie Lodge.

Potential geologic hazards that need to be considered in this analysis include landslide, debris flow, avalanche, rockfall, subsidence, expansive soils, and earthquake.

Study Area:

- Potential flow path under multiple dam breach scenarios

Indicators:

- Hazard classification
- Failure Risk
- Dam breach and downstream inundation analysis

Air Resources

Snowplay activities at Snowbowl could increase vehicular traffic and may negatively impact air quality in the region.

Background:

The Environmental Protection Agency has promulgated primary and secondary National Ambient Air Quality Standards (NAAQS) for six criteria pollutants (carbon monoxide, nitrogen dioxide, particulate matter, ozone, sulfur dioxide, and lead). Primary and secondary standards are adopted to protect public health and welfare, respectively. States are required to adopt ambient air quality standards which are at least as stringent as the federal NAAQS, however, the state standards may be more stringent. Arizona has adopted the federal NAAQS.

Study Area:

- The Snowbowl SUP area and the proximate Class 1 airshed [12]

Indicator:

- Compliance with local, state and federal regulations regarding air quality

[12] The nearest Class I airshed is Sycamore Canyon Wilderness. The Kachina Peaks Wilderness is not classified as a Class I airshed, though it is treated as if it were.

CHAPTER 2
DESCRIPTION OF ALTERNATIVES

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Coconino National Forest
Peaks Ranger District

2. DESCRIPTION OF ALTERNATIVES

INTRODUCTION

Chapter 2 describes the alternatives considered within this environmental analysis and summarizes the environmental consequences anticipated to result with the implementation of each. As required by the Council on Environmental Quality (CEQ), the alternatives considered are presented in comparative form.[1] Mitigation measures and best management practices (BMPs), designed to lessen or avoid impacts anticipated to occur as a result of implementation of the action alternatives, are also detailed.

The National Environmental Policy Act (NEPA) requires that an environmental analysis examine a range of alternatives, which are "reasonably related to the purpose of the project.[2] Both CEQ Regulations and Forest Service Handbook direction emphasize that alternatives must meet the "reasonableness" criteria in order to warrant detailed analysis. Alternatives which were considered within the analysis process, but were determined not reasonable were eliminated from detailed study with a brief discussion of the rationale for their elimination.[3]

The process used to develop alternatives to the Proposed Action followed external public and internal agency scoping. The issues raised during the scoping process were used as the basis for determining the need for alternatives to the Proposed Action. A Comment Disposition Analysis, documenting the categorization and responses to all comments submitted, was prepared as a key component of the scoping and alternatives formulation process. The Comment Disposition Analysis is contained in the Project Record.

ALTERNATIVES CONSIDERED IN DETAIL

In addition to the Proposed Action, a second action alternative (Alternative 3) and the required No Action Alternative are analyzed in detail within this EIS.

FOREST PLAN AMENDMENT

A component of Alternatives 1, 2 and 3 includes amending the Coconino Forest Plan with a non-significant amendment[4] clarifying the direction in Management Area 15 – Developed Recreation Sites. Page 188 of the Forest Plan makes reference to the 1979 FEIS as guidance for the management of the Snowbowl ski area. This management direction necessitates being updated to reference the Arizona Snowbowl's Master Development Plan based on NEPA analyses and subsequent approvals. The original management emphasis did not allow for the changed

[1] 40 CFR 1502
[2] 40 CFR 1502.14a
[3] Id.
[4] 36 CFR 219.10(f) directs the Forest Service to determine if a proposed amendment to a forest plan would be considered a significant change.

circumstances that may initiate a new environmental analysis of the ski area operations. The reader is referred to Appendix B for more information.

ALTERNATIVE 1 – NO ACTION

As required by NEPA, a No Action Alternative has been included in this analysis for review alongside the action alternatives.[5] The No Action Alternative reflects a continuation of existing management practices without changes, additions, or upgrades. Selection of Alternative 1 would result in creation of a new Master Development Plan (MDP) which would provide for operation and maintenance of existing facilities. No new facilities, trail improvements, or snowmaking would occur under the No Action Alternative and the Snowbowl would continue to operate at its existing Comfortable Carrying Capacity (CCC) of 1,880 skiers-at-one-time. Peak day visitation would continue to reach in excess of 3,400 skiers-at-one-time.[6] The No Action Alternative provides a baseline for comparing the effects of the Proposed Action and Alternative 3.

All costs associated with the operation and maintenance would be fully the responsibility of the Arizona Snowbowl.

The No Action Alternative is illustrated on Figure 2-1.

Snowplay

Dispersed snowplay (sledding, tubing, building snowmen) is not permitted within the Snowbowl SUP area or at any point along the Snowbowl Road. Parking along the Snowbowl road was recently prohibited in order to manage the level of dispersed snowplay activities and their attendant issues. Under the No Action Alternative, snowplay would continue to be prohibited within the Snowbowl SUP and along the Snowbowl Road.

Lifts/Uphill Capacity

Under the No Action Alternative, the Snowbowl would continue to operate five lifts: Agassiz (triple); Sunset (triple); Hart Prairie (double); Aspen (double); and Spruce (portable surface). Over time, as the lifts age, their periodic replacement would become necessary and would occur.

Terrain

Under the No Action Alternative, Snowbowl's terrain would remain in its current configuration with 32 formal (named) trails covering approximately 139 acres.

Guest Service Facilities

Existing on-mountain visitor services are provided in two buildings: the Hart Prairie Lodge (at the base of the Hart Prairie and Sunset chairlifts) and the Agassiz Lodge at the base of the Agassiz Chairlift. In total, these two buildings comprise approximately 23,500 square feet of guest service and administrative space. There are presently a total of 614 indoor, cafeteria style seats, and 648 outdoor seats available between the two buildings. Under the No Action

[5] 40 CFR 1502.14(d)

[6] Refer to the Recreation section presented in Chapter 3 for additional details regarding daily and annual visitation.

Alternative, neither building would change, with the exception of minor modifications and routine maintenance.

Summer Activities

Under Alternative 1, no change would occur to the Scenic Sky Ride program that operates daily on the Agassiz Chairlift. As is currently the case, hiking from the top of the lift back to the base area is not allowed, guests would therefore continue to be required to return back to the base area via the lift.

Infrastructure and Utilities

Sewer and Wastewater

Snowbowl's existing septic system is adequate to meet the current demands of the ski area. Snowbowl currently relies on vehicular delivery for 100 percent of its potable and non-potable water demands. It is estimated that over 60 percent of the potable water transported to the ski area is ultimately consumed by toilet services. Under the No Action Alternative, this practice would continue.

Roads

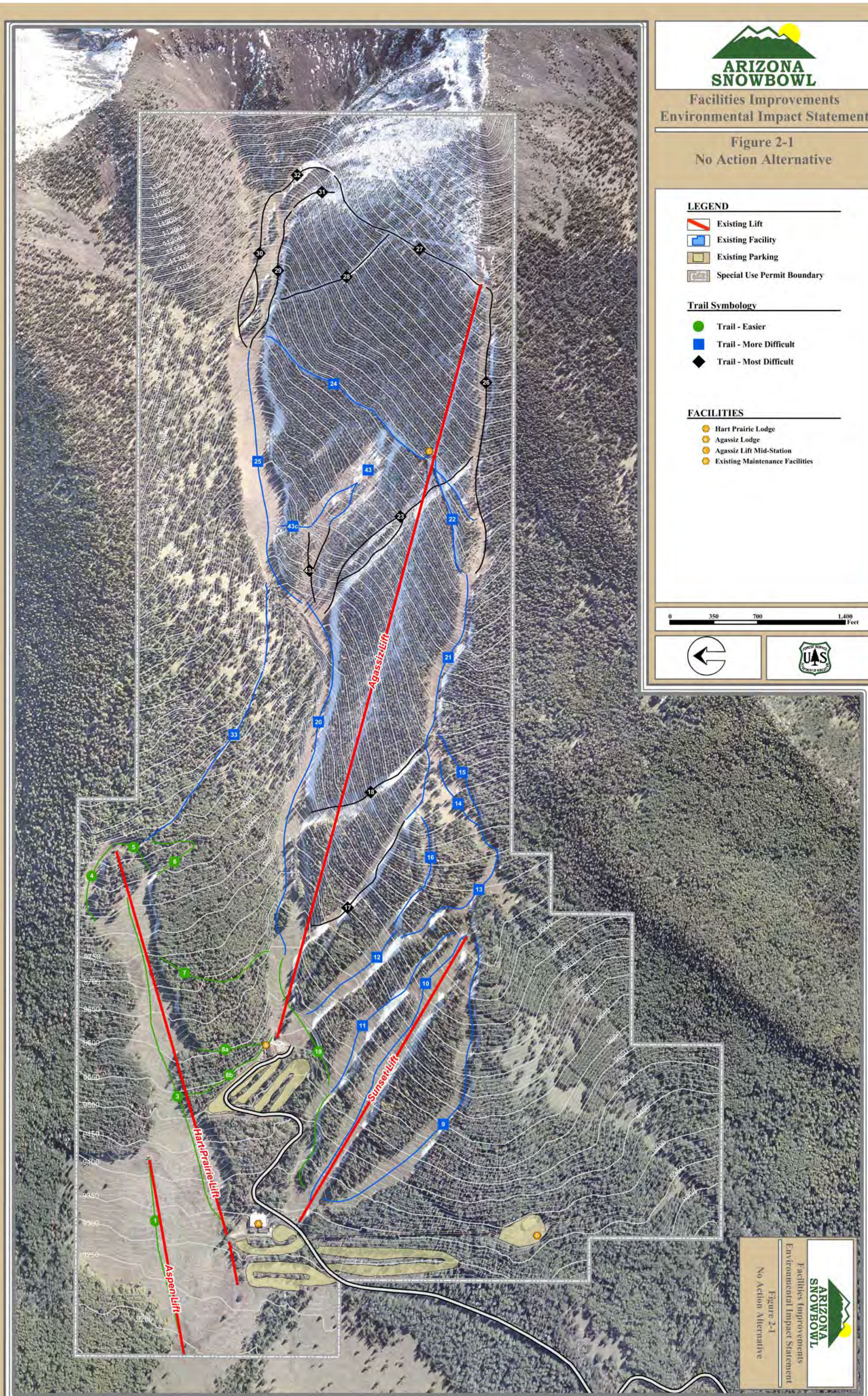
Under the No Action Alternative, Snowbowl would not construct any new on-mountain maintenance roads.

Parking

Approximately 10.3 acres of parking are currently provided in the parking lots adjacent to the Hart Prairie Lodge, and the upper lots below the Agassiz Lodge. The combined capacity of the lots is approximately 1,200 vehicles. No additional parking areas would be constructed under Alternative 1.

Pedestrian Access

Under the No Action Alternative, pedestrian movement across the main access road (between the Hart Prairie lodge/parking areas and the Sunset Chairlift) would not change.


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-1
No Action Alternative
LEGEND
Existing Lift
Existing Facility
Existing Parking
Special Use Permit Boundary
Trail Symbology
Trail - Easier
Trail - More Difficult
Trail - Most Difficult
FACILITIES
Hart Prairie Lodge
Agassiz Lodge
Agassiz Lift Mid-Station
Existing Maintenance Facilities
0 350 700 1,400 Feet
Agassiz Lift
Sunset Lift
Hart Prairie Lift
Aspen Lift

ALTERNATIVE 2 – PROPOSED ACTION

Alternative 2 would result in the creation of a MDP that includes all projects outlined in the following Proposed Action description.

Under the Proposed Action, the Snowbowl's CCC would increase to the approved[7] level of 2,825 skiers-at-one-time. Peak day visitation would continue to reach in excess of 3,400 skiers-at-one-time.

All costs associated with the planning, development, construction, operation, and maintenance of all proposed infrastructure would be fully the responsibility of the Arizona Snowbowl.

The Proposed Action is illustrated on figures 2-2 through 2-6.

Snowmaking

Snowbowl proposes to install the necessary snowmaking infrastructure to cover 205.3 acres of terrain throughout the duration of its winter operating season (refer to Figure 2-3). Snowbowl would almost certainly cover the full extent of this area during the pre- and early season (approximately November through December) each year in order to create a sufficient base layer that would subsequently be covered by natural snowfall. However, the ski area may continue to produce snow throughout the winter to compensate for inadequate natural snowfall, depending on weather trends.

The City of Flagstaff has agreed to provide the ski area with up to 1.5 million gallons per day (gpd) of Class A reclaimed water from the Rio De Flag Water Reclamation Plant (WRP) between November 1st and the end of February, for a period of five years from March 20, 2002. Terms of the agreement allow for renewal for three (3) additional five (5) year periods. Currently, reclaimed water from the Rio De Flag WRP is used to irrigate city parks, school playgrounds, and golf courses during the summer, but goes unused throughout the winter, being allowed to flow down Rio de Flag channel. The Arizona Department of Environmental Quality (ADEQ) allows reclaimed water with an "A" rating to be used for snowmaking purposes. The reclaimed water produced by the Rio de Flag WRP currently exceeds this standard.[8]

The reclaimed water originating from the Rio de Flag WRP would be transported to the ski area via an approximate 14.8-mile buried pipeline (refer to Figure 2-4). The waterline would be connected to the reclaimed water circulation system currently used by the City of Flagstaff near Thorpe Park and follow existing utility easements and rights-of-way across a mix of federal, state, and private lands to the intersection of U.S. Highway 180 and Snowbowl Road. From this point the waterline would follow the Snowbowl Road to the ski area and subsequently be routed up a ski trail to a proposed 10 million gallon impoundment (explained below). Two booster stations would be installed along the pipeline to maintain appropriate pressure. These would

[7] Approved in the 1979 Arizona Snowbowl Ski Area Proposal Final Environmental Statement and subsequently incorporated by reference the CNF Forest Plan.

[8] Should additional water quality standards be promulgated by EPA and/or ADEQ subsequent to, or following, an approval to use reclaimed water, the Arizona Snowbowl would be held in compliance with this standard.

likely be located near Thorpe Park and along Snowbowl Road. Each pump station would entail the construction of a small pump house building/vault.

The currently proposed pipeline route was identified after discussions with Transwestern Pipeline Company, the Forest Service, Arizona State Land Department, and Lowell Observatory. Lowell Observatory is very interested in providing fire hydrants on observatory property west of their campus and also in replacing a private and antiquated potable water delivery system to the campus from Flagstaff. In accordance with Forest Plan direction to locate additional uses within existing utility corridors, the proposed reclaimed water pipeline route follows the Transwestern Lateral Natural Gas Pipeline from west of the observatory to the intersection of U.S. Highway 180 and Snowbowl Road. The remainder of the proposed pipeline route is located on Observatory private property and existing Forest Service Road 515 in Section 7. The proposed route was also selected to minimize impacts and inconveniences to traffic and private property during construction of the pipeline.

A 10 million gallon water storage impoundment (approximately 30.7 acre-feet in volume and 1.9 acres in surface area) is proposed to be constructed near the top terminal of the existing Sunset Chairlift for operation of the snowmaking system (refer to Appendix A for more detail on the proposed impoundment's design specifications). Ten million gallons of capacity would not only provide for early and mid-season snowmaking, but would help ensure a sufficient water supply of snowmaking water past the end of February, when the City of Flagstaff would discontinue reclaimed water service. An analysis of the snowmaking system sizing and capacity was conducted in the initial project planning stages. This analysis is contained in its entirety in the project Record. The sizing analysis examined three different potential impoundment capacities at 1.5, five, and 10 million gallons. The system analysis, which considered: operational temperatures, system throughput, and the rate of re-claimed water delivery; concluded that a 10 million gallon storage volume would provide an optimal system capacity within the available space and siting constraints for the storage reservoir. Necessary pumps and a compressor would be installed within a primary pumphouse building to be located near the impoundment. Preliminary discussions with City officials have identified a potential desire to maintain pressure throughout the snowmaking pipeline throughout the year to provide a water source for fire suppression needs within the residential communities proximate to the pipeline between Flagstaff and the ski area. Hydrants could be situated along the pipeline to provide access to this water.[9] Additionally, a residual pool would be maintained within the impoundment during the summer months to allow for potential use by wild land fire suppression.

Generally, "airless" style fan-gun snowmaking technology would be used in the base area, while high-tech air/water tower guns are proposed for the upper portions of the mountain. Construction of the snowmaking system would involve the burial of air, water, and power lines along the edges of trails to be covered, as well as the construction of a 3,000 to 4,000 square foot snowmaking control building in the vicinity of the existing maintenance shop (refer to Figure 2-3).

Because of rocky terrain, it is anticipated that burying the snowmaking water lines to a depth that prevents freezing would be impractical and expensive. Therefore, the proposed snowmaking

[9] The exact number and locations of hydrants is yet to be determined.

system has been designed to back drain after each snowmaking period. This would allow for the water lines to be buried at shallower depths because the entire network of snowmaking lines could be drained after each use. Depending on location, orientation, and distance of the water lines from the snowmaking water impoundment, the back drainage system would return the reclaimed water to the main snowmaking water impoundment or an addition smaller catchment pond (approximately one acre-foot capacity) proposed to be located north of the snowtubing parking lots.

Approximately 178 million gallons of water would be available to Snowbowl between November 1 and February 28 of each year.[10] At 325,852 gallons of water per acre foot (AF), this equates to approximately 548 AF of water available to Snowbowl each season.

However, annual water use for the snowmaking system would vary according to natural conditions, and has been modeled according to dry, wet and average precipitation years.[11]

Snowplay/Tubing Facility

Snowbowl proposes the development of a managed and professionally designed snowplay/tubing facility at the base area. The snowtubing area would entail dedicating approximately eight acres of terrain in Hart Prairie area to development of six to eight tubing lanes (refer to Figure 2-2). These lanes would be serviced by a combination of four surface lifts. While the surface of the snowtubing area would be graded, construction of the individual lanes would be completed with snow each season (and is dependant upon snowmaking). The snowtubing facility has been designed with a capacity of approximately 600 tubers-at-one-time.

A 400-space parking area (approximately 3.3 acres) would be constructed to service the proposed tubing facility (skiers would be prohibited from parking in this lot). From the parking area, guests would have foot access to a proposed guest service facility adjacent to the tubing area. Constructed and located specifically for snowplaying activities, this 5,000 square foot building would offer food service, restrooms (necessitating construction of an on-site septic system), ticket sales, and a sun deck. A buried 10,000-gallon water storage tank is proposed to be located proximate to the facility containing reclaimed water for use in toilets.

Lifts/Uphill Capacity

Antiquated lift equipment is proposed to be replaced with more modern and efficient chairlift technology as detailed below (refer to Figure 2-2):

Sunset Chairlift

The Sunset Chairlift would be replaced and realigned with a high speed chair. It would also be realigned and lengthened with a new top-drive terminal located at 10,900 feet in elevation – approximately 300 feet south/southwest of the existing mid-station on the Agassiz Chairlift.

[10] 1.5 million gpd x 119 days.

[11] Refer to either the Watershed (Section H) or Soils (Section I) analyses of Chapter 3 for additional details.

Humphreys Chairlift

The existing Sunset Chairlift would be relocated and installed as the proposed Humphreys Chairlift, accessing a new pod of proposed ski trails. The lift would start near the Agassiz Lodge and extend approximately 3,000 linear feet to terminate at an elevation of approximately 10,400 feet. The Humphreys Chairlift would require vehicular access to both terminals. Permanent access to the top terminal would be via the existing mountain access road and temporary access would be via a portion of one of the proposed ski trails. Power would be supplied to the bottom terminal via a spur from the Agassiz Lodge power line.

Hart Prairie Chairlift

The Hart Prairie Chairlift would be upgraded to a high-speed, detachable lift; it would remain top-driven with the bottom terminal being relocated approximately 200 feet downhill and 250 feet north of the present terminal site. The resulting lift alignment would require only incidental vegetative clearing.

Aspen Chairlift

The Aspen Chairlift would be upgraded and realigned, swinging the bottom terminal approximately 500 feet north, within the existing SUP boundary. This realignment would also improve on-fall-line skiing within the pod.

Surface Lifts

Three 150-foot surface conveyor (Magic carpet) type lifts are proposed for the area north of the Hart Prairie Lodge, which would be redesigned and designated as a beginner/learning area. One additional 300-foot handle tow (surface lift) is proposed to service the planned halfpipe and terrain park (detailed below).

Snowtubing Surface Lifts

As noted, a combination of four surface lifts would service the snowtubing facility. Snowtubing lifts are designed and engineered specifically for pulling snowtubes.

Terrain

Approximately 65.6 acres of additional skiing terrain is proposed for beginner and intermediate (including low and advanced intermediate) skill levels, as well as some advanced terrain, bringing total developed skiable terrain (i.e., excluding glades) at the Snowbowl to approximately 204.2 acres. Specific areas planned for additional skiing terrain include an extension of the *Spur Catwalk* (trail #27), widening of the existing lift line below the *Spur Catwalk* paralleling the Agassiz Chairlift (trail #43B), widening of *White Lightning* (trail #28) and *Tiger* (trail #18), the creation of new trails under the proposed Sunset and Humphreys chairlifts, the construction of one new trail connecting *Lower Ridge* (trail #21) with *Wild Turkey* (trail #20), and the development of a skiway (trail #44) (providing skier, ski patrol, and maintenance/construction access) from *Upper Logjam* (trail #25) to the top terminal of the proposed Humphreys Chairlift.

Additionally, approximately 47.4 acres of tree thinning/glading would occur within the Agassiz

and Sunset pods to create improved gladed skiing opportunities. Thinning within these pods is proposed to address recreational, fuel reduction, and forest health objectives. Timber removal would be concentrated on unhealthy/dead trees. Overall, the thinning has been designed to maintain 80 percent of the existing overstory vegetation.

Table 2-1 describes the nature of the proposed terrain additions.

Table 2-1
Proposed Terrain Breakdown (acres)

Ability Level	Acreage
Beginner	2.0
Novice	44.0
Low Intermediate	34.5
Intermediate	51.0
Advanced Intermediate	41.9
Expert	31.8
Total	***204.2***

In association with the creation of additional terrain and snowmaking coverage, a number of areas are proposed to be graded and smoothed to improve the skiing experience. Two separate methods of earthwork are proposed for specific areas; grading and stumping/smoothing. Graded areas would be carefully stripped of topsoil resources, reshaped and re-contoured, followed by redistribution of topsoil and immediate revegetation. In areas to be stumped/smoothed, rocks and stumps protruding from the surface would be disposed of. Disturbed areas would be promptly revegetated per mitigation measures outlined in Table 2-2.

A dedicated teaching area would be developed near the Hart Prairie Lodge in order to better accommodate beginner skiers. Construction of the teaching area would require re-contouring approximately three acres.

A halfpipe[12] would also be built approximately 300 feet southeast of the bottom terminal of the Sunset Chairlift. The contour of the halfpipe would be rough-shaped out of dirt to minimize the total snowmaking coverage necessary for its use. Additionally, a small surface lift would be installed immediately parallel to the proposed halfpipe.

Guest Service Facilities

In order to better accommodate existing use levels, both the Hart Prairie and Agassiz day lodges would be enlarged and upgraded. The Hart Prairie Lodge would increase by approximately 6,000 square feet. A new guest services facility totaling approximately 10,000 square feet would be developed immediately adjacent to the existing Agassiz Lodge. The increased building space would allow for the provision of critical guest functions such as additional restrooms, lockers, dining and kitchen areas, and first aid services. This would increase Snowbowl's total

[12] Halfpipes are linear, U-shaped terrain features constructed down appropriately steep slopes used for freestyle skiing and snowboarding. Halfpipes are common amenities at ski areas all over the world.

guest/administrative square footage from approximately 23,500 square feet to approximately 39,500 square feet. All guest services would be designed to meet ADA requirements.

Snowbowl proposes the development of a 2,500 square foot Native American cultural and education center, which would be incorporated into the design of the Agassiz Lodge.

On the mountain, three new ski team buildings are proposed to replace the existing buildings. The start and finish race facilities would be approximately 100 square feet each; the start would be located on *Phoenix* (trail #16) just below the split with *Lower Ridge* (trail #21), and the finish would be located on the skier's right near the bottom of *Agassiz* (trail #12). The third building would be a clubhouse approximately 640 square feet in size located approximately 150 feet south of the Agassiz Lodge.

Summer Trails

Snowbowl proposes the construction of a trail from the existing Agassiz Chairlift mid-station to the top terminal.[13] Hikers would primarily use the trail; however, the trail would be wide enough to permit ski area maintenance personnel to access the top terminal using all terrain vehicles (e.g., four wheelers). Additionally, the proposed trail would provide a method of moving guests from the upper reaches of the Agassiz Chairlift should a summer lift evacuation be necessary. This trail would be approximately 5,280 feet in length and constructed to a width of five feet (slightly wider at switchbacks) to allow for ATV use. Vegetation removal associated with construction of this trail would be focused on understory and dead/dying trees, however, incidental removal of live overstory trees may be necessary to maintain proper grades along the trail alignment.

The proposed trail has been designed to allow guests to hike from the observation deck at the top of the Agassiz Chairlift down to the mid-station, then follow *Midway Catwalk* (trail #24 – refer to Figure 2-2 for specific location) north to proposed trail #44. Guests could then descend through the proposed Humphreys pod to proposed trail #33 for access to Hart Prairie. The main base area could be accessed through Hart Prairie.

Additionally, Snowbowl proposes an Americans with Disabilities Act (ADA) compliant summer access trail into Hart Prairie from the parking lot near Agassiz Lodge.

Infrastructure and Utilities

Wastewater

Snowbowl is currently dependent on vehicular delivery for 100 percent of its water needs (potable and non-potable alike). This results in potable water being used for non-potable uses.[14] In order to reduce the environmental impacts and costs associated with the vehicular delivery, Snowbowl proposes to install a spur from the reclaimed water pipeline to the Hart Prairie and Agassiz day lodges, as well as the snowplay facility to service non-potable uses such as toilets.

[13] Thirty percent of guests who participate in the summer Sky Ride express an interest in being allowed to hike off the mountain.

[14] Arizona Snowbowl estimates that over 60 percent of the potable water transported to the ski area is ultimately consumed by toilet services.

A buried 10,000-gallon water storage tank would be constructed at each of the lodges and at the snowplay building to facilitate the use of reclaimed water.

Roads

Snowbowl proposes a redesigned entrance circle which would have signage directing guests to parking lots, day lodges, and snowplay parking. Additionally, the traffic circle would allow the ski area to more effectively manage capacity by providing a safe location to turn vehicles around once the parking areas are full.

In order to construct and maintain the proposed snowmaking water impoundment, Snowbowl would require permanent access to the facility. This is proposed to be achieved by using a portion of an existing, although infrequently used, two-track road between the maintenance area and the top of the Sunset Chairlift. Approximately 3,650 feet of the existing two-track road would be used after bringing it up to a Forest Service maintenance level II road standard in order to accommodate construction and maintenance equipment with adequate drainage and surfacing, as needed. However, an approximate 1,100-foot spur of new road would be constructed between the existing maintenance road that traverses *Sunset Boulevard* (trail #10) and *Southern Belle* (trail #9) and the upgraded impoundment access road. In total the road length would be approximately 4,760 feet. However, with the proposed road construction and reconstruction, a 3,050-foot segment of the existing two-track road would be obliterated and reclaimed. In association with this proposal, a roads analysis (Road Analysis Process, RAP) was completed by the Forest Service and is contained in the project file.

Parking

Skier Parking

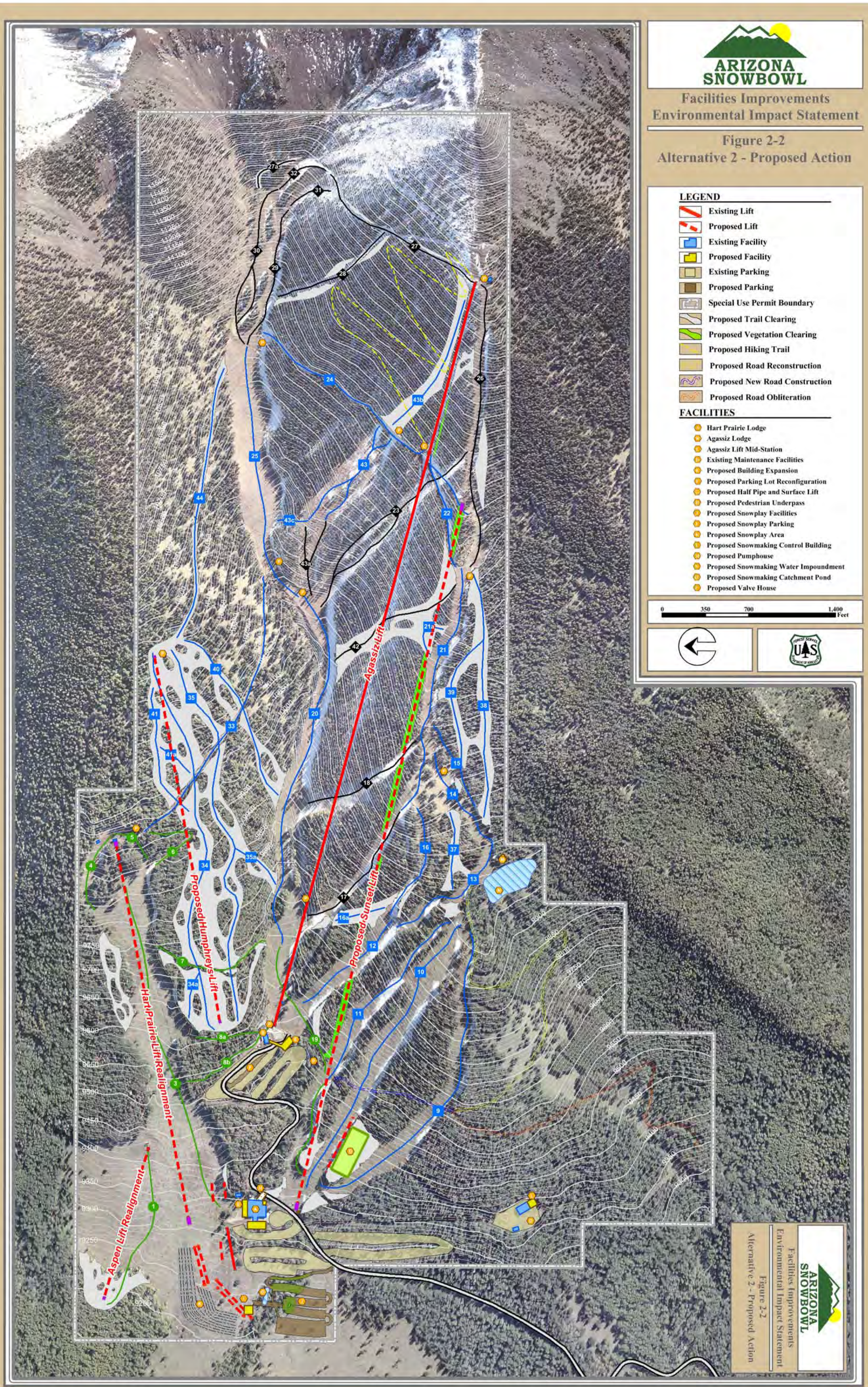
To increase parking lot efficiency, facilitate snow removal, and improve pedestrian safety, Snowbowl proposes to combine existing parking lots #1 and #2 by re-grading and leveling them. See Figure 2-2, item “F” for parking area location. This would add a marginal number of parking spaces – approximately 35 spaces across 0.3 acre.

Snowplay Parking

Snowbowl proposes the development of a 400-space parking lot to the north of the proposed entrance loop. As discussed in the snowplay/tubing section, skiers would be prohibited from parking in this lot.

Pedestrian Access

A pedestrian underpass is proposed to allow skiers to pass directly to and from the Hart Prairie lodge/parking areas and the Sunset Chairlift without walking across the main access road.


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-2
Alternative 2 - Proposed Action
LEGEND
Existing Lift
Proposed Lift
Existing Facility
Proposed Facility
Existing Parking
Proposed Parking
Special Use Permit Boundary
Proposed Trail Clearing
Proposed Vegetation Clearing
Proposed Hiking Trail
Proposed Road Reconstruction
Proposed New Road Construction
Proposed Road Obliteration
FACILITIES
Hart Prairie Lodge
Agassiz Lodge
Agassiz Lift Mid-Station
Existing Maintenance Facilities
Proposed Building Expansion
Proposed Parking Lot Reconfiguration
Proposed Half Pipe and Surface Lift
Proposed Pedestrian Underpass
Proposed Snowplay Facilities
Proposed Snowplay Parking
Proposed Snowplay Area
Proposed Snowmaking Control Building
Proposed Pumphouse
Proposed Snowmaking Water Impoundment
Proposed Snowmaking Catchment Pond
Proposed Valve House
0 350 700 1,400 Feet
Agassiz Lift
Proposed Sunset Lift
Proposed Humphreys Lift
Hart Prairie Lift Realignment
Aspen Lift Realignment

ARIZONA SNOWBOWL

Facilities Improvements
Environmental Impact Statement

Figure 2-3
Snowmaking Plan
Alternative 2 - Proposed Action

LEGEND

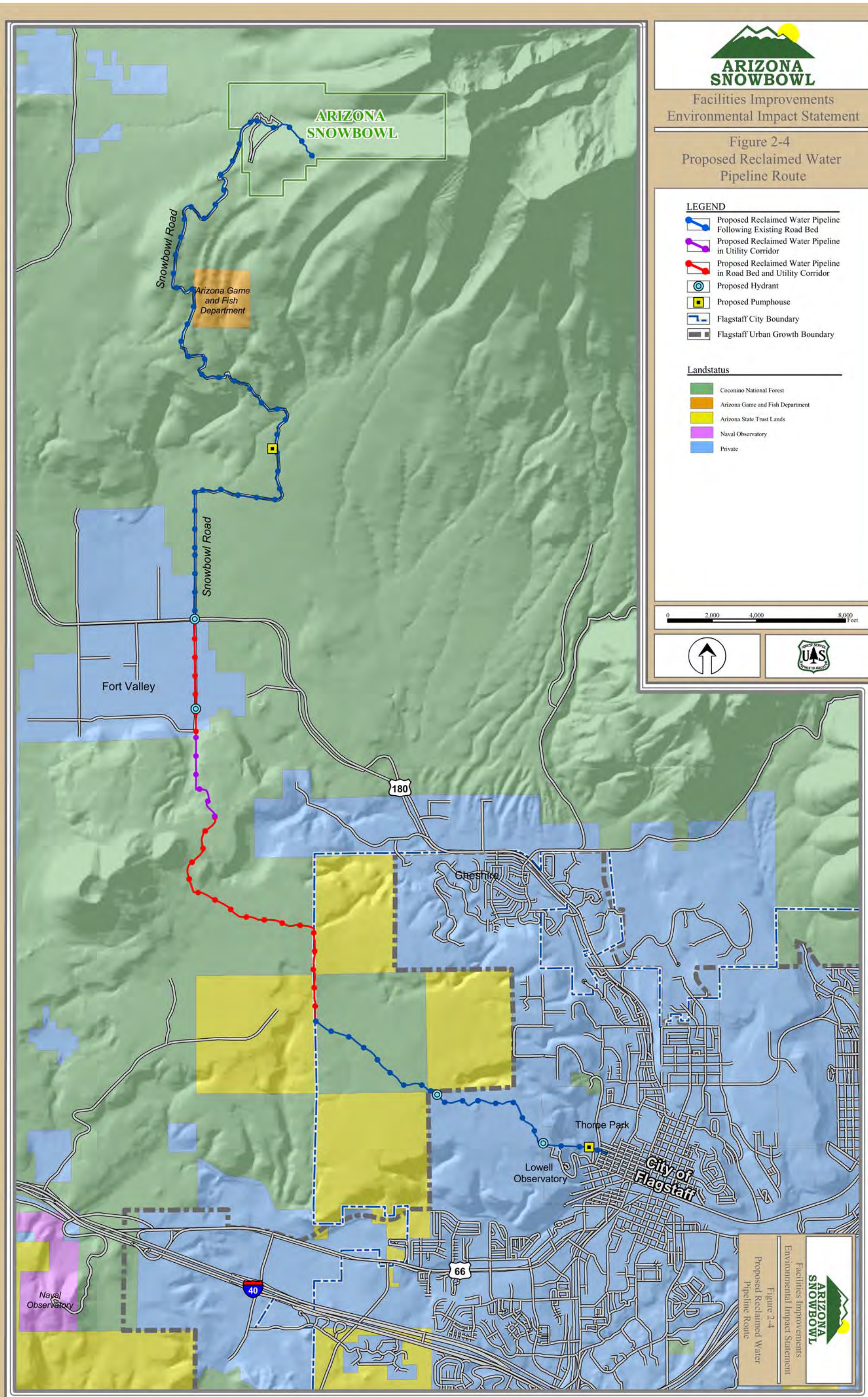
- Existing Lift
- Proposed Lift
- Existing Facility
- Proposed Facility
- Special Use Permit Boundary
- Proposed Snowmaking Coverage
- Proposed Snowmaking Pipeline
- Proposed Road Reconstruction
- Proposed New Road Construction
- Proposed Road Obliteration

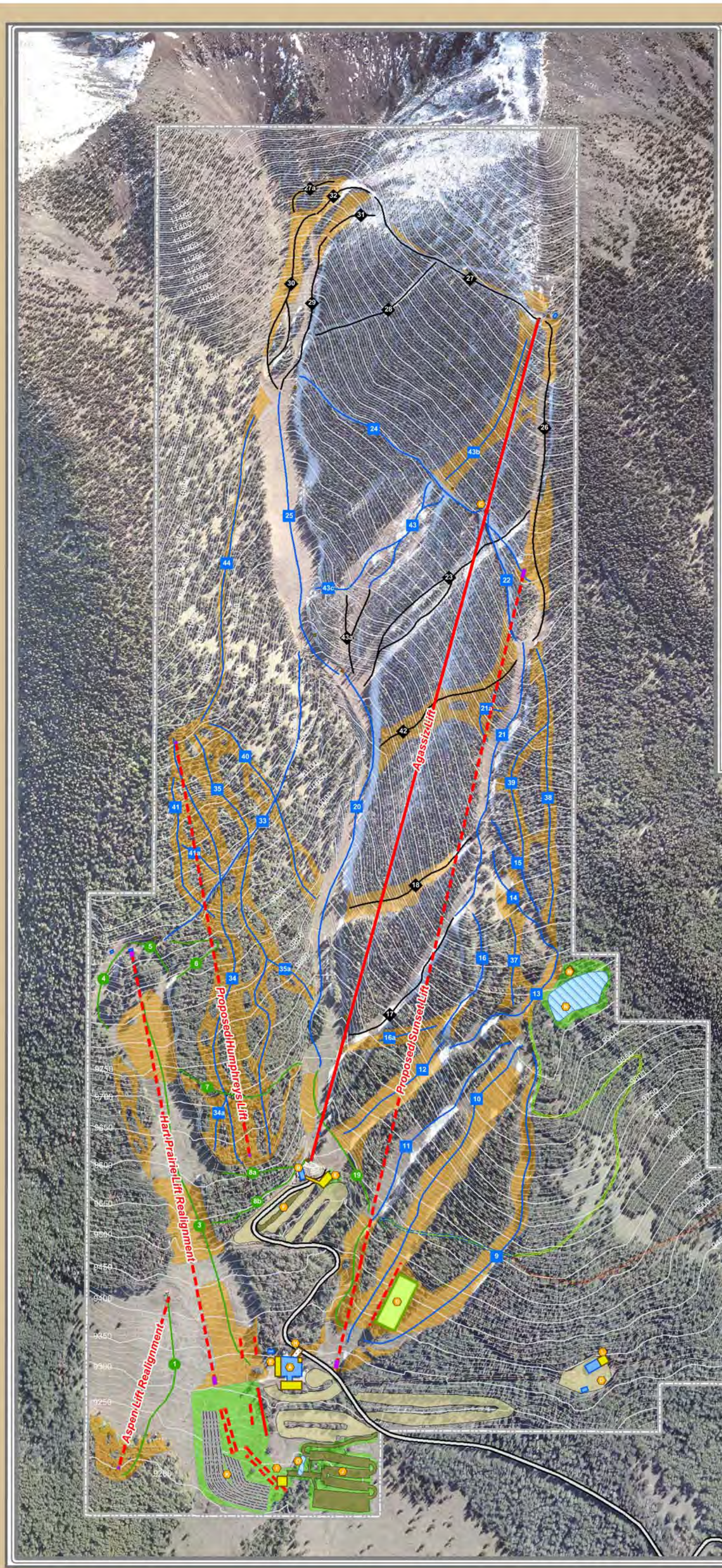
FACILITIES

- Proposed Snowmaking Water Impoundment
- Proposed Snowmaking Catchment Pond
- Proposed Snowmaking Control Building
- Proposed Pumphouse
- Proposed Valve House

0 350 700 1,400 Feet

ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-3
Snowmaking Plan
Alternative 2 - Proposed Action


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-4
Proposed Reclaimed Water
Pipeline Route
LEGEND
Proposed Reclaimed Water Pipeline Following Existing Road Bed
Proposed Reclaimed Water Pipeline in Utility Corridor
Proposed Reclaimed Water Pipeline in Road Bed and Utility Corridor
Proposed Hydrant
Proposed Pumphouse
Flagstaff City Boundary
Flagstaff Urban Growth Boundary
Landstatus
Coconino National Forest
Arizona Game and Fish Department
Arizona State Trust Lands
Naval Observatory
Private
0
2,000
4,000
8,000
Feet
ARIZONA SNOWBOWL
Snowbowl Road
Arizona Game and Fish Department
Snowbowl Road
Fort Valley
180
Cheshire
Thorne Park
Lowell Observatory
City of Flagstaff
66
40
Naval Observatory
ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-4
Proposed Reclaimed Water
Pipeline Route



ARIZONA SNOWBOWL

Facilities Improvements
Environmental Impact Statement

Figure 2-5
Grading Plan
Alternative 2 - Proposed Action

LEGEND

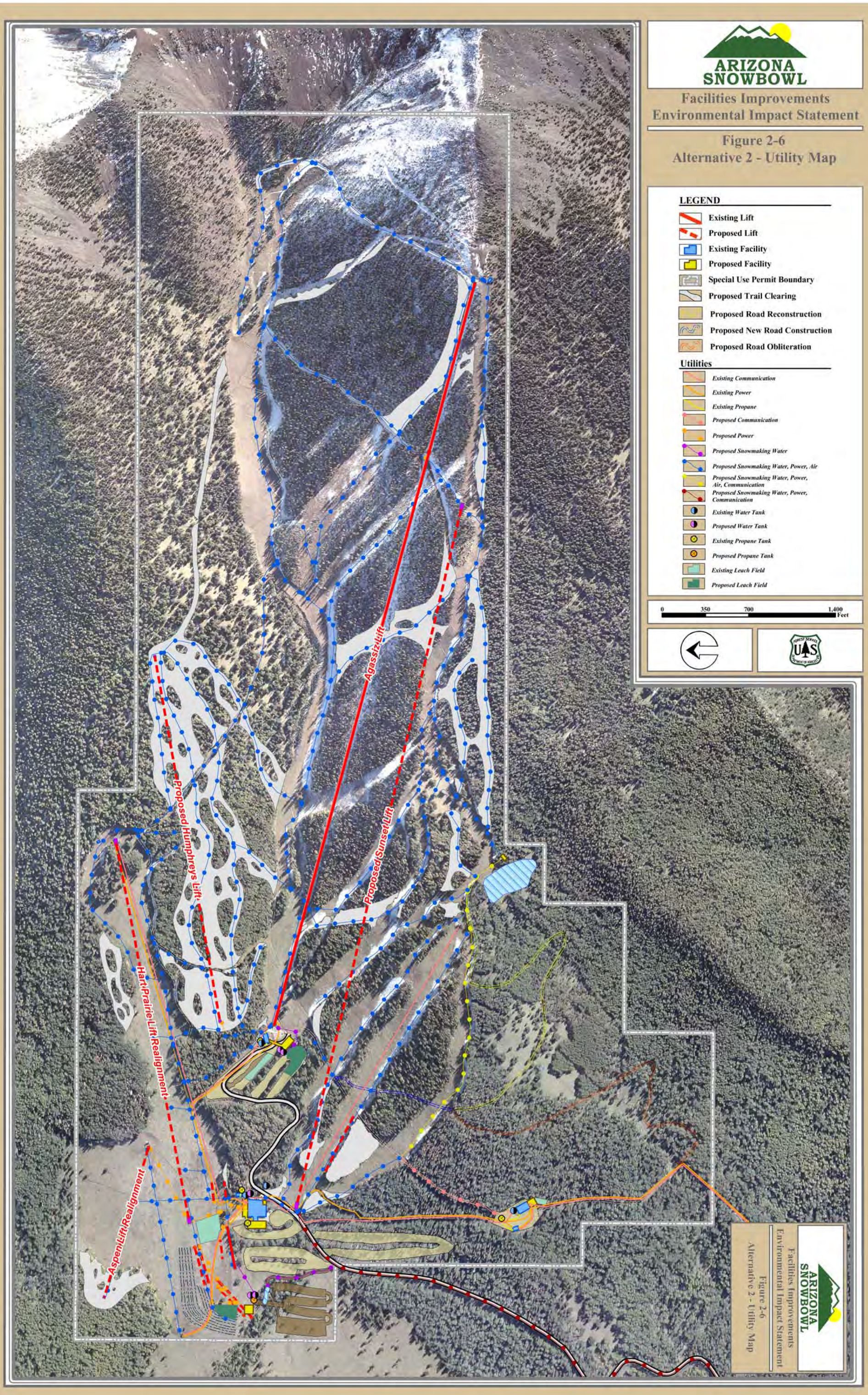
- Existing Lift
- Proposed Lift
- Existing Facility
- Proposed Facility
- Existing Parking
- Proposed Parking
- Special Use Permit Boundary
- Proposed Trail Grading and Smoothing
- Proposed Grading
- Proposed Road Reconstruction
- Proposed New Road Construction
- Proposed Road Obliteration

FACILITIES

- Hart Prairie Lodge
- Agassiz Lodge
- Agassiz Lift Mid-Station
- Existing Maintenance Facilities
- Proposed Building Expansion
- Proposed Parking Lot Reconfiguration
- Proposed Half Pipe and Surface Lift
- Proposed Pedestrian Underpass
- Proposed Snowplay Facilities
- Proposed Snowplay Parking
- Proposed Snowplay Area
- Proposed Snowmaking Control Building
- Proposed Pumphouse
- Proposed Snowmaking Water Impoundment
- Proposed Snowmaking Catchment Pond

0 350 700 1,400 Feet

ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-5
Grading Plan
Alternative 2 - Proposed Action


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-6
Alternative 2 - Utility Map
LEGEND
Existing Lift
Proposed Lift
Existing Facility
Proposed Facility
Special Use Permit Boundary
Proposed Trail Clearing
Proposed Road Reconstruction
Proposed New Road Construction
Proposed Road Obliteration
Utilities
Existing Communication
Existing Power
Existing Propane
Proposed Communication
Proposed Power
Proposed Snowmaking Water
Proposed Snowmaking Water, Power, Air
Proposed Snowmaking Water, Power, Air, Communication
Proposed Snowmaking Water, Power, Communication
Existing Water Tank
Proposed Water Tank
Existing Propane Tank
Proposed Propane Tank
Existing Leach Field
Proposed Leach Field
0 350 700 1,400 Feet
Agassiz Lift
Proposed Sunset Lift
Proposed Humphreys Lift
Hart Prairie Lift Realignment
Aspen Lift Realignment

ALTERNATIVE 3 – NO SNOWMAKING OR SNOWPLAY

As with the Proposed Action, Alternative 3 would result in the creation of a MDP that includes all projects outlined in the Proposed Action description, with the major exception of snowmaking (including the transmission line from Flagstaff, pipelines, and the impoundment). Because construction and use of the proposed snowplay facility is dependant upon the ability of the Snowbowl to produce snow, this facility and associated parking would not be constructed under Alternative 3. Finally, Alternative 3 does not include realignment of the Aspen Chairlift or associated vegetation clearing in the northwestern portion of Hart Prairie, as in the Proposed Action.

Under Alternative 3 the Snowbowl's CCC would increase to the approved[15] level of 2,825 skiers-at-one-time. Peak day visitation would continue to reach in excess of 3,400 skiers-at-one-time. Developed skiing terrain would increase to approximately 202.6 acres. Peak day visitation would be expected to continue to exceed 3,400 skiers-at-one-time.

All costs associated with the planning, development, construction, operation, and maintenance of all proposed infrastructure would be fully the responsibility of the Arizona Snowbowl.

Alternative 3 is illustrated in figures 2-7 through 2-9.

By excluding all snowmaking infrastructure and the associated use of reclaimed water on the San Francisco Peaks, tribal and public concerns over effects to cultural and spiritual values as well as effects to water quality within the watershed would be addressed. Alternative 3 also responds to Heritage Issue #2 (scarring of the San Francisco Peaks) with reduced ground and vegetation disturbance. When compared to the Proposed Action, Alternative 3 reduces permanent and temporary ground disturbance (refer to Table 2-4). However, with the absence of snowmaking in Alternative 3, additional grading is proposed on new and existing terrain to minimize the depth of natural snow required for skiing (refer to Figure 2-8).

As detailed within the Social and Economic Resources, and Recreation sections of Chapter 3, operations under Alternative 3 would continue to be heavily dependant upon natural snowfall. Correspondingly, skier visitation levels, and therefore revenues, are not anticipated to stabilize. As such, it is probable that the owners of the Snowbowl would be unable or unwilling to continue to infuse the recurring capital necessary to maintain the quality and service level currently offered, or to implement all of the projects included in Alternative 3. Likely, a portion of the Alternative 3 improvements - those requiring smaller investments – would be developed. Dependant upon which facilities are ultimately implemented, the actual effects to the human, physical and biological environment would realistically be a blending of those effects described under the No Action Alternative and those detailed under Alternative 3.

For the purposes of comparison, this analysis primarily assesses anticipated effects of Alternative 3 assuming that *all* of the Alternative 3 improvements would be implemented.

[15] Approved in the 1979 Arizona Snowbowl Ski Area Proposal Final Environmental Statement and subsequently incorporated by reference the CNF Forest Plan.

ARIZONA SNOWBOWL

Facilities Improvements
Environmental Impact Statement

Figure 2-7
Alternative 3

LEGEND

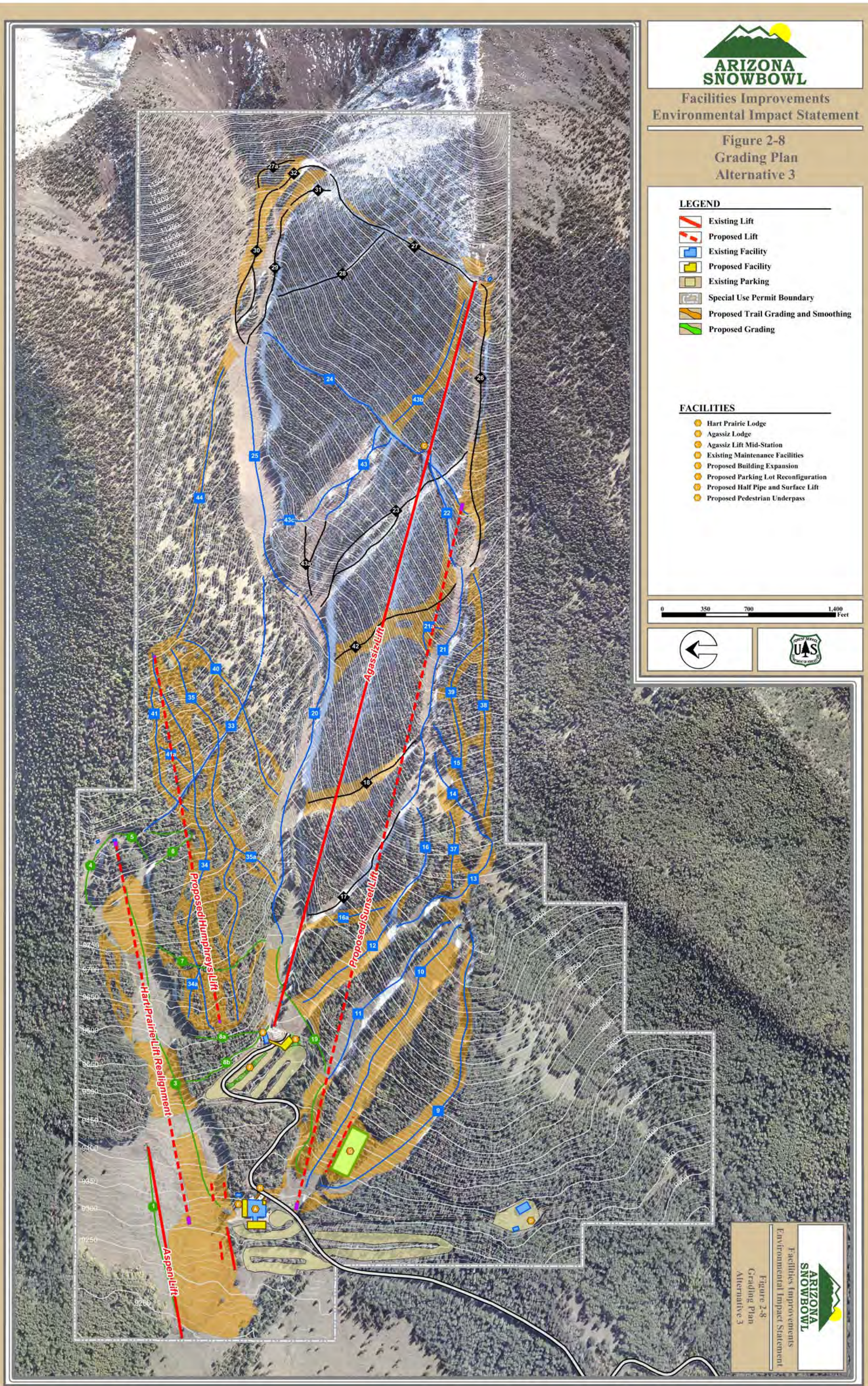
- Existing Lift
- Proposed Lift
- Existing Facility
- Proposed Facility
- Existing Parking
- Special Use Permit Boundary
- Proposed Trail Clearing
- Proposed Vegetation Clearing
- Proposed Hiking Trail

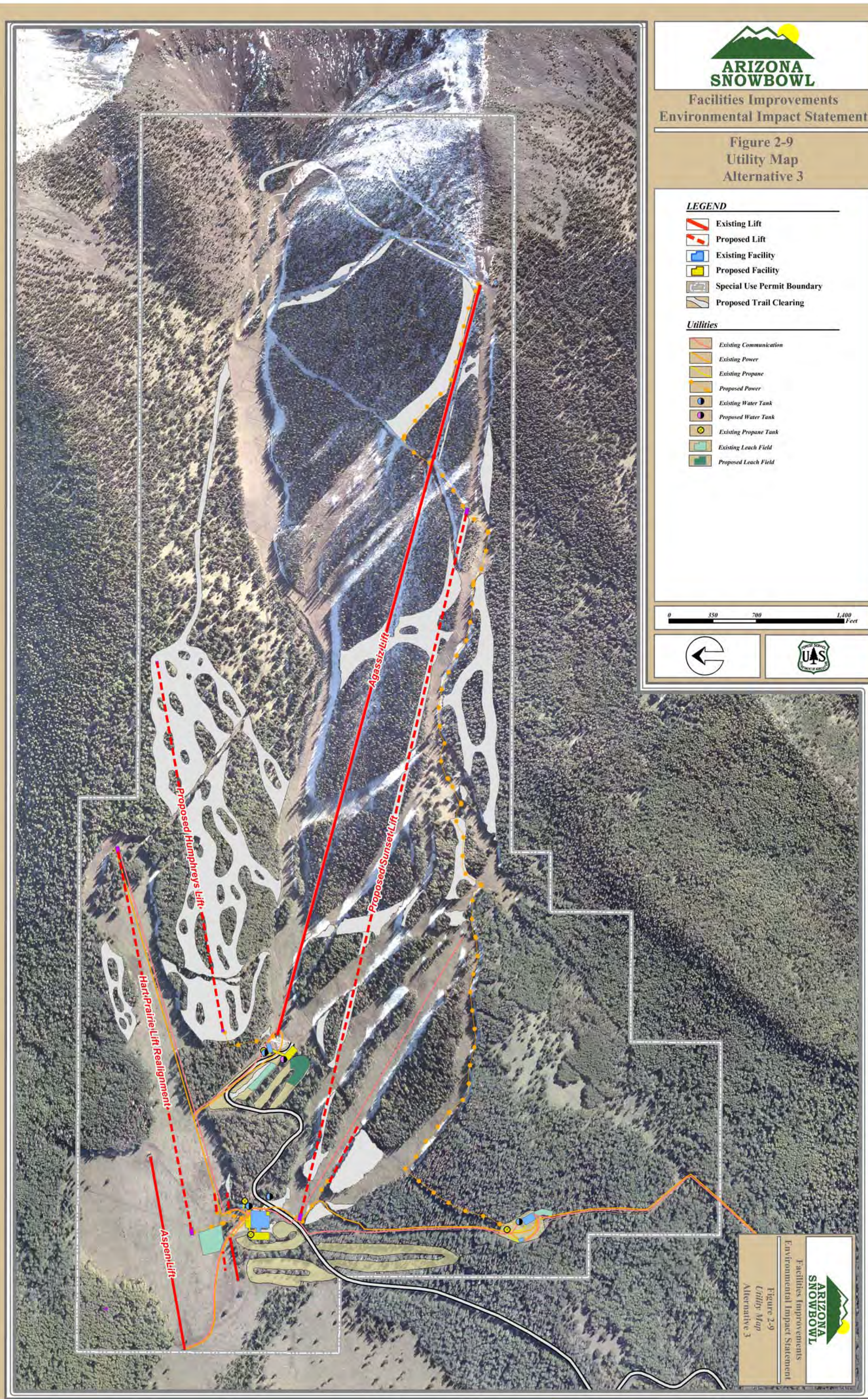
FACILITIES

- Hart Prairie Lodge
- Agassiz Lodge
- Agassiz Lift Mid-Station
- Existing Maintenance Facilities
- Proposed Building Expansion
- Proposed Parking Lot Reconfiguration
- Proposed Half Pipe and Surface Lift
- Proposed Pedestrian Underpass

0 350 700 1,400 Feet

ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-7
Alternative 3


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-8
Grading Plan
Alternative 3
LEGEND
Existing Lift
Proposed Lift
Existing Facility
Proposed Facility
Existing Parking
Special Use Permit Boundary
Proposed Trail Grading and Smoothing
Proposed Grading
FACILITIES
Hart Prairie Lodge
Agassiz Lodge
Agassiz Lift Mid-Station
Existing Maintenance Facilities
Proposed Building Expansion
Proposed Parking Lot Reconfiguration
Proposed Half Pipe and Surface Lift
Proposed Pedestrian Underpass
0 350 700 1,400 Feet
Agassiz Lift
Proposed Sunset Lift
Proposed Humphreys Lift
Hart Prairie Lift Realignment
Aspen Lift
ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-8
Grading Plan
Alternative 3


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-9
Utility Map
Alternative 3
LEGEND
Existing Lift
Proposed Lift
Existing Facility
Proposed Facility
Special Use Permit Boundary
Proposed Trail Clearing
Utilities
Existing Communication
Existing Power
Existing Propane
Proposed Power
Existing Water Tank
Proposed Water Tank
Existing Propane Tank
Existing Leach Field
Proposed Leach Field
0
350
700
1,400
Feet
Agassiz Lift
Proposed Humphreys Lift
Proposed Sunset Lift
Hart Prairie Lift Realignment
Aspen Lift
ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-9
Utility Map
Alternative 3

MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

NEPA and CEQ regulations require that all relevant, reasonable mitigation measures that will reduce the impacts resulting from a project be identified, even if those measures are outside the jurisdiction of the Forest Service. Mitigation, as defined in the CEQ regulations, includes the following:

- Avoiding the impact altogether by not taking a certain action or parts of an action
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments

An integral part of the analysis process is mitigation of the potential effects resulting from implementation of the action alternatives. Therefore, to minimize resource impacts, the mitigation measures detailed in Table 2-2 would be implemented for either of the action alternatives. The potential effects of each alternative (provided in Chapter 3) were analyzed with the specified mitigation measures applied. Appropriate mitigation measures and BMPs would occur previous to, or simultaneously with, approved ground disturbing activities.

Each mitigation measure or BMP includes rating of anticipated effectiveness and feasibility as well as an indicated objective. Responsibility for ensuring that these mitigation measures are implemented rests with the Snowbowl management and the Forest Service. In all cases, the ultimate enforcement mechanism for implementation of the specified mitigation measures would be the Record of Decision for this EIS, and would extend to the Forest Service Special Use Permit Administrator, the District Ranger, and the Forest Supervisor.

The effectiveness, feasibility, and objectives of the required mitigation measures and BMPs detailed in Table 2-2 were assessed based on the following rating system:

EFFECTIVENESS

High	Almost always reduces effects substantially. Commonly applied.
Moderate	Usually results in a substantial reduction of effects. Commonly applied.
Low	May not substantially reduce effects.[16]

[16] BMPs with effectiveness ratings of "Low" were avoided to provide more adequate protection of natural resources.

FEASIBILITY

F1 May be technically difficult.
F2 Technically probable. Costs moderate in comparison to other options.
F3 Technically easy. Cost high in comparison to other options.
F4 Technically easy. Costs low in comparison to other options.

Categorical objectives have been developed for the Mitigation Measures and BMPs detailed in the following table and are referenced using the following codes:

OBJECTIVE

A Promote revegetation of disturbed sites
B Reduce runoff, erosion, and sediment delivery
C Conserve productive soil resources
D Protect soil and water resources from contamination
E Minimize the effects of smoke, particulate matter and air emissions generated
F Reduce the visual prominence of proposed projects
G Reduce impacts to cultural resources
H Prevent overtopping of the snowmaking water impoundment embankment crest
I Prevent piping[17] development in the downstream toe of the snowmaking water impoundment embankment
J Prevent liquefaction[18] of the embankment foundation
K Ensure the protection of protected status flora and/or fauna
L Promote active vegetation management within the SUP area
M Define appropriate response scenarios, provide for specific notification plans, for all potential modes of snowmaking water impoundment failure
N Identify, minimize and correct any discovered safety deficiencies related to the snowmaking water impoundment.
O Monitor impacts to cultural resources
P Protect wildlife species, reduce the potential for human/wildlife encounters

[17] Piping involves the transport of solid particles from within an embankment or foundation soil in response to high seepage pressures or seepage velocities.
[18] Liquefaction is a phenomenon that causes loss of shear strength during the strong ground motion accompanying an earthquake. Liquefaction requires two conditions: loose cohesionless soils and saturated conditions.

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
VEGETATION		
Understory vegetation will be preserved to the extent possible in all areas designated for flush cutting and/or overstory vegetation removal.	A, B, C, G	High/F4
Prior to construction, the disturbance limits of the site will be flagged. Pop fencing, flagging, or a staked rope line will be established to denote the limits of construction proximate to sensitive resource boundaries.	A, B, C, D, K	High/F4
Prior to removal of merchantable timber, decking areas and removal routes will be designated in the field and approved by the Forest Service. Timber removal shall minimize soil disturbance, re-use landings and skid trails that are weed-free and incorporate over-snow, skyline, or helicopter logging when and where feasible. Soil disturbance shall further be minimized by treatment of fuels in-place, use of low-impact equipment (big tires), use of equipment that carries rather than drags logs, use of hand fellers and hand piling, and by avoiding decking of logs in the woods.	C, D, K	Moderate/F4
The Snowbowl shall continue to restrict access to within the SUP during the summer months to prevent potential impacts to San Francisco Peaks groundsel and bearded gentian. Interpretive signage shall be developed and placed along the summer trail to be constructed between the Agassiz Chairlift top terminal and mid-station. As a portion of its ongoing interpretive program, Arizona Snowbowl shall provide general enforcement of access restrictions along the proposed summer trail. Arizona Snowbowl shall annually monitor the condition of alpine tundra areas to assess potential impacts and the adequacy of the restrictions. No equipment shall be operated at anytime outside the SUP.	K	High/F3
The Snowbowl shall coordinate with the CNF Silviculturalist to develop a vegetation management plan or specific treatment prescription for stands within the SUP. The CNF will approve the final prescription plan to address to insect outbreaks (spruce beetle), fire risk, safety, and other management considerations that will maintain desired landscape characteristics.	L	Moderate/F3

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Topsoil replacement, native seedbank promotion, seeding, and weed-seed free mulching (as necessary), will be used to stabilize disturbed soils in all areas where grading and soil disturbance will occur to promote native plant re-establishment. Weed-free topsoil shall be stockpiled and replaced in disturbed areas.	A, C, D, F, K,	Moderate/F2
Local seeding guidelines will be used to determine detailed procedures and appropriate mixes. Preference is given to local seed sources, cultivars, and species available commercially. To avoid weed contamination, all seed purchased shall be certified weed-seed free. Seed will be tested by the producer in a certified seed lab against the Coconino NF invasive weed list, the Arizona noxious weed list, and the federal noxious weed list.	A, C, D, F, K,	Moderate/F2
Before ground-disturbing activities begin, identify and locate all equipment staging areas in the SUP. Use weed-free staging areas if possible, otherwise treat existing noxious weeds in these areas prior to the staging of any equipment. Establish equipment wash stations (1) at the base of the ski area for construction activities and (2) at the base of Snowbowl Road for construction of the reclaimed water pipeline. Specific locations shall be approved by a forest officer prior to use. Each station shall have a filter system, for example at least 6 inches of large cinder or gravel spread over an area 10'x 30'. Filter cloth may be used for temporary stations. The area will be a perched drainage to allow excess moisture to drain after being filtered. Equipment wash stations shall be located at least 200 yards from any natural drainage to avoid contamination. All soiled equipment shall be washed before entering and before leaving the project area. This includes construction personnel vehicles in addition to trucks and other heavy equipment. A "contaminated" parking area shall be designated where vehicles and equipment can remain through the duration of construction activities to minimize the need for repeated cleaning. Equipment wash stations shall be monitored frequently and annually after completion of all construction activities. All weed materials shall be removed promptly.	A, C, D, F, K	Moderate/F3
For construction of the reclaimed water pipeline, the existing paved surface of the Snowbowl Road shall be used for all equipment staging and materials stockpiling. Any fill dirt obtained off-site shall be certified to be free of noxious weeds prior to its use in construction areas. Stockpiled materials shall be maintained in a weed-free condition.	A, D, F, K,	Moderate/F3

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Monitor all construction areas and roadways within the SUP annually for at least five growing seasons and treat any noxious weeds found. Annually inspect all parking lots and areas surrounding guest service and maintenance facilities at the base of the ski area within the SUP and document and treat any new noxious weed infestations. Non-herbicidal treatments shall be given priority. If herbicides are necessary, their proposed use shall be publicly posted (including at trailheads) and alternative access routes shall be provided. Herbicide application, if used, shall incorporate dye markers to identify spray locations. Herbicide use shall strictly follow label directions and applicable legal requirements. If pesticides (herbicides) are used, specific plans will be developed to address application monitoring and evaluation, spill contingency, cleaning and disposal of containers, and control of pesticide drift, incorporating the measures described in Appendix B of FEIS for Integrated Treatment of Noxious and Invasive Weeds. Use of herbicides is prohibited in occupied "No Activity Centers" for Mexican Spotted Owls and in occupied nesting stands for Northern Goshawks. Only herbicides specified in Table 26 of the Required Protection Measures for Pesticide Application in Identified Species Habitat (RPMPA) of the fore-mentioned FEIS may be used within Mexican Spotted Owl Protected Activity Centers (PACs) and Northern Goshawk Post-Fledgling Family Areas (PFAs), including along road right-of-ways through such areas.	D, L	High/F4
Prior to ground disturbances affecting bearded gentian, the plants will be either transplanted to other suitable areas or collected for research purposes at the discretion of the Forest Botanist.	K	Low/F4
SOIL AND WATER		
A grading plan will be developed and submitted to the Forest Service for review and approval prior to implementation of proposed project elements.	A, B, C, D	High/F4
A site-specific erosion control plan for all approved project elements that entail ground disturbance will be developed and submitted to the Forest Service for review and approval prior to implementation.	A, B, C, D	High/F4

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Soil-disturbing activities will not be initiated during periods of heavy rain or excessively wet soils.	B, C	High/F4
Immediately following completion of approved ground disturbing activities and seeding, all areas of ground disturbance will be mulched with weed-free straw, wood chips, bark, or jute mat.	A, B, C	Moderate/F3
In all areas where grading or soil disturbance will occur (excluding flush cut lift corridors), stockpile topsoil and re-spread topsoil following slope grading and prior to re-seeding. The stockpiled soil will be protected from wind and water erosion.	A, C, D	Moderate/F3
Check dams and sediment barriers (i.e., silt fence, weed-freed hay bales, wattles) will be placed in all temporary erosion channels with minimum sufficient spacing to control runoff velocity and encourage sediment deposition.	B, C	High/F4
Removal of logs and logging debris will be conducted with minimal dragging or pushing through the soil in order to minimize disturbances.	B, C	Moderate/F4
In areas where site conditions necessitate (i.e., excessively steep slopes and/or highly erosive soil types), temporary sediment detention basins will be created to detain runoff and trap sediment. Sediment basins will be created within the overall disturbance limits of the applicable project elements. Temporary sediment basins will be reclaimed following reestablishment of permanent vegetation and will likewise be revegetated.	B, C	High/F4

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
On steeper slopes (>30% slope gradient), areas exposed by grading will require implementation of jute-netting or other appropriate geo-textiles to further stabilize disturbed soils. Installation should include: • Seeding and mulching of the disturbed area • Burial of the top end of the netting in a trench of at least four inches depth and eight inches width. The trench shall be backfilled and tamped. • Netting should extend beyond the edge of the mulched and/or seeded area at least one foot on the sides and three feet on the top and bottom. • The netting should be rolled downslope and secured with staples or pins. • Netting should overlap at least four inches on the sides and secured with staples five feet apart along the overlap • The lower end of the uphill strip should overlap the downhill strip at least one foot and should be secured with staples one foot apart.	A, B, C	High/F3
Water bars (12 to 18 inches deep) and cross-drains will be constructed across all roads, trails, and other disturbed areas after seeding and fertilization at 50, 75, or 100-foot intervals as a function of slope angle, or as necessary, to disperse road surface runoff. The frequency will be sufficient to prevent rill erosion and sediment delivery channel formation. Alternatively, "parabolic slope water bars" may be constructed at the gradient beginning at the center of the road or trail surface and traversing outward to spill into undisturbed vegetation on both sides of the road or trail prism. Waterbars and outlets will be inspected seasonally, maintained, and cleared of sediment at regular intervals as necessary.	A, B, C	High/F4
Windrows will be installed where fill-slope erosion is possible, or where road-derived sediment may be delivered (i.e., outflow area of culverts and rolling dips).	B, C, D	Moderate/F4
All towers and concrete necessary for lift construction will be transported via helicopter, unless otherwise approved by the Forest Service in the field.	C, K, F	High/F3
Prior to construction, a construction access plan will be developed detailing access routes to pertinent project elements (i.e., lift towers, lift terminals, building sites, helicopter routes).	C, K, F	High/F4
Fuel delivery and storage will be located, designed, constructed and maintained to reduce the potential and severity of spills.	D	High/F4

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Fuel, oil and other hazardous materials will be stored in structures placed on impermeable surfaces with impermeable berms designed to fully contain the hazardous material plus accumulated precipitation for a period at least equal to that required to mitigate a spill.	C, D, K	High/F4
Helicopter refueling area(s) will be designated according to Forest Service refueling standards.	D, K	High/F4
An oil spill contingency plan will be developed and approved prior to initiation of construction activities.	D	High/F4
New and expanded parking lots and roads will be surfaced with aggregate materials.	B, D	High/F4
Concrete truck washout areas will be designated in the field and approved by the Forest Service prior to construction commencement.	D	High/F4
Where snowmaking and utility lines will be installed on slopes greater than 30 percent, temporary check dams will be placed within open sections of trench when those open sections exceed 100' in length.	B, C	High/F4
DUST ABATEMENT		
During construction under dry conditions, all exposed soil, including roadways, parking lots, buildings and lift terminal areas will be sufficiently watered to prevent excessive amounts of dust. In the absence of natural precipitation, watering of these areas will occur as necessary. This measure excludes trail grading or other project elements that do not have sufficient road access to facilitate water truck access.	E	High/F4
AIR QUALITY		
The primary contractor shall be responsible to ensure that all construction equipment is properly tuned and maintained.	E	Moderate/F4
Idling time and construction-related trips will be minimized, as appropriate	E	Moderate/F4
In order to minimize emissions and particulate matter, existing power sources and/or clean fuel generators will be used rather than temporary power generators	E	Moderate/F4

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Lop and scatter slash and small woody debris generated across the width of new trails	B, C, E	Moderate/F4
Burning of slash/timber will be staged to reduce the volume of smoke being produced at any one time.	E	High/F4
Slash burning will be minimized by the removal of commercial grade timber and the practice of lopping and scattering where possible.	E	Moderate/F3
To the extent practicable, burning of slash piles during periods of time when the atmospheric conditions would transport smoke away from the Flagstaff area.	E	Moderate/F4
Non-agricultural material will not be included in slash burns.	E	High/F4
AESTHETICS		
Construct new structures with materials that blend with the landscape character.	F	Moderate/F3
Strategically locate and camouflage or screen all proposed fuel and water tanks.	F	High/F4
Straight edges in the forest canopy will be avoided by feathering the layouts of proposed trails and by selectively removing trees of different species and ages to the extent possible.	G, F	Moderate/F3
CULTURAL RESOURCES		
Pursuant to 36 CFR 800.6(b), the Forest Service has consulted with the 13 tribes for which the San Francisco Peaks have religious and cultural significance, and, pursuant to 36 CFR 800.6(c), has invited the Tribes and the Snowbowl to execute a Memorandum of Agreement (MOA) as concurring parties. The MOA is contained in Appendix D of the FEIS and indicates mitigation measures and stipulations that are designed to minimize the effects of any approved projects on historic properties.	G	Moderate/*Required*
WILDLIFE		
Arizona Snowbowl will install bear-proof waste receptacles in public areas within the SUP as necessary to discourage scavenging by black bears and to reduce encounters by humans and bears.	P	High/F4

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Tree removal within Restricted Areas or PACs is limited to eleven trees along the Snowbowl Road within the Snowbowl PAC. Prior to initiating construction of the reclaimed water pipeline, a subsequent survey will be conducted to identify any occupied nest sites within the PACs. If an active nest is located, any construction activities within ½-mile radius of the active nest site will be restricted to periods outside the breeding season, which extends from March 1 to August 31.	K	High/F4
Prior to initiating construction of the reclaimed water pipeline, a subsequent survey will be conducted to identify any occupied nest sites within the PFAs. If an active nest is located, any construction activities within ½-mile radius of the active nest site will be restricted to periods outside the breeding/fledging season, which extends from March 1 to September 30.	K	High/F4
The water impoundment will be surrounded by a fence to exclude big game wildlife. Specifications of the fence (material, height, and color) will be determined during final design of the impoundment.	P	High/F4
STABILITY OF SNOWMAKING WATER IMPOUNDMENT		
The uncontrolled emergency spillway should be checked routinely and frequently as part of normal operations for potential blockage by snow, ice, or debris and cleared if significant blockage is found.	H	High/F4
Install an automatic cutoff switch that would shut down pumps when the water surface in the impoundment reaches its maximum storage level.	H	High/F4
A composite liner system consisting of HDPE liner above a minimum six-inch thick bedding of compacted clay would restrict the flow volume sufficiently to prevent saturation of the foundation and embankment soils and create enough head loss to reduce high exit gradients in the toe area of the dam.	I	High/F4
Grout will be injected into any open fractures exposed during excavation prior to covering with the local sand bedding and the HDPE liner. The plugging of these fractures will either prevent the entry of water into the fractures or at least create enough head loss to reduce exit pressures at the embankment site.	I	Moderate/F4

Table 2-2
Mitigation Measures and BMPs

Resource, BMP/Mitigation Measure	Objective	Effectiveness/Feasibility
Check the relative density of entire soil profile and quantify the liquefaction potential of the deeper soils through a site-specific drilling program at the time of final design of the impoundment. If a liquefaction risk is identified at the time of final design, it can be easily mitigated by removing loose soil and replacing it with compacted, densified soil, or deep layers can be stabilized with grout.	J	High/F3
An Emergency Action Plan will be assembled to define appropriate response scenarios for all potential modes of failure and includes specific notification plans (updated at least every two years with current phone numbers), and evacuation plans. All responsible operating staff must be familiar with the Emergency Action Plan.	M	Moderate/F4
Snowmaking water impoundment will require an Operation & Maintenance inspection by a qualified Forest Service engineer on an annual basis. Timing of said inspection shall be such to allow correction of discovered safety deficiencies prior to the immediately following season of operation. Inspection criteria shall be according to current safety criteria and engineering state-of-art judgment, and manual FSM 7500 direction. In addition, there shall be completed within three calendar days after any event of any unusual event; such as an earthquake of Richter magnitude 5.0 or greater within a twenty-mile radius of the event epicenter, in the event of an overtopping event, or at the discretion of the Forest Service. The Forest Service shall be notified by the facility owner/operator in the event of any unusual facility operational behavior or physical characteristic.	N	High/F4

ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not analyzed in detail.[19] Public comments received during the scoping process and in response to the DEIS provided suggestions for alternative methods for achieving the established project purpose and need. Some of these alternatives may have been outside the scope of the proposal, duplicative of the alternatives considered in detail, or determined to be components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for reasons summarized below. Some of the topics presented here may have constituted only portions of a complete alternative.

REMOVAL OF THE SKI AREA

The existence of ski trails and infrastructure on the San Francisco Peaks led to some members of the public questioning why an alternative analyzing the dismantling of the Snowbowl was not considered. In 1979 the Forest Service issued a Final Environmental Statement that analyzed several alternatives including an alternative that would allow further development of the ski area and another alternative to dismantle the ski area facilities. In the Record of Decision that accompanied the Environmental Statement, the Forest Supervisor selected an alternative that allowed further development of the ski area. This decision was appealed and dealt with administratively by the Regional Forester and then the Chief of the Forest Service, who ultimately upheld the Forest Supervisor's decision. The Forest Service was subsequently sued by six plaintiffs seeking to halt further development and removal of the existing ski facilities. The Forest Service decision was reviewed and eventually upheld by the US District Court and then the US Court of Appeals. The US Supreme Court refused to hear the case, effectively upholding the decision of the US Court of Appeals. In 1987, the Coconino National Forest Land and Resource Management Plan was adopted. It included the continued operation of Snowbowl in accordance with the 1979 Environmental Statement as part of the management direction for Management Area 15. In 1993 a 40-year Ski Area Term special use permit was issued. Each of these choices has affirmed the existence of the ski area. Given this series of decisions it did not seem appropriate to consider the dismantling alternative in detail.

NIGHT LIGHTING

In the fall of 2002, the Snowbowl developed and submitted a proposal to the Forest Service for improving the recreational opportunities at the ski area while addressing safety, customer service, and economic issues associated with the existing ski area operations. A large-scale, state-of-the-art night lighting system was included to enable the ski area to provide night skiing, snowplay and adequate lights in the ski area's parking lots to accommodate proposed nighttime activities. At that time, CNF Supervisor Jim

[19] 40 CFR 1502.14

Golden accepted night lighting as a part of Snowbowl's proposal and the NEPA process was initiated.

The public and tribal scoping process (detailed in Chapter 1) quickly revealed the controversial nature of the night lighting component of the Proposed Action. Concerns raised by the public and tribes pertaining to night lighting precipitated the identification of two issues. First, the general public was concerned with the "sky glow" that would inevitably be produced in the horizon due to lighting Snowbowl's reflective, snow covered trails. The sky glow's effects on Flagstaff's designation as a Dark Sky Community, visibility of the lights from points across the Colorado Plateau, and effects to local observatories were a major concern. Second, tribal concerns focused on the cultural/spiritual effects of installing a large scale lighting system on the San Francisco Peaks, which are held sacred. To the tribes, night lighting would interfere with the natural processes of day and night and therefore the ability of the San Francisco Peaks to rest at night.

Public and tribal concerns regarding lighting, in addition to both the expense and technical difficulty of modeling the visual impacts of the lighting system (as well as mitigating the effects) led Snowbowl and the CNF to determine that it is not prudent to carry the night lighting component forward. Therefore, the night lighting system (associated with nighttime skiing and snowtubing, as well a parking lot lighting system to accommodate proposed nighttime activities) were eliminated from the proposal and are therefore not analyzed in this EIS.

However, prior to night lighting being dropped from the Proposed Action, three alternatives were developed by the ID Team that would have responded to issues surrounding the night lighting issue. Those alternatives, which have since been eliminated from further analysis, included the following:

No Snowmaking, Night Lighting or Snowplay

This alternative included all components of the original Proposed Action, with the exception of snowmaking (and all associated infrastructure – including the transmission line from Flagstaff, pipelines and the reservoir), lighting, and the snowplay facility.

This alternative responded to issues raised during the public and internal scoping process. Two of these issues were subsequently eliminated by withdrawing the proposed night lighting system. With the elimination of lighting from the Proposed Action, this alternative was in essence identical to the Alternative 3, and therefore was not needed.

No Night Skiing (With Minimal Lighting for Snowplay)

This alternative included all components of the original Proposed Action, with the exception of the lighting system necessary for night skiing. This alternative would have included installation of a minimal, low-level lighting system associated with evening operation of the snowplay facility and lighting in the snowplay parking lot.

By eliminating higher wattage lighting necessary for night skiing, potential for sky glow would have been minimized and this alternative would have responded to the two issues (that were subsequently eliminated) raised by the public and tribes. With the elimination off any nightlighting this alternative was not analyzed any further.

Proposed Action Without Night Lighting

This alternative would have included all components of the original Proposed Action with the exception of the lighting system (for night skiing, snow tubing, and parking).

By eliminating all forms of night lighting, all issues associated with night lighting would have been responded to. This alternative would have been identical to the Proposed Action currently under analysis in this EIS.

ELIMINATION OF THE HUMPHREYS POD

In response to the issue relating to permanently evident visible alterations ("scarring") on the Peaks (detailed in Chapter 1 of this document) the Forest Service initially considered an alternative that would have carried forward all projects identified in the Proposed Action, with the exception of new lift and trail construction associated with the Humphreys Pod. This alternative would have partially addressed the "scarring" issue by eliminating both permanent and temporary ground disturbance; overstory vegetation removal, and lift construction in the Humphreys Pod.

However; this alternative was not carried forward because it only partially responded to the issue raised and would have failed to meet a key purpose and need of the Proposed Action - "To improve skiing and recreational opportunities, bringing terrain and infrastructure into balance with current use levels." Specifically, the stated need to "Improve the quantity and distribution of beginner and intermediate terrain by developing additional ski trails and spaces within the existing SUP area" could not have been met. The proposed Humphreys Pod offers a unique, and needed, source of intermediate terrain within an undeveloped portion of Snowbowl's SUP area.

Additionally, an alternative that excludes lift and trail development in Humphreys Pod would not relieve Snowbowl's current uphill (i.e., lift) capacity shortfalls on peak days, in which lift line wait times can exceed 40 minutes. In contrast, under the Proposed Action the comfortable capacity of the ski area would increase to 2,825, whereas under an alternative without the Humphreys Pod, the CCC would only increase to 2,360. Given that frequent peak days will continue to exceed 3,400 skiers, the "No Humphreys Pod" alternative accomplishes far less in terms of fulfilling the need to service existing levels of visitation to the ski area and providing an adequate guest experience.

Additionally, the visual simulation which was completed to assess the anticipated visual changes resulting from the development of the Humphreys Pod indicates that the mosaic

of these trails would not be inordinately visible – and in fact is very much in keeping with the Scenic Integrity Levels required by the CNF Forest Plan.[20]

REDUCED SNOWMAKING COVERAGE

In order to address potential effects associated with providing snowmaking coverage on the full extent of Snowbowl's terrain (approximately 205.2 acres), the Forest Service initially considered an alternative to the Proposed Action that would have reduced the total amount of snowmaking coverage, and therefore the amount of reclaimed water used on the mountain. Focusing snowmaking infrastructure in the base area would not have provided for snowpack consistency throughout the extent of SUP area. Additionally, this alternative would have only slightly reduced anticipated concerns related to the use of reclaimed water, water quantity and quality, and reduced temporary soil disturbance within the SUP area. Therefore, a reduced snowmaking alternative would not reduce or mitigate heritage issues and impacts to the TCP. Given the extraordinary level of infrastructure necessary to introduce snowmaking at the Snowbowl, developing only a portion of the system (and therefore coverage areas) was determined to be impractical – particularly given the potential alternative's inability to meaningfully respond to the specific issues. This potential alternative was therefore eliminated from further detailed analysis.

ALTERNATIVE ON-SITE AND NEARBY WATER SOURCES

For several years prior to the current proposal, Snowbowl explored the possibility of using numerous different water sources to meet potential snowmaking needs. Some of those sources included the following:

- Drilling deep wells within the SUP area
- Developing nearby wells in lower Hart Prairie that were drilled in the 1970s as components of another development plan for the ski area
- Drilling wells on private property owned by the Snowbowl in Fort Valley and constructing a six-mile pipeline to transport water to the ski area
- Acquiring the rights to an existing well in Fort Valley that Snowbowl had used for potable water in the 1980's
- Hauling water by tanker truck to the Snowbowl for storage in a reservoir
- Tapping into the pipeline/storage distribution system owned by the City of Flagstaff which currently transports water from the Inner Basin on the San Francisco Peaks to the City
- Using potable water from the City of Flagstaff with a pipeline identical to the one being proposed
- Collecting rain from summer monsoons

Snowbowl entertained the concept of using various potable water sources to potentially meet its snowmaking needs. After ample due diligence, (logistical and economic

[20] Refer to the Section D - Aesthetic Resources of Chapter 3, specifically Figure 3D-2, for additional details and photo simulations of the lift and trail development in the Humphreys pod.

considerations and water availability research) it was determined that the use of potable water sources was not a prudent choice to meet the Snowbowl's snowmaking requirements. In addition, the Forest Service determined that the additional environmental and political issues that would inevitably accompany any potable water alternative would make such a concept imprudent. Finally, collecting rain water and hauling water to the site were both deemed economically and logistically infeasible given the large capacity of water that would be required to run the snowmaking system.

Therefore, in order to achieve the quantity of water necessary for Snowbowl's snowmaking needs, the current proposal to use reclaimed water from the City of Flagstaff represents the most reliable, practical, and ecologically responsible option.

ADDITIONAL / ALTERNATIVE SUMMER RECREATIONAL OPPORTUNITIES

For many years local outdoor enthusiasts have voiced their opinions and desires for the Snowbowl to provide additional recreational activities, similar to those currently occurring at other ski areas. Mountain biking on the ski area with lift access and paragliding from near the top of the Agassiz lift are the most frequently requested activities (comments were received relating to both activities during the scoping process). Both mountain biking and paragliding are gaining in popularity in Flagstaff and across the western Unites States. Chairlift accessed mountain biking programs are common at ski areas operating on NFS lands, and several ski areas are nationally recognized for their paragliding programs. Construction of an Alpine slide for use during summer months was also briefly considered, but eliminated as it was not deemed appropriate for NFS lands.

The Snowbowl has the physical and operational attributes that would make all of these activities possible, as well as the consumer demand from within the local community and the state of Arizona. However, the Forest Service and the management of the Snowbowl jointly determined that the most immediately critical need for the ski area was to ensure a consistent and reliable winter operating season, thereby maintaining the economic viability of the Snowbowl (as referenced in the Purpose and Need). Therefore, mountain biking and paragliding were considered but eliminated at the early stages of planning for the Snowbowl's Proposed Action. These potential additional summer recreation activities were deemed not to be critical to the success of the ski area. They would not respond to the purpose and need for increased economic viability because summer activities, by nature, yield very low per capita profits.[21] The main reasons for not evaluating these two activities follow:

Paragliding

The primary launch site for paragliders could potentially impact critical botanical habitat in the Alpine areas. Additionally, flight paths would most certainly be over the Kachina Peaks Wilderness.

[21] Hiking access between the base area and the top of the Agassiz Chairlift was retained in the proposal because it essentially an extension of existing opportunities offered at the Snowbowl and because it would service a dual purpose of providing motorized (ATV) maintenance access which is currently lacking.

Mountain Biking

The Forest Service feels that there is currently ample mountain biking trails and opportunities in the greater Flagstaff area. Having lift-served mountain biking at the ski area is not critical to providing general mountain biking opportunities. In addition, the Forest Service believes that biking within the SUP could lead to the development of unsanctioned "social" trails exiting the SUP area and entering the surrounding Kachina Peaks Wilderness. Prohibiting mountain bike use within the adjacent Wilderness would be virtually impossible. Finally, Snowbowl has no existing mountain road system appropriate for bikes, especially the novice level cyclists which are typically attracted to lift-served programs. Single track trails and roads would need to be constructed (involving inherent ground disturbance); projects that the Forest Service did not believe were appropriate uses of the National Forest at this time.

ALTERNATIVE SNOWMAKING WATER PIPELINE ALIGNMENTS

Several potential routes for the proposed snowmaking water pipeline between the City of Flagstaff and the Snowbowl were evaluated. After a thorough review, it was determined that several suitable locations for connecting to Flagstaff's reclaimed water distribution system existed. Preliminary reclaimed water pipeline alternatives that were considered early in this proposal are described below and are depicted on Figure 2-10.

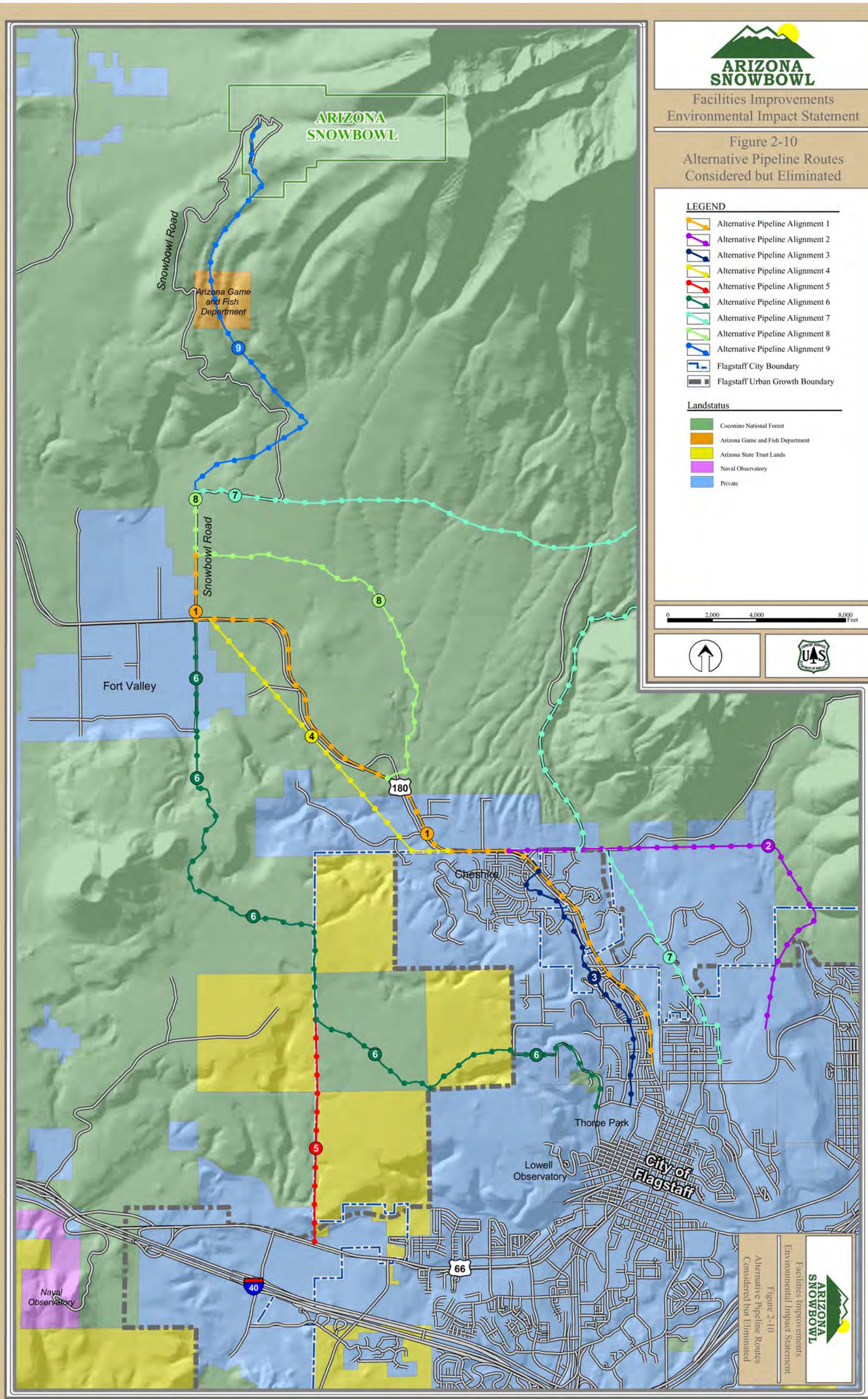
1. Forest Avenue and U.S. Highway 180 to Fort Valley
2. Buffalo Park north to Elden Lookout Road and Shultz Pass
3. Rio de Flag through Coconino Estates to Cheshire
4. Existing utility corridors for Arizona Public Service overhead power lines from Cheshire to Fort Valley
5. West Route 66 over A-1 Mountain in an existing utility corridor
6. Westridge Estates near Thorpe Park across State and Federal property
7. Cedar Hill to Elks Lodge to Shultz Pass Road to Transwestern Main Line
8. Highway 180 to FS Road 164b to Snowbowl Road
9. APS/Qwest overhead power line corridor from Hot Shot Ranch to Maintenance Shop

Each of the above mentioned routes were evaluated for financial feasibility, necessary entitlements, issues pertaining to co-locating with existing utilities, engineering constraints, overall distance, traffic mitigation, community inconvenience, private property impacts, and availability of electrical service.

The initial and most direct route would have connected the snowmaking water pipeline with Flagstaff's reclaimed water distribution network at the intersection of Forest Street and U.S. Highway 180. A buried pipeline would have then followed U.S. Highway 180 to the Snowbowl Road intersection. This would have provided for possible future reclaimed water use at Sechrist Elementary School, Museum of Northern Arizona Property, Cheshire Park, and could easily accommodate the installation of fire hydrants near several rural subdivisions to aid in fire suppression.

The feasibility of the U.S. Highway 180 route was further evaluated as part of the City of Flagstaff's proposed urban trail along U.S. Highway to Cheshire. ADOT engineers were asked to determine the feasibility of locating a 12-inch diameter pipeline under the highway, adjacent to the highway or underneath the proposed urban trail. The engineering evaluation determined that such a pipeline could not be placed within the Highway easement or within the corridor established for the urban trail. It was determined that the highway easement, the trail corridor, and the highway itself are already at maximum capacity in terms of existing utilities which are already in place within the corridor. Therefore, the design specifications and code requirements pertaining to reclaimed water pipelines could not have been met with the U.S. Highway 180 route to Cheshire.

The currently proposed pipeline route was identified after discussions with Transwestern Pipeline Company, the Forest Service, Arizona State Land Department, and Lowell Observatory. Lowell Observatory is very interested in providing fire hydrants on observatory property west of their campus and also in replacing a private and antiquated potable water delivery system to the campus from Flagstaff. As a part of the Proposed Action, the Forest Service has agreed to consider the reclaimed water pipeline to be co-located within the Transwestern Lateral Natural Gas Pipeline easement from west of the observatory all the way to the intersection of U.S. Highway 180 and Snowbowl Road. The remainder of the proposed pipeline route is located on observatory private property or existing Forest Service roads or utility easements. The proposed route was also selected due to minimize impacts and inconveniences to traffic and private property during construction of the pipeline. Under the proposed pipeline route, Sechrist School and Cheshire Park would not have the ability to obtain reclaimed water from a new and nearby pipeline.


ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 2-10
Alternative Pipeline Routes
Considered but Eliminated
LEGEND
Alternative Pipeline Alignment 1
Alternative Pipeline Alignment 2
Alternative Pipeline Alignment 3
Alternative Pipeline Alignment 4
Alternative Pipeline Alignment 5
Alternative Pipeline Alignment 6
Alternative Pipeline Alignment 7
Alternative Pipeline Alignment 8
Alternative Pipeline Alignment 9
Flagstaff City Boundary
Flagstaff Urban Growth Boundary
Landstatus
Coconino National Forest
Arizona Game and Fish Department
Arizona State Trust Lands
Naval Observatory
Private
0 2,000 4,000 8,000 Feet
Snowbowl Road
Arizona Game and Fish Department
Fort Valley
180
Cheshire
Thorpe Park
Lowell Observatory
City of Flagstaff
66
40
Naval Observatory

COMPARISON OF ALTERNATIVES

Table 2-3 compares each alternative as based on response to issues.

Table 2-3
Response to Issues

Issue	Alternative 1 *No Action*	Alternative 2 *Proposed Action*	Alternative 3 *No Snowmaking*
Heritage #1 - Snowmaking (creating snow by artificial means, use of reclaimed water)	**Yes:** No snowmaking is proposed	**No:** Approximately 205 acres of snowmaking coverage are proposed	**Yes:** No snowmaking is proposed
Heritage #2 – Scarring (Ground disturbance associated with grading, vegetation clearing and snowmaking pipeline installation)	**Yes:** No additional ground disturbance is proposed	**No:** Includes ~245 acres of temporary/permanent ground disturbance and approximately 76 acres of overstory vegetation removal.	**Yes:** Reduces temporary/permanent ground disturbance and overstory vegetation removal compared to the Proposed Action.

Table 2-4 provides a comparison of project elements associated with each alternative.

Table 2-4
Alternatives Matrix

	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3
GUEST CAPACITIES			
On-Mountain Comfortable Carrying Capacity (skiers)	1,880	2,825	2,825
Uphill Capacity (skiers)	1,880	2,825	2,825
Snowtubing Facility (tubers)	N/A	600	N/A
ON-SITE PARKING			
Existing Parking Area (acres)	10.3	10.3	10.3
Proposed Parking Area (acres)			
Improved On-Mountain Parking	N/A	0.3	0.3
Snowtubing Parking	N/A	3.3	N/A
Total Parking Area (acres)	*10.3*	*13.9*	*10.6*
Parking Capacities (Vehicles):			
On-Mountain	1,200	1,235	1,235
Snowtubing	N/A	400	N/A
Parking Capacities (Guests):			
Guests – On-Mountain	3,000	3,087	3,087
Guests – Snowplay	N/A	600	N/A
TERRAIN			
SUP Area	777 acres	777 acres	777 acres
Developed On-Mountain Terrain (acres):			
Existing	138.6	138.6[a]	138.6
Proposed	N/A	65.6	64.0

	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3
Total	*138.6*	*204.2*	*202.6*
Improved Glades (acres)	N/A	47.4	47.4
Terrain Distribution (percent):			
Beginner	1	3	3
Novice	44	35	35
Low Intermediate	25	22	22
Intermediate	22	23	23
Advanced Intermediate	6	13	13
Expert	2	4	4
LIFT NETWORK			
Aerial Chairlifts:			
Sunset Realignment	N/A	Yes	Yes
Agassiz	No Change	No Change	No Change
Hart Prairie Realignment	N/A	Yes	Yes
Aspen Realignment	N/A	Yes	N/A
Proposed Humphreys	N/A	Yes	Yes
Total Aerial Chairlifts	*4*	*5*	*5*
Surface Lifts			
Spruce	No Change	No Change	No Change
Hart Prairie Beginner Chairlifts	N/A	3	3
Halfpipe	N/A	1	1
Snowtubing	N/A	4	N/A
Total Surface Lifts	*1*	*9*	*5*
Total Lifts in Network	***5***	***14***	***10***
SNOWMAKING			
Coverage Area (acres)	**N/A**	**205.2[b]**	**N/A**
GUEST SERVICES			
Guest Service Space (square feet):			
Agassiz Lodge	5,080	15,080	15,080
Hart Prairie Lodge	18,425	24,425	24,425
Snowtubing Facility	N/A	5,000	N/A
Native American Cultural & Education Center	N/A	2,500	2,500
Total Guest Services Square Footage	*23,505*	*47,005*	*42,005*
GROUND DISTURBANCE			
Permanent (acres):			
Buildings	N/A	0.8	0.5
Lift Terminals	N/A	0.2	0.2
Snowmaking Valve Houses	N/A	0.02	N/A
Snowmaking Water Impoundment	N/A	2.4	N/A
Snowmaking Catchment Pond	N/A	0.1	N/A
Hiking/Maintenance Access Trail	N/A	0.6	0.6
Parking Lots	N/A	3.6	0.3
Snowplay Access	N/A	0.3	N/A
Pedestrian Underpass	N/A	0.1	0.1
Road Reconstruction	N/A	1.7	N/A
New Road Construction	N/A	0.6	N/A
Total Permanent Ground Disturbance	*N/A*	*10.4*	*1.7*

	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3
Temporary (acres):			
Buildings	N/A	2.3	1.7
Lift Terminals	N/A	2.0	2.4
Grading			
Trails	N/A	87.3	111.6
Pedestrian Underpass	N/A	0.1	0.1
Snowmaking Water Impoundment	N/A	1.0	N/A
Parking	N/A	2.0	N/A
Grading Sub-Total	N/A	90.4	111.7
Vegetation Clearing	N/A	4.8	4.8
Utility and/or Snowmaking Pipelines	N/A	72.0	9.7
Snowmaking Pipeline Corridor	N/A	64.3	N/A
Total Temporary Ground Disturbance	*N/A*	*235.7*	*130.3*
Total Temporary & Permanent Ground Disturbance (acres)	***N/A***	***245.4***	***131.4***
OVERSTORY VEGETATION DISTURBANCE (ACRES)			
Developed Trails	N/A	64.3	58.6
Buildings	N/A	1.1	0.7
Lift Terminals	N/A	1.2	1.2
Snowmaking Water Impoundment	N/A	1.8	N/A
Pedestrian Underpass	N/A	0.04	0.04
Snowplay Walkway	N/A	0.3	N/A
Lift Corridors	N/A	3.6	3.6
Road Reconstruction	N/A	0.8	N/A
New Road Construction	N/A	0.4	N/A
Parking Lot Construction/Improvements	N/A	2.1	0.3
Snowmaking Water Transmission Line	N/A	See footnote[c]	N/A
Total Permanent Overstory Vegetation Removal	*N/A*	*76.3*	*64.4*
ROAD IMPROVEMENTS AND RECLAMATION			
Road Construction	N/A	1,110 feet	N/A
Road Reconstruction	N/A	3,650 feet	N/A
Road Obliteration	N/A	3,050 feet	N/A

[a] In the Proposed Action, the snowtubing facility would occupy approximately 7.8 acres of existing skiable terrain in Hart Prairie.
[b] In the Proposed Action, snowmaking coverage differs from total developed on-mountain terrain for two reasons: 1) the snowtubing area is excluded from the developed terrain acreage but is dependent on snowmaking, and 2) one existing trail (#18) is excluded from snowmaking coverage.
[c] Incidental removal of overstory vegetation would occur along the extent of the 14.8-mile snowmaking water transmission line corridor, making an acreage estimate impractical. Therefore, a tree count was performed, indicating that 167 trees (pines and aspens of different sizes) would be removed for construction of the transmission line.

Table 2-5 provides a *brief* summary of the direct and indirect environmental consequences associated with implementation of each alternative, as further detailed in Chapter 3 – Affected Environment and Environmental Consequences. Table 2-5 is broken down according to resource area, issue statement and indicator. In some cases, the effects of different alternatives are combined in order to avoid redundancy.

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
HERITAGE AND CULTURAL RESOURCES		
Issue #1: ***The installation and operation of snowmaking infrastructure as described in the Proposed Action***		
▪ *Indicator - Qualitative discussion of the cultural values of the San Francisco Peaks and the potential for incremental change as a result of implementation of the Proposed Action*		
N/A	Snowmaking would adversely impact the belief in the natural process of precipitation. From an ethnographic landscape perspective, the use of reclaimed water and resulting increased moisture associated with snowmaking within the SUP area may further impact the spiritual character of the entire Peaks beyond historic and existing ground disturbance. This could impact the tribes' ability to properly complete rituals.	N/A
Issue #2: ***Proposed ground disturbances and vegetation removal may result in permanently evident alterations of the San Francisco Peaks landscape***		
▪ *Indicator - Narrative description of existing and historic vegetation and ground disturbance within the SUP area*		
While numerous changes to lands within the boundary of the Snowbowl SUP have occurred, comments to Forest Service personnel over the years indicate that the Peaks retain an integrity related to the traditional religious, cultural, natural, and social values which make the Peaks important to the tribal people of the region.		
▪ *Indicator - Quantification of existing and additional proposed temporarily and permanently evident vegetation and ground disturbances*		
Since approximately 1938, approximately 100 acres of overstory vegetation have been cleared throughout the Snowbowl SUP area, along with additional ground disturbance for terrain and related infrastructure.	▪ 76.3 acres of overstory vegetation removal ▪ 10.4 acres of permanent ground disturbance ▪ 235.7 acres of temporary ground disturbance	▪ 64.4 acres of overstory vegetation removal ▪ 1.7 acres of permanent ground disturbance ▪ 130.3 acres of temporary ground disturbance
▪ *Indicator - Qualitative discussion of the cultural significance of proposed ground and vegetative disturbances within the SUP area*		
N/A	The Peaks are viewed as a living entity, where any additional ground disturbances would be harmful.	

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
▪ *Indicator - Narrative discussion why the Proposed Action is not dependent upon completion of the National Register nomination/designation processes*		
The National Register Nomination process is underway and will be completed regardless of which alternative is approved.		
▪ *Indicator - Narrative discussion of the ability for the proposed projects to coexist with a National Register designation if nomination is approved*		
The cultural values that pertain to the Peaks would be retained under any alternative.		
Some people feel the effects of the Proposed Action cannot be adequately described until the significant qualities of the San Francisco Peaks are identified as part of the National Register nomination process.		
▪ *Indicator - Narrative discussion why the Proposed Action is not dependent upon completion of the National Register nomination/designation processes* ▪ *Indicator - Narrative discussion of the ability for the proposed projects to coexist with a National Register designation if nomination is approved*		
The San Francisco Peaks is a TCP as defined in National Register Bulletin 38: *Guidelines for Evaluating and Documenting Traditional Cultural Properties.* The Peaks have also been determined eligible for inclusion in the National Register of Historic Places as part of the White Vulcan Mine Settlement Agreement and Mine Closure in August 2000. Completion of a National Register nomination is underway by the Forest Service and will occur regardless of whether the Proposed Action is approved.		
NOISE		
The proposed snowmaking system would increase noise levels potentially disturbing resident, recreationists, and/or wildlife.		
▪ *Indicator - Modeled analysis of snowmaking-related noise emissions above ambient background levels (dBA)*		
▪ Existing ambient levels 30-43 dBA ▪ Existing short duration levels 43-85 dBA	▪ Heavy Equipment: 72-93 dBA at 50 feet ▪ Rock Drills: 81-98 dBA at 50 feet ▪ Fan Gun: 62 dBA at 200 feet ▪ Tower Gun: 73 dBA at 200 feet ▪ Booster Stations: Not audible beyond 100 feet ▪ Snowmaking Control Building: Not audible >100 feet	▪ Heavy Equipment: 72-93 dBA at 50 feet ▪ Rock Drills: 81-98 dBA at 50 feet
▪ *Indicator – Modeled analysis of noise dispersion to define audible areas*		

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
N/A	Hart Prairie/The Nature Conservancy could be disrupted by nighttime snowmaking and rock drills during construction period; snowmaking noise would not be audible from within homes of buildings. From the Fort Valley area operation of the snowmaking system would not be audible; temporary audible noise during construction of water transmission line from Flagstaff to the Snowbowl.	Hart Prairie/The Nature Conservancy could temporarily be disrupted by construction-related activities.
TRAFFIC AND RESORT ACCESS		
The Proposed Action could affect traffic volumes and/or congestion on U.S. Highway 180 and/or the Snowbowl Road.		
▪ *Indicator - Historic and projected traffic counts for U. S. Highway 180* ▪ *Indicator - Comparison of anticipated winter traffic volumes with existing winter traffic volumes and the design capacities of U.S. Highway 180 and the Snowbowl Road* ▪ *Indicator - Relative comparison of existing and anticipated winter traffic with current summer traffic volumes*		
See Chapter 3, Section C for historic average annual daily traffic (AADT) on U.S. Highway 180. ▪ Winter: average ~350 vehicles/day on U.S. Highway 180 attributable to Snowbowl's operations between December and March ▪ Summer: average ~95 vehicles/day on U.S. Highway 180 attributable to Snowbowl's operations between Memorial and Labor day ▪ No additions to capacities of Snowbowl Road or U.S. Highway 180 would be necessary	See Chapter 3, Section C for historic AADT on U.S. Highway 180. ▪ Winter: average ~500 vehicles/day on U.S. Highway 180 attributable to Snowbowl's operations between December and March ▪ Summer: average ~95 vehicles/day on U.S. Highway 180 attributable to Snowbowl's operations between Memorial Day and Labor Day ▪ No additions to capacities of Snowbowl Road or U.S. Highway 180 would be necessary	See Chapter 3, Section C for historic AADT on U.S. Highway 180. ▪ Winter: average ~365 vehicles/day on U.S. Highway 180 attributable to Snowbowl's operations between December and March ▪ Summer: average ~95 vehicles/day on U.S. Highway 180 attributable to Snowbowl's operations between Memorial and Labor ▪ No additions to capacities of Snowbowl Road or U.S. Highway 180 would be necessary

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
AESTHETIC RESOURCES		
Proposed ground disturbance and vegetation removal within the SUP may incrementally affect the aesthetic quality of the west face of the San Francisco Peaks.		
▪ *Indicator - The incremental aesthetic effects of the proposed projects compared to historic landscape alterations within the SUP area*		
No changes to Snowbowl's SUP area would occur under the No Action Alternative and its facilities would continue to comply with Forest Plan VQOs of Modification and Maximum Modification.	Some ground disturbing activities under the Proposed Action are considered temporary in nature, since these areas would be promptly revegetated. Direct, permanent aesthetic impacts are associated with components of the Proposed Action that, whether occurring in new or previously disturbed areas, would represent long-term visible elements of the ski area's presence within the SUP area when perceived in either the foreground, middleground or background views. Proposed landscape alterations can be implemented while maintaining full consistency with the VQOs of Modification and Maximum Modification.	While Alternative 3 eliminates temporary ground disturbance associated with snowmaking line installation, it includes essentially all of the lift and trail additions contained in the Proposed Action. However, Alternative 3 increases temporary ground disturbance associated with trail grading – necessary to provide for increased skiability under reduced natural snow conditions. Overall, the aesthetic impacts are slightly reduced between alternatives 2 and 3. However, for the purposes of this analysis, they can be considered virtually identical, especially when perceived in the middleground and background distance zones.
▪ *Indicator - Visual simulations from identified representative viewpoints of the proposed landscape alterations as compared to the existing condition.*		
Refer to Chapter 3, Section D which depicts a series of photo simulations.		
SOCIAL AND ECONOMIC RESOURCES		
Implementation of the Proposed Action may have social and economic effects on Flagstaff and Coconino County.		
▪ *Indicator – Discussion of the potential for the Proposed Action to affect a change in key local economic indicators*		
Refer to Table 3E-13 within Chapter 3	Refer to Table 3E-13 within Chapter 3	Refer to Table 3E-13 within Chapter 3
▪ *Indicator – Analysis of the correlation between Snowbowl annual skier visitation and annual retail and Bed, Board, and Booze (BBB) and tax revenues*		
Calculations indicate that Snowbowl visitors make a positive contribution to BBB tax collections. However, because this is an economy of significant size, BBB tax generated by Snowbowl visitors constitutes a small portion of total tax collections.		

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
▪ *Indicator – Narrative description of the recreational/social function which Snowbowl serves*		
The continuation of the current operation as a for-profit business may not be sustainable; the ski area would likely decrease expenditures on maintenance and non-essential services leading to an overall reduction in the quality of the services offered under Alternative 1. In this event, much of the social and economic functions served by Snowbowl may be reduced or lost. The quality of the most significant Alpine recreation venue within the Flagstaff area would be diminished.	The recreational and social functions of the Snowbowl would be enhanced under Alternative 2, as described in chapters 2 and 3.	Same as for Alternative 1.
▪ *Indicator – The effects of dry roads/fair weather on tourism in Flagstaff and the BBB*		
The relationship between annual snowfall and Flagstaff's annual tourism volume is shown in Figure 3E-5 in Chapter 3. There is no obvious relationship between snowfall and Flagstaff tourism. The analysis suggests that, over the years, dry roads/fair weather bears little relationship to Flagstaff tourism volume and thus the BBB tax.		
▪ *Indicator – Presentation of historical data analyzing the relationship between winter tourism levels for the City of Flagstaff, with annual snowfall, and annual skier visitation*		
The relationship between average monthly precipitation and average variation in Flagstaff's monthly tourism volume is shown in Figure 3E-6 in Chapter 3. There is no obvious relationship between the two variables. While declining precipitation appears to relate to increasing tourism in May and June, tourism is at its highest level in the month with the highest average precipitation (July).		
▪ *Indicator – The percentage of the total economy represented by winter tourism*		
Tourism in total is estimated to account for approximately 24.5 percent of the Flagstaff economy; winter tourism can be estimated to account for approximately 8.6 percent of the City's economy.		
▪ *Indicator – Financial viability of the ski area under all alternatives*		
Alternative 1 would result in no significant change in the Snowbowl's viability as a for-profit business. While average annual skier visits are projected to increase by 12.7 percent over the current level, season-to-season totals would continue to fluctuate dramatically. As such, it is	While the investment required to achieve Alternative 2 is substantial and would result in a higher break-even point (more skier visits required to achieve profitable operations), year-to-year variations in business levels would be minimalized and would result in positive net	A prudent business operator would likely not make the majority of the investments in Alternative 3, as the break-even point for profitable operations would increase while skier visit totals would continue to fluctuate dramatically. The overall viability of the ski area would decline

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
reasonable to project that under Alternative 1, the ski area would continue to experience negative net income in 30 to 40 percent of its operating seasons. Thus, the viability of the ski area would remain tenuous.	income in a higher percentage of seasons than under current operating conditions. The ski area would be in a significantly better financial position from which to maintain the physical facilities and maintain quality levels. The viability of the Arizona Snowbowl as a for-profit business would be enhanced under this alternative.	significantly if the Alternative were to be fully implemented.
RECREATION		
The effects of the Proposed Action on the quality, distribution, and opportunity for winter and summer recreational experiences within the SUP area.		
▪ *Indicator - Comparison of historic annual winter and summer recreational visitation versus those anticipated under various alternatives*		
Annual winter visitation could be expected to fluctuate from roughly 98,000 (historic) to 110,000 between year 0 and year 11. The summer Ski Ride program would be expected to continue to draw approximately 30,000 visitors each year.	Annual winter visitation levels could be expected to increase from roughly 98,000 in year 0 to around 215,000 by year 11. Overall summer visitation would not be expected to increase substantially, and would likely continue to be approximately 30,000 visitors annually.	Under Alternative 3, winter attendance is anticipated to increase slightly above the No Action Alternative, but below that of the Proposed Action. Alternative 3 could be expected to produce annual skier visitation levels between 98,000 and 118,000 between year 0 and year 11. Overall summer visitation would not be expected to increase substantially, and would likely continue to be approximately 30,000 visitors annually.
▪ *Indicator - Narrative description of the quality of winter and summer recreational opportunities under all alternatives.*		
In lieu of updating guest service facilities at Snowbowl, selection of the No Action Alternative would translate to a continuation of crowded, and sometimes undesirable, guest experiences in many areas, such as in the lodges and on the chairlifts.	The only aerial lift at Snowbowl that would remain unchanged is Agassiz. Snowbowl's developed terrain network would increase from approximately 139 acres to approximately 204 acres (a 47 percent increase). Snowmaking technology would provide consistent snowpack from season-to-season that would help redefine the Snowbowl as a reliable winter sports facility in Northern Arizona's recreational setting. Terrain/infrastructural upgrades and increased CCC under	Alternative 3 does not include the primary elements associated with the Proposed Action which would most affect the overall recreational experience (snowmaking and snowtubing). Therefore, the overall recreation experience at Snowbowl would be less desirable than the Proposed Action, particularly on busy days, and would continue to deteriorate as skiers and snowboarders seek more favorable, out-of-state opportunities. The ski area's reputation in Northern Arizona's recreational environment

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	the Proposed Action would improve the Snowbowl's ability to accommodate the existing levels of visitation. Skier densities would remain within the industry norm while lift line waiting periods would decrease. The proposed hiking trail from Agassiz Lodge to the top of the Agassiz Chairlift would add a new element to Snowbowl's summertime recreational offerings.	would continue to be defined by climatic conditions with a continued dependency on natural precipitation. While difficult to measure, skier export to neighboring states would be expected to continue, as warranted by snowfall and climatic trends.
Implementation of the Proposed Action may affect the experience of wilderness users within the surrounding Kachina Peaks Wilderness.		
▪ *Indicator - Quantification of seasonal Wilderness use and visitation* ▪ *Indicator - Narrative discussion of the anticipated effects to Wilderness users*		
Annual use of the Wilderness would be expected to follow historic trends, as provided in Table 3F-6 in Chapter 3. Access, use and enjoyment of the Wilderness would not change.	Similar to the No Action Alternative, neither of the Action Alternatives would directly or indirectly impact summer or winter access, use or enjoyment of the adjacent Kachina Peaks Wilderness. All projects likely to occur under either of the Action Alternatives would be confined to the established Snowbowl SUP area, and no additional access to, or use of, the Wilderness area is anticipated.	
INFRASTRUCTURE AND UTILITIES		
Effects of the Proposed Action on ski area infrastructure and supporting utilities within and beyond the SUP area.		
▪ *Indicator – Disclosure of current versus anticipated requirements for guest seating, power, domestic water supply and wastewater treatment, and parking capacity*		
CCC would remain at 1,880. Facilities and infrastructure would continue to be work well for this CCC, but would become overtaxed when exceeded.	CCC would increase to 2,825. Guest service facilities and related infrastructure have been sized to accommodate 125 percent of CCC.	CCC would increase to 2,825. As with the Proposed Action, Alternative 3 would size guest service facilities and related infrastructure to accommodate approximately 125 percent of CCC.
Snowbowl would continue to transport all of its domestic water from Flagstaff - there would be no additional storage capacity and demand would be anticipated to remain the same.	The Snowbowl would continue to transport 100 percent of its potable water via truck from Flagstaff. However, with construction of the reclaimed water pipeline, it would no longer be necessary for the Snowbowl to use potable water for non-potable services.	Without the reclaimed water pipeline to supply non-potable water, Snowbowl would continue to use approximately 60 percent of the potable water it trucks to the ski area to accommodate its non-potable water needs.

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Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
Because the existing electrical service is adequate to meet Snowbowl's current needs, upgrades to power supply and distribution are not necessary.	With the addition of snowmaking infrastructure, new/upgraded lifts and other projects, Snowbowl's existing power supply is inadequate and would need to be upgraded.	Because Alternative 3 excludes snowmaking, Snowbowl's existing power supply is adequate be meet anticipated needs
No additional communication lines would be installed.	The main telephone line servicing Snowbowl would need to be upgraded.	Alternative 3 would not necessitate any changes to the existing communications network at Snowbowl.
Guest seating and restrooms would continue to be inadequate on even moderately busy days.	Proposed improvements to the Hart Prairie and Agassiz day lodges would help achieve a better balance between guest services and attendance levels.	Alternative 3 improvements to guest services would be identical to the Proposed Action.
WATERSHED RESOURCES		
The application of Class A reclaimed water for snowmaking within the SUP area may affect water quality within the receiving subwatersheds.		
▪ *Indicator - Description of the certification process for allowing Class A water to be used for snowmaking* ▪ *Indicator - Discussion of the applicability of the Rio de Flag Water Reclamation Plant NPDES permit to the proposed snowmaking application*		
ADEQ developed the Reclaimed Water Permit Program to define conditions and requirements for reuse of treated municipal wastewater. The program specifies reclaimed water standards and defines five classes of reclaimed water. Class A reclaimed water is the highest quality and is required for reuse applications where there is a relatively high risk of human exposure to treated effluent. The State of Arizona specifically allows Class A and A+ reclaimed water for direct reuse in snowmaking.		
▪ *Indicator - Literature search on use of reclaimed water for various recreational and municipal purposes*		
Reuse of municipal wastewater has become increasingly important during the past several decades due to the growth in urban population, constraints on the development of new water sources, and more stringent treatment requirements to protect the quality of the receiving water for aquatic life. Reuse is practiced extensively in the United States and around the world.		
▪ *Indicator - Literature search and narrative description of the potential presence of pharmaceuticals, pathogens, and hormones in Class A reclaimed water*		
Municipal wastewater contains a variety of PPCPs that are pharmaceutically active and known to act on the endocrine system at therapeutic doses. Although the occurrence of antibiotics and steroids has generated nearly all the controversy to date, many other classes of drugs, bioactive metabolites and transformation products, and personal care products have yet to be examined. Chemicals found in both non-prescription and prescription medications have been detected in municipal wastewaters and may act as endocrine disruptors. In addition to prescribed human drugs, other PPCPs of potential concern include veterinary and illicit drugs and such common substances as caffeine, cosmetics, food supplements,		

Table 2-5
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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
sunscreen agents, solvents, insecticides, plasticizers, and detergent compounds. The analysis notes that humans are thought to be susceptible to endocrine disrupting compounds only at high exposure levels.		
▪ *Indicator - Documentation of compliance with State and Federal water quality standards regarding Class A wastewater and its uses*		
The Rio de Flag Water Reclamation Plant (WRP) is authorized to discharge treated wastewater to the Rio de Flag under National Pollutant Discharge Elimination System (NPDES) Permit that was issued in November 1999. The permit requires that water quality of the reclaimed water meet State Surface Water Quality Standards for discharge to the Rio de Flag. ADEQ has assigned designated uses of partial-body contact (PBC) and aquatic and wildlife for effluent-dependent water to the receiving waters of the Rio de Flag WRP. EPA and ADEQ conduct annual inspections of the Rio de Flag WRP to assure the facility is operated and maintained in compliance with Federal and State regulations. NPDES inspection reports obtained for the past four years indicate that no deficiencies were found in the operation and maintenance of the Rio de Flag WRP.		
▪ *Indicator - Analysis of potential water quality effects of using reclaimed water in the snowmaking system to down gradient users*		
N/A	Additional groundwater recharge associated with use of reclaimed water for snowmaking would increase the concentration of solutes in groundwater. Groundwater recharge that occurs in areas of proposed snowmaking would contain larger concentrations of TDS, TOC, total nitrogen, and other dissolved constituents from the reclaimed water than groundwater recharge from natural precipitation. However, the solute concentrations would be decreased substantially from concentrations in the reclaimed water by commingling and blending with natural precipitation. <u>Snowbowl Sub-Area</u>: The net effect of changes in groundwater recharge from alternating dry, average, and wet climatic conditions would be to dilute and attenuate the flux of solute concentrations reaching the underlying perched aquifer system. <u>Agassiz Sub-Watershed</u>: Although concentrations of TDS, TOC, and total nitrogen concentrations are larger than	N/A

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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
	comparable concentrations assumed for water available for groundwater recharge from natural precipitation, the concentrations of TDS and TOC are decreased by more than an order of magnitude from concentrations in the reclaimed water. Hart Prairie Watershed: Due to the distant location of the four small springs downgradient from the Agassiz sub-watershed and limited overall change in solute concentrations, the anticipated indirect effects to water quality at springs in Hart Prairie from Alternative 2 are considered to be negligible.	
Use of reclaimed water for snowmaking purposes between November and February of each year could affect aquifer recharge.		
▪ *Indicator - Quantification of anticipated snowmaking water use in average dry, median, and wet years*		
N/A	Agassiz Sub-Watershed ▪ Dry Year: 40 AF/yr ▪ Average Year: 30 AF/yr ▪ Wet Year: 20 AF/yr Hart Prairie Watershed ▪ Dry Year: 446 AF/yr ▪ Average Year: 334 AF/yr ▪ Wet Year: 223 AF/yr	N/A
▪ *Indicator - Description and quantification of the Rio de Flag WRP's historic seasonal discharges*		
The Rio de Flag WRP was built to provide four millions gallons per day (MGD) of wastewater treatment capacity, with the potential for expansion to six MGD. The Rio de Flag WCP has treated wastewater at an average rate of 681 million gallons per year (1.87 MGD) during the past four years. The most recent data from 2002 indicate that approximately 25 percent of the wastewater treated at the WRP was beneficially reused in the Reclaimed Water System and 75 percent was discharged as Grade A+ treated effluent to the Rio de Flag channel.		

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Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
▪ *Indicator - Description and quantification of current uses of reclaimed water within the City of Flagstaff by season*		
The Rio de Flag WRP currently provides reclaimed water for turf irrigation to the Catholic Cemetery; Northern Arizona University; Pine Canyon Golf Course; Flagstaff Medical Center; the Flagstaff public school system; and the city's public parks, facilities, and cemetery. Reclaimed water from the Wildcat Hill WWTP is used for irrigation at golf courses, public parks, the Christmas tree farm, and for dust control at various locations in east Flagstaff.		
▪ *Indicator - Discussion of existing water rights and the ability to implement the proposed snowmaking with or without procuring additional water rights*		
The right to the use of reclaimed water in Arizona was established by the 1989 decision of the Arizona Supreme Court in the case of *Arizona Public Service v. Long*.		
▪ *Indicator - Narrative description of both the City of Flagstaff's well field and reclaimed water uses and their hydrologic relationship to the regional aquifer*		
N/A	As noted in Table 3H-4, proposed snowmaking would result in an estimated net average reduction in groundwater recharge to the regional aquifer of 178 AF per year. This calculated reduction represents slightly more than two percent of the City of Flagstaff's total annual water production (as averaged over the 10 year period from 1992 to 2001). This amount is negligible compared to the annual groundwater recharge rate of approximately 290,000 AF to the regional aquifer estimated for the Lake Mary well field.	N/A
▪ *Indicator - Quantification of annual consumptive watershed losses resulting from snowmaking*		
N/A	<u>Snowbowl Sub-area</u> ▪ Dry Year: 1,464 AF/yr ▪ Average Year: 1,692.9 AF/yr ▪ Wet Year: 1,681.7 AF/yr <u>Agassiz Sub-Watershed</u> ▪ Dry Year: 830.2 AF/yr ▪ Average Year: 1,276.7 AF/yr ▪ Wet Year: 1,350.9 AF/yr	N/A

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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
	Hart Prairie Watershed ▪ Dry Year: 4,532.1 AF/yr ▪ Average Year: 6,442.6 AF/yr ▪ Wet Year: 6,569.2 AF/yr	
SOILS AND GEOLOGY		
The Proposed Action has potential to change soil chemistry and moisture due to the application of machine produced snow.		
▪ *Indicator - Anticipated volume of machine-produced snow applied under various scenarios: dry year, average year, wet year (refer to Table 3I-10 for watershed breakdown)*		
N/A	▪ Wet Year: 243 AF/yr ▪ Dry Year: 486.0 AF/yr ▪ Average Year: 364 AF/yr	N/A
▪ *Indicator - Modeled anticipated changes in the duration and intensity of annual snowmelt compared to historic natural variation*		
N/A	The application of snowmaking alters the volume and timing of snowmelt; machine-produced snow typically begins to melt later in the season than natural snow. This can increase the average duration of seasonal melt. Trail clearing affects the water balance by decreasing the amount of water removed via evapotranspiration, thus increasing the quantity of water available for infiltration or runoff. Interception and evaporation losses from the forest canopy would be reduced. Vegetation removal would affect the infiltration characteristics of the watershed, generally resulting in quicker runoff generation. Changes in vegetative cover also can affect the solar energy balance of the watershed, permitting increased solar radiation and therefore earlier and faster snowmelt. Together these changes would alter water balance characteristics and snowmelt timing.	N/A

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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
	Average Year: Introduction of additional water equivalent in the form of machine-produced snow, coupled with changes in land use due to trail construction activities, would result in a six percent increase in watershed recharge in an average year. Dry Year: Overall, an eight percent increase in annual recharge would be anticipated during dry-year conditions. Wet Year: In a wet year, snowmaking represents a very small percentage of the overall water balance. For the Snowbowl watershed, receiving most of the snowmaking input, the change in recharge compared to existing conditions is two percent.	
▪ *Indicator - Modeled anticipated changes in erosion/sedimentation due to predicted changes in total snowpack*		
N/A	While the sediment detachment quantities predicted by the WEPP model are measures of potential detachment, and not actual sediment yield or delivery, the anticipated increase in post-implementation detachment is approximately 483 tons. After re-vegetation, with de-commissioning of a portion of the existing mountain access road reducing detachment by approximately 14 tons per year, the total increase in detachment is anticipated to be almost 180 tons. This increase is driven primarily by 43.3 acres of the 131 acres of total disturbance that are proposed to occur on slopes of 30 percent slope gradient or higher.	The anticipated increase in detachment immediately following project implementation is approximately 466 tons, and is four percent lower than the Proposed Action The detachment rates are driven primarily by 42 acres of the 119 acres of total grading that are proposed to occur on slopes of 30 percent slope gradient or higher.

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
▪ *Indicator - Analysis of potential changes to soil chemistry due to anticipated increases in soil moisture and nutrient loading*		
N/A	Overall, percolating treated wastewater through the soil profile would be unlikely to have a negative impact on either the soils or treated water.	N/A
VEGETATION		
Plant communities (including T, E and S plant species, and regionally important plants) within the SUP area may be altered as a result of the proposed projects		
▪ *Indicator - Acres of mixed conifer forest on the San Francisco Peaks, within the SUP, and potentially effected by the Proposed Action*		
There would be no overstory tree removal in the analysis area; therefore, the total acreage of mixed conifer and Spruce-fir forest on the San Francisco Peaks would not change.	76.3 acres of permanent overstory vegetation removal within Spruce-fir forest in the SUP area; and treatment of 47.4 acres of Spruce-fir forest within the Agassiz and Sunset pods, consisting of 20% tree removal, are proposed.	64.4 acres of permanent overstory vegetation removal within Spruce-fir forest in the SUP area; and treatment of 47.4 acres of Spruce-fir forest within the Agassiz and Sunset pods, are proposed.
▪ *Indicator - Potential impacts to montane grasslands within the SUP as a proportion of total grasslands on the San Francisco Peaks*		
There would be no change in acreage of montane grassland either within the SUP area or on the San Francisco Peaks.	2.7 acres of permanent loss, and 18.2 acres of temporary disturbance, to montane grassland in the SUP area are proposed.	0.1 acre of permanent loss, and 17.7 acres of temporary disturbance, to montane grassland in the SUP area are proposed.
▪ *Indicator - Disclosure of effects to potentially occurring T, E, and/or S plant species or potential habitat*		
There would be no effect on the endangered San Francisco Peaks groundsel or its habitat, including designated critical habitat in the upper portion of the SUP.	This alternative would result in disturbance within mapped critical habitat for the threatened San Francisco Peaks groundsel, but would not affect actual habitat or plants.	This alternative would result in disturbance within mapped critical habitat for the threatened San Francisco Peaks groundsel, but would not affect actual habitat or plants.
The Proposed Action has potential to change vegetation composition within the SUP area due to the application of machine-produced snow.		
▪ *Indicator - Description of likely snowmaking scenarios for dry, wet and average snow years*		
N/A	See issue Soils and Geology, above.	N/A

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
▪ *Indicator - Analysis of potential changes to botanical composition due to anticipated increases in soil moisture consistency and/or delayed snowpack desiccation*		
Vegetation communities in the analysis area would receive only natural precipitation.	Additional water and nitrogen from snowmaking would increase plant growth and may change plant species composition on existing and newly developed ski trails.	Vegetation communities in the analysis area would receive only natural precipitation.
▪ *Indicator - Description of the certification process for allowing Class A water to be used for snowmaking*		
The State of Arizona allows Class A and A+ reclaimed water for direct reuse in snowmaking. ADEQ developed the Reclaimed Water Permit Program to define conditions and requirements for reuse of treated municipal wastewater. The program specifies reclaimed water standards and defines five classes of reclaimed water. Class A reclaimed water is the highest quality and is required for reuse applications where there is a relatively high risk of human exposure to treated effluent.		
▪ *Indicator - Literature search on use of reclaimed water for various recreational and municipal purposes uses*		
Reuse of municipal wastewater has become increasingly important during the past several decades due to the growth in urban population, constraints on the development of new water sources, and more stringent treatment requirements to protect the quality of the receiving water for aquatic life. Reuse is practiced extensively in the United States and around the world.		
▪ *Indicator - Documentation of compliance with State and Federal water quality standards regarding Class A wastewater and its uses*		
The Rio de Flag WRP is authorized to discharge treated wastewater to the Rio de Flag under NPDES Permit (currently referred to as an AZPDES Permit since the program has been delegated to State authority) that was issued in November 1999. The AZPDES Permit requires that water quality of the reclaimed water meet State Surface Water Quality Standards (SWQS) for discharge to the Rio de Flag. The Arizona Department of Environmental Quality (ADEQ) has assigned designated uses of partial-body contact (PBC) and aquatic and wildlife for effluent-dependent water (A&Wedw) to the receiving waters of the Rio de Flag WRP.		
▪ *Indicator - Description of nitrogen constituents of Class A wastewater*		
Effects of supplemental nitrogen on plant communities on ski trails would be dependent on local conditions, nitrogen concentrations in the reclaimed water, and deposition rates. The rate of nitrogen saturation of the soil would be dependent on a number of factors, including soil physical and chemical characteristics, existing soil nutrient content, plant species diversity and density, and climate. Net nitrogen deposition as a result of snowmaking in the SUP would be from about two-fold to over 60-fold lower than that in the studies cited. Therefore, nitrogen saturation would likely occur over a longer time period.		

Table 2-5
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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
WILDLIFE		
The Proposed Action may result in the alteration and/or removal of habitat for terrestrial wildlife species within the SUP		
▪ *Indicator - Identification of any T, E, and S; MIS; and other wildlife species and habitats present within the SUP area and along the pipeline corridor*		
One federally-listed threatened wildlife species occurs regularly within general the analysis area: Mexican spotted owl (Strix occidentalis lucida). The threatened bald eagle (Haliaeetus leucocephalus) may occur in the analysis area in winter. The endangered black-footed ferret (Mustela nigripes) is not known or expected to occur in the analysis area. On the San Francisco Peaks, the Navajo Mountain Mexican vole has been found in open grassy areas amid limber pine, spruce, fir, and aspen. There are two PFAs within the analysis area, both of which are located along the Snowbowl Road and the reclaimed water pipeline alignment. The Veit Spring PFA largely overlaps the Snowbowl Mexican spotted owl PAC. There are no MIS identified for Developed Recreation Areas (i.e., the Arizona Snowbowl SUP). Alpine habitat occupies about 20 acres above timberline in the SUP area and covers an estimated 1,600 acres on the San Francisco Peaks, generally above 11,500 feet. Only the water pipit is known to breed in this habitat type. The analysis area is located within Game Management Unit (GMU) 7. Large game species managed by the Arizona Game and Fish Department are the pronghorn antelope, black bear, elk, mule deer, and wild turkey. Mountain lions are also known to occur in the analysis area. A number of smaller game animals and fur bearers also occur, including Abert and red squirrel, gray-collared chipmunk, mantled ground squirrel, Gunnison's prairie dog, coyote, and bobcat. Several species of bats have been documented in the Fort Valley area, west of the Snowbowl Road.		
▪ *Indicator - Disclosure/quantification of anticipated effects to those species and habitats present within the SUP area and along the pipeline corridor*		
This alternative would have No Effect on any threatened, endangered, or sensitive species, management indicator species, migratory birds, or game and non-game wildlife	Threatened, Endangered, or Sensitive species: Alternative 2 would not adversely affect threatened or endangered species within the analysis area. Regarding sensitive species, this alternative may impact individuals of the Navajo Mexican vole and habitat for the northern goshawk but is not likely to result in a trend toward Federal listing or loss of viability. Management Indicator Species: Tree removal would not substantially affect habitat for the Abert squirrel, pygmy nuthatch, wild turkey, elk, hairy woodpecker, red squirrel, red-naped sapsucker, or pronghorn antelope. Migratory Birds: Proposed activities may affect migratory bird species within the SUP directly through habitat removal or modification or indirectly through changes in	Threatened, Endangered, or Sensitive species: Alternative 3 would not adversely affect threatened or endangered species within the analysis area. Regarding sensitive species, this alternative may impact individuals of the Navajo Mexican vole and habitat for the northern goshawk but is not likely to result in a trend toward Federal listing or loss of viability. Management Indicator Species: No effect on management indicator species. Migratory Birds: Proposed activities may affect migratory bird species within the SUP directly through habitat removal or modification or indirectly through changes in

Table 2-5
Summary of Direct and Indirect Environmental Consequences

ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
	prey populations. Game and Non-game Wildlife: Effects would result from increased moisture and nutrients due to snowmaking, construction activities, forest fragmentation, and summer recreation.	prey populations. Game and Non-game Wildlife: Effects would result from noise due to construction activity, forest fragmentation, and an increase in summer recreation.
Proposed snowmaking activities may result in a longer-duration snowpack and additional water storage for wildlife in the SUP area.		
▪ *Indicator - Acreage of proposed snowmaking coverage*		
N/A	205.2 acres	N/A
▪ *Indicator - Comparison of natural snowpack duration with the extended snowpack due to snowmaking*		
N/A	Snowmaking would generally extend the duration of snowpack in the SUP area. Snow grain (crystal) size of machine-produced snow is typically smaller than that of natural snow. This would result in denser snow that typically takes longer to melt than natural snow.	N/A
▪ *Indicator - Effects of both longer-duration snowpack and water storage (impoundment) on wildlife in the analysis area*		
N/A	Greater moisture availability from snowmaking and an extended snowpack would generally enhance the growth of grasses and forbs on cleared ski trails within the SUP area. This would locally increase forage conditions for deer and elk and result in higher densities of these game species in the SUP area. The snowmaking water impoundment would have no effect on most game and non-game wildlife because access would be precluded by fencing.	N/A

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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
GEOTECHNICAL		
Geotechnical feasibility and associated hazards associated with construction of the proposed snowmaking impoundment on the ridge above the Sunset Chairlift must be analyzed		
▪ *Indicator - Hazard classification*		
N/A	The structure would classify as a low hazard dam using the State of Arizona criteria, and a moderate hazard dam using the Forest Service criteria. Therefore, it is recommended that the final structure be designed using design criteria associated with a moderate hazard dam.	N/A
▪ *Indicator - Failure Risk*		
N/A	Low risks of failure are associated with: ▪ overtopping ▪ piping (with appropriate mitigation) ▪ static instability ▪ excessive displacement during an earthquake is low ▪ liquefaction (believed to be low, but needs to be verified by site-specific investigation at the time of final design) ▪ excessive settlement	N/A

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ALTERNATIVE 1 – NO ACTION	ALTERNATIVE 2 – THE PROPOSED ACTION	ALTERNATIVE 3
▪ *Indicator - Dam breach and downstream inundation analysis*		
N/A	The model indicates that the flood wave attenuates substantially on its way down the mountain and dissipates almost entirely in the broad floodplain of Fort Valley. Downstream from Fort Valley, it is anticipated that existing hydraulic structures (bridges and culverts) on the Rio De Flag would accommodate the passing breach flood without impact through the Flagstaff area.	N/A
AIR QUALITY		
Snowplay activities at Snowbowl could increase vehicular traffic and may negatively impact air quality in the region.		
▪ *Indicator - Compliance with local, state and federal regulations regarding air quality*		
There is no projected increase in visitation under Alternative 1. The area would remain in attainment for all six criteria pollutants and the visibility of the Kachina Peaks Wilderness would remain unimpaired. Snowbowl would maintain compliance with all local, state, and Federal air quality regulations.	While the Proposed Action would be accompanied by an increase in total annual vehicular traffic and short-term, construction related affects to air quality, Snowbowl would remain in attainment for all six criteria pollutants. It would also maintain the integrity of the visibility in the nearby Kachina Peaks Wilderness. Snowbowl would maintain compliance with all local, state, and Federal air quality regulations.	As a result of implementation of Alternative 3, Snowbowl would remain in attainment for all six criteria pollutants with a net reduction of direct and indirect effects as compared to those disclosed under the Proposed Action. It would also maintain the integrity of the visibility in the nearby Kachina Peaks Wilderness. Snowbowl would maintain compliance with all local, state, and Federal air quality regulations.

DATA INTEGRITY

Prior to undertaking this NEPA analysis, a thorough review of the existing mapping and data for Arizona Snowbowl was conducted. For the scope and detail of this analysis, the existing mapping and data was determined to be insufficient to model and analyze the Proposed Action in the detail required. For this analysis, high resolution, ortho-rectified, aerial photography and digital contour data was acquired for a 6,800 acre area including and surrounding the ski area. Digital contour data was created at a ten foot contour interval and the ortho-photography was captured at a one-foot pixel resolution. Additionally, this mapping was augmented using supplementary detailed data from a local surveyor and via GPS technology.

All of the data used in this analysis has been either created from, or corrected by, the digital aerial mapping. These datasets include but are not limited to the base mapping of the ski area such as lifts, trails, and infrastructure. DEM (Digital Elevation Model) and TIN (Triangulated Irregular Network) files have been compiled based on the elevation data from aerial and ground surveys. Additional datasets from sources such as the Forest-wide GIS database and sub-contractors have been corrected and rectified to coincide with the data generated from the aerial photography. This state-of-the-art GIS database was used to create, calculate, and analyze all of the anticipated impacts displayed within this analysis.

CHAPTER 3

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

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Coconino National Forest
Peaks Ranger District

3. THE AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

CEQ regulations direct agencies to succinctly describe the environment that may be affected by the alternatives under consideration.[1] As such, Chapter 3 describes the existing physical, biological, social, and economic components of the project area which have potential to be affected by implementing any of the alternatives (i.e., the Existing Conditions). Each Existing Condition description is followed by an Environmental Consequences discussion that provides an analysis of the potential effects of implementation of each of the alternatives.

Chapter 3 is organized by resource area, and follows the organization of issues and resources requiring further analysis (and indicators) as presented in Chapter 1. Each resource section in Chapter 3 is organized in the following order:

SCOPE OF ANALYSIS

The scope of analysis briefly describes the geographic area(s) potentially affected by the alternatives for each issue and its indicator(s). The scope of analysis varies according to resource area and may be different for direct, indirect, and cumulative effects.

EXISTING CONDITIONS

The Existing Conditions section provides a description of the environment potentially affected, as based upon current uses and management activities/decisions.

DIRECT AND INDIRECT ENVIRONMENTAL CONSEQUENCES

This section provides an analysis of direct and indirect environmental effects of implementing each of the alternatives, according to the issues or resources requiring additional analysis and indicators identified in Chapter 1. Cumulative effects are discussed separately.

Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (i.e., likely to occur within the duration of the project).

CUMULATIVE EFFECTS

Cumulative effects are the result of the incremental direct and indirect effects of any action when added to other past, present, and reasonably foreseeable future actions, and can result from individually minor but collectively major actions taking place over a period of time.

[1] 40 CFR 1502.15

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

An irreversible commitment is a permanent or essentially permanent use or loss of resources; it cannot be reversed, except in the extreme long term. Examples include minerals that have been extracted or soil productivity that has been lost. An irretrievable commitment is a loss of production or use of resources for a period of time. One example is the use of timber land for a logging road. Timber growth on the land is irretrievably lost while the land is a road, but the timber resource is not irreversibly lost because the land could grow trees in the near future. The Forest Service recognizes the fact that certain management activities will produce irreversible or irretrievable commitments of resources.

FOREST PLAN CONSISTENCY

In conjunction with each resource analysis presented in this chapter, a thorough review of the Forest Plan was conducted in order to determine consistency with standards and guidelines at the Forest and management area levels on the CNF. The Forest Plan consistency analysis is contained in the official Project Record. Aside from a specific reference to the 1979 EIS, the Forest Plan Consistency Analysis identified no inconsistencies in the Proposed Action. Therefore, as indicated in the Proposed Action description in Chapter 2, a minor, non-significant Forest Plan amendment is associated with all alternatives. The amendment language can be found in Appendix B of this EIS.

3A. HERITAGE AND CULTURAL RESOURCES

SCOPE OF THE ANALYSIS

The scope of the cultural and heritage resources analysis within this document focuses on the cultural and spiritual values of the San Francisco Peaks, and the San Francisco Peaks Traditional Cultural Property (TCP), an area of approximately 74,381 acres that is defined in the Existing Conditions discussion. The analysis area for the project encompasses the entirety of the San Francisco Peaks with the understanding that the actual affected environment is far smaller, consisting only of lands within the SUP area (i.e., existing and proposed areas of disturbance). It should be noted that it is difficult to be precise in the analysis of the impact of the proposed undertaking on the cultural and religious systems on the Peaks, as much of the information stems from oral histories and a deep, underlying belief system of the indigenous peoples involved. Pilles,[2] in his draft National Register nomination, has noted that we "can only attempt to describe the major characteristics to which values are assigned that lead to an understanding of the deep, cultural meaning of the Peaks to the traditional people of the First Nations of the Southwest."

EXISTING CONDITIONS

NFS lands within Snowbowl's 777-acre SUP area have been used for winter sports and recreational use since 1938, when the ski area's original base area was established in Hart Prairie. Since that time, developed recreation at the Snowbowl has evolved with the creation of additional trail systems, buildings, lifts and infrastructure. Snowbowl's existing developed terrain network is comprised of 32 trails creating approximately 139 acres of skiable areas.

Vegetation breaks within the SUP area were cut throughout the development of Snowbowl; for the most part, vegetation breaks within the SUP area have been "feathered" and undulated in an attempt to mimic natural breaks in the vegetation across the San Francisco Peaks. With the exception of the Hart Prairie area (approximately 40 acres), which is a natural alpine meadow, approximately 100 acres of overstory vegetation have been cleared throughout Snowbowl's development history.

FOREST SERVICE TRUST RESPONSIBILITIES

The United States government has a trust responsibility brought about by treaties and laws related to American Indians. This responsibility is unambiguous in that the welfare of American Indians and their land and its resources are entrusted to the United States. While trust responsibilities are clear as they relate to the Bureau of Indian Affairs (BIA) because its mission centers around caring for the welfare, land and interests of American Indians, trust responsibilities are less clear for the Forest Service, who's mission is providing goods and services related to NFS lands for the benefit of *all* people. For the Forest Service, trust

[2] Pilles 2003, section 10:1

responsibilities are defined by executive orders, laws, and treaties that are directly related to NFS lands. While there are no treaties tied to the San Francisco Peaks, the Forest Service responds to trust responsibilities by following the laws that protect tribal rights and by making a strong concerted effort to manage NFS lands in a way that accommodates the needs and concerns of Native American groups, while still maintaining a responsibility to all citizens of the United States. Managing and protecting forest resources is a part of the Forest Service multiple-use management direction.

LEGAL MANDATES

In addition to the National Environmental Policy Act, the Forest Service has followed pertinent laws, regulations, and policies in conducting the cultural analysis presented in this FEIS. These include:

National Historic Preservation Act[3]

The National Historic Preservation Act requires agencies to inventory lands under their jurisdiction for historic properties and determine if those properties meet the criteria of eligibility for nomination to the National Register of Historic Places.

Section 106 (*Advisory Council on Historic Preservation*) of the National Historic Preservation Act provides specific directions on how federal agencies are to take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places. It specifies how agencies are to conduct and document consultations with the public, Indian tribes, State Historic Preservation Officers, Tribal Historic Preservation Officers, and the Advisory Council on Historic Preservation.

Section 101(d)(6)(B) (*National Register of Historic Places*) of the National Historic Preservation Act requires that, in carrying out its responsibilities under section 106, a Federal agency shall consult with any Indian tribe that attaches religious and cultural significance to properties

Section 110 (*Federal Agencies' Responsibility to Preserve and Use Historic Properties*) of the National Historic Preservation Act, provides direction to federal agencies to establish programs and activities to identify and nominate historic properties to the National Register and to consult with tribes.

Executive Order 13007

Executive Order 13007 "*Indian Sacred Sites*" requires federal agencies to accommodate access to and ceremonial use of sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such places. It also requires agencies to notify tribes of proposed actions or policies that may restrict access or adversely affect sacred sites.

[3] 16 U.S.C. 470 et seq.

Executive Order 12898

Executive Order 12898 "*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*" provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

Executive Order 13175

Executive Order 13175 "*Consultation and Coordination with Indian Tribal Governments*" requires federal agencies to "establish regular or meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationship with Indian Tribes…" The "policies that have tribal implications refer to regulations, legislative comments or proposed legislation, and other policy statements…" The remainder of the EO refers to potential legislation or regulations based on legislation and recognition of the need to communicate with Tribal governments. In light of the content of this executive order, it does not appear to apply to the proposed projects at the Snowbowl, in that this is a site-specific project that does not result in legislation or regulation changes.

Forest Service Manual 1500

Section 1563, "*American Indian and Alaska Native Relations*" in Forest Service Manual 1500, Chapter 1560 - State, Tribal, County, and Local Agencies; Public and Private Organizations, provides policy and guidance on how the Forest Service relates to Native Americans, emphasizing government to government relationships.

American Indian Religious Freedom Act of 1978

The American Indian Religious Freedom Act directs federal agencies to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.

National Register Bulletin 38

National Register Bulletin 38: *Guidelines for Evaluating and Documenting Traditional Cultural Properties*[4] provides guidance in addressing the National Register eligibility of traditional cultural properties such as the San Francisco Peaks (defined below).

[4] http://www.cr.nps.gov/nr/publications/bulletins/nrb38/

The San Francisco Peaks and The National Register of Historic Places

The National Register of Historic Places (National Register) is the Nation's official list of properties recognized for their significance in American history, architecture, archaeology, engineering, and culture. National Register properties include districts, sites, buildings, structures, and objects. They can be to a local community, a state, an Indian tribe, or the Nation as a whole.

A Traditional Cultural Property (TCP) is a place that is associated with the cultural practices or beliefs of a living community. Those practices or beliefs must be rooted in the history of the community and be important in maintaining the continuing cultural identity of the community. While not all TCPs are eligible for the National Register, a TCP is eligible if the property plays a role in a community's historically rooted beliefs, customs, and practices and meets at least one of four National Register Criteria for Significance: A) associated with significant events; B) associated with a significant person; C) is an outstanding example of a type; or D) is associated with information contained in an archaeological site.

The Forest Service has identified the San Francisco Peaks as a TCP as defined in National Register Bulletin 38: *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. The Peaks have also been determined eligible for inclusion in the National Register of Historic Places as part of the White Vulcan Mine Settlement Agreement and Mine Closure in August 2000.[5] The San Francisco Peaks are associated with culture and beliefs of living Native American communities that are rooted in their history and are important in maintaining the continuing cultural identity of their community. A number of places considered Traditional Cultural Properties and used for religious purposes, have been nominated to the National Register of Historic Places.

Simply being on the National Register does not afford a property any additional protection. It merely gives the property formal recognition of its importance. Once a property has been formally determined eligible, it has just as much protection as if it were listed. As a result of the determination of eligibility, the Forest Service is required to protect the Peaks as if they were already on the National Register and consult with Tribes and interested parties regarding the impacts of proposed actions upon the Peaks as they relate to affecting the values that makes the Peaks eligible for the Register.[6] At the time of publication of this EIS, the Forest Service is in the process of completing a National Register nomination form for the Peaks.

The San Francisco Peaks TCP is bounded by Forest Road 418 on the north; U.S. Highway 89 on the east; and the boundary between CNF, State, City of Flagstaff, and private lands on the southern and eastern boundary of the Fort Valley Experimental Forest. There are private lands within the TCP boundary, but the designation applies only to federal lands. The TCP boundary goes south to approximately the El Paso Natural Gas Pipeline, then west to U.S. Highway 180. It then generally follows U.S. Highway 180 to its junction with Forest Road 418. It includes the

[5] USDA Forest Service 2000a

[6] Pursuant to 36 CFR Part 800 Protection of Historic Properties.

San Francisco Peaks, all peaks and ridges that form the skyline view of the Peak, the Inner Basin, all springs in the Inner Basin, most other springs on the Peaks (except those on state, city, or private lands), Lockett Meadow, Weatherford Canyon, Mt. Elden, Little Mt. Elden, Schultz Pass, the Dry Lake Hills, Friedlein Prairie, Hart Prairie, and the Hochderffer Hills.[7] The Snowbowl SUP area is included in the National Register boundary.

In addition, two sites listed on the National Register of Historic Places are contained within the boundaries of the San Francisco Peaks TCP area. The C. Hart Merriam Base Camp is located three miles north/northwest of the SUP area and Fern Mountain Ranch is located 1.5 miles northwest of the SUP area. As part of the 1980 lawsuit, it was determined that the significant qualities of these two sites would not be effected by upgrading the Arizona Snowbowl facilities.

ETHNOGRAPHIC LANDSCAPE

An additional issue that is often considered with National Register-eligible properties is that the Peaks may be considered an ethnographic landscape. Ethnographic landscapes, as defined by the National Park Service, are those landscapes containing a variety of natural and cultural resources that people define as heritage resources (e.g., small plant communities, animals, shrines, and ceremonial grounds). As such, ground disturbance to the landscape can impact its integrity, even if the disturbance does not occur in the specific area of ethnographic usage. For example, historic ground and vegetation disturbances within the Snowbowl SUP area have impacted the Peaks. These indirect impacts may have compromised the entire mountain's spiritual character and the effectiveness of rituals related to the Peaks.

TRIBAL CONTACTS

The San Francisco Peaks are of traditional cultural and spiritual significance to people from many tribes, including the Hopi, Navajo, Acoma, Zuni, Hualapai, Havasupai, Yavapai, Apache, and Southern Paiute. In an effort to provide tribes with an early opportunity to comment on the Proposed Action, consultation between the Forest Service and 13 tribal leaders was initiated in June 2002, with a formal letter from the Forest Supervisor. The reader is referred to Chapter 1 "Public Involvement" for more information on Tribal contacts and consultation that occurred throughout the NEPA process.

CULTURAL BACKGROUND

The San Francisco Peaks are sacred to at least 13 formally recognized tribes that are still actively using the Peaks in cultural, historic, and religious contexts. A central underlying concept to all tribes for whom the Peaks are especially important is the recognition that the San Francisco Peaks are a source of water in the form of rain, springs, and snow. It is believed that the Peaks were put there for the people and it is therefore the peoples' duty to protect it for the benefit of the world.[8] "We believe the snow that comes down the Peaks is like a human being or a spiritual

[7] Pilles, 2003
[8] Id.

deity that brings us water. Water runs throughout the body and nourishes us."[9] Pilles[10] identifies nine significant qualities that characterize the Peaks for the tribes. These qualities include:

- They are the abode of deities and other spirit beings.
- They are the focus of prayers and songs whereby humans communicate with the supernatural.
- They contain shrines and other places where ceremonies and prayers are performed.
- They are the source of water.
- They are the source of soil, plant, and animal resources that are used for ceremonial and traditional purposes.
- They mark the boundaries of traditional or ancestral lands.
- They form a calendar that is used to delineate and recognize the ceremonial season.
- They contain places that relate to legends and stories concerning the origins, clans, traditions, and ceremonies of various Southwestern tribes.
- They contain sites and places that are significant in the history and culture of various tribes.

Pilles also notes that most tribes acknowledge they have shrines on the Peaks, or specific places where ceremonial things are done, but they are reluctant to identify them for fear they will be disturbed or desecrated, as well as the fact that such places should not be visited by people unless they have the sufficient religious training and have made the appropriate preparations to go there. "They wanted indications of sacred sites on this mountain, and we can't say X and X are sacred sites on the east side, or the top is a sacred site. The Mountain was put there for the people, not just part of it, so it's our duty to protect this place for the benefit of the world, for our people, and everyone else."[11] The Forest Service facilitates tribal access to the Peaks for the purposes of collecting plants, visitation to shrines, and other religious activities. The tribes have not identified any specific shrines, trails, or sacred resources located directly within the Snowbowl SUP area.

The qualities listed above are manifested by the undisturbed appearance of the Peaks as a landmark upon the horizon, as viewed from the traditional or ancestral lands of the Hopi, Zuni, Acoma, Navajo, Apache, Yavapai, Hualapai, Havasupai, and Paiute.

Sacred sites play an integral role in Native American religions and cannot be disturbed or the spirits may leave. Native American religions often emphasize the natural world in its entirety; every part of nature contains sacred knowledge, and the relationship of man to every creature and place is one of kinship. The entire earth is sacred; it is seen as the source of life. Some parts of

[9] Reid, 2001
[10] Pilles, 2003; *Dine*' Medicineman's Association 1999; Western Navajo Agency, 1999; Hopi Tribe, 1975; Hopi Cultural Resources Advisory Task Team, 2002; Watson, 1964:22
[11] Kiefer, 1998

the natural world, such as the San Francisco Peaks, are accorded special reverence. These special places may be where spiritual beings or forces originated or where they reside or where individuals or spiritual leaders communicate with them. Thus, the relationship between native people and the land is central and indispensable to their religion, culture, and way of life.

The concept of landscape should be considered when discussing Native American relationships to the land.[12] Large areas such as mountains may be considered sacred preserves, with various activities occurring that relate to the culture and religion. While preserving places important to a group is important in helping perpetuate the culture, a more effective approach is to widen the focus by considering the culturally landscape within which each group functions and from which they derive their cultural values. In this regard, many groups consider the landscape to be part of a living cultural system, which encompasses both the people and the land together. The most sacred and places for Native Americans are those where there is a symbiotic relationship among land, religion and people - and the place is important in the creation/origin stories of the people. It is these places where there are shrines or offering places and where ceremonies and rituals are conducted.

Developing a cultural understanding about the sacredness of a TCP is difficult within the parameters of a NEPA analysis. Pilles[13] notes that we can only attempt to describe the major characteristics to which values are assigned that lead to an understanding of the deep, cultural meaning of the Peaks to the tribes for which they are sacred.

Two examples of the cultural significance of the San Francisco Peaks are the Hopi and Navajo peoples' religious and spiritual connections to the Peaks, as discussed below.

Hopi

Hopi clans migrated through the San Francisco Peaks (called *Nuvatukyaovi*, "High Place of Snow"), made settlements nearby, and placed shrines on the Peaks. All of the religious ceremonies focus on *Nuvatukyaovi* and demonstrate the sacred relationship of the Peaks to the Hopi people. The history of clan migrations through the area continue to be related, discussed, and passed on from generation to generation. The Peaks contain clan and society shrines, and gathering areas for medicinal and religious use. Hopi religious leaders visit the Peaks annually. The San Francisco Peaks are the spiritual essence of what Hopis consider the most sacred landscapes in Hopi religion. They are the spiritual home of the *Katsinam*,[14] significant religious beings that all Hopis believe in, and are therefore, sacred. The ceremonies associated with the Peaks, the plants and herbs gathered on the Peaks, and the shrines and ancestral dwellings located in the vicinity of the Peaks are of central importance to the religious beliefs and traditions that are the core of Hopi culture.[15]

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[12] Kelley and Francis, 1994
[13] Pilles, 2003
[14] Note: *"Katsina" and "Katsinam"* are the linguistically correct ways of spelling the more-commonly used terms "Kachina" and "Kachinas".
[15] Titiev, 1944; Loftin, 1991

Katsinam represent the multi-layered spirit powers who personify nature: clouds, sky, storms, trees, etc. They function as protective supernatural beings who can help humans if they are asked properly and respectfully. They also represent the spirits of Hopi ancestors who, in the form of clouds, bring much-needed rain. They serve as entertainers and discipliners of children, look after the interests of humans, serve as intermediaries to the gods, and can bestow good fortune, such as fertility, power, and long life.[16]

The Hopis recognize hundreds of specific *Katsinam* who personify the forces of nature and the spiritual essence of plants, animals, other tribes, specific people and supernatural forces. *Katsinam* return to live in Hopi villages every year, beginning in February after descending from their home on top of the San Francisco Peaks. The top of the Peaks is considered to be a cloud house, since the *Katsinam* are manifested as clouds.[17] There is a kiva for the *Katsinam* on the very top of the Peaks[18] and the *Ka'nas Katsina*, for example, lives in an ice cave on top of the Peaks.[19] The *Katsinam* remain in the villages until *Niman*, the Going Home Ceremony, in late July, at which time they return to the San Francisco Peaks. Boughs are collected from the Peaks for use during *Niman*; water from springs is collected as well, usually from high up on the Peaks.[20]

The Peaks are one of the major landmarks that define the traditional and spiritual boundaries of *Hopitutsqwa*, "Hopi land" and the territory for which they act as stewards of the land through their pact with *Ma'saw*, the guardian of this world.[21] The Peaks are mentioned, or figure prominently, in numerous folk tales and oral traditions of the Hopi.[22] These traditions mention the Peaks as a reference point[23] or as the location where the stories took place.

Pilles[24] notes that trails lead from the Hopi Mesas to the San Francisco Peaks and are traditionally used as part of annual pilgrimages and collecting expeditions. During the winter solstice when the *Soyalung* ceremony is done, the Hopi re-enact their emergence tradition. Pilgrimages are made to the Peaks to collect Douglas-fir, evergreen plants, and ice for the ceremony. "Prayers are said for prosperity, for good health, for our own families, our grandchildren, ourselves, and for the world over."[25] Former Tribal Chairman Ferrell Secakuku describes the Peaks as a spiritual center of the Hopi. "We go there to make prayers to our ancestors and deities to protect us and to support our prayers when we do our ceremonies, so we

[16] Loftin, 1991
[17] Malotki, 1987:10
[18] Malotki, 1987:32,169
[19] Malotki, 1987:30
[20] Pilles, 2003
[21] Id.
[22] Nequatewa, 1936; Parsons, 1967
[23] Mullett, 1979:76, 80; Nequatewa, 1936:86-93
[24] Pilles, 2003
[25] Reid, 2001

could come in touch with the cloud people, who bring rain. Rain is a symbol of life. Rain represents nourishment."[26]

Navajo

The Navajo people believe that the Creator placed them on land between four sacred mountains: Blanca Peak in Colorado, Mount Taylor in New Mexico, the San Francisco Peaks in Arizona, and Hesperus Peak in Colorado. According to their own history, the Navajos have always lived between these mountains. Each of the four mountains is associated with a cardinal direction, symbolizing the boundaries of the Navajo homeland. For the Navajo, the Peaks are the sacred mountain of the west, *Doko'oo'sliid*, "Shining on Top," a key boundary marker and a place where medicine men collect soil for their medicine bundles and herbs for healing ceremonies. Navajo traditions tell that San Francisco Peak was adorned with *Diichilí*, Abalone Shell, Black Clouds, Male Rain, and all animals, besides being the home of *Haashch'éélt'i'í* (Talking God), *Naada'algaii 'Ashkii* (White Corn Boy), and *Naadá 'Altsoii 'At'ééd* (Yellow Corn Girl). The sacred name of the Peaks is *Diichilí Dzil* – (Abalone Shell Mountain). The Navajo people have been instructed by the Creator never to leave their sacred homeland.[27] *Dook'o'osliid* and the other three sacred mountains are the source of curing powers. They are perceived as a single unit, such as the wall of a hogan, or as a particular time of a single day. *Dook'o'osliid* is seen as a wall made of abalone shell and stone, with mixed yellow and white bands.[28]

The Peaks are recognized as a source of water. As one Navajo said, "I go to the Inner Basin to place *nlt'iz* and prayers for rain." The Peaks contain numerous sacred places, such as springs, trails, cairns, offering places, plant gathering areas, and mineral gathering areas. In addition, rocks, plants, trees, coal, clay, water, and soil are specifically collected from the Peaks.[29] Each of these is important for specific ceremonies as well as for food and other every-day purposes.[30] For example, pinyon nuts and firewood collecting are the main reasons Navajo go to the forests, other than to collect medicinal plants.[31] Ear ache medicine was prepared from the pulp of a tree (*tsidisi)* found on the San Francisco Peaks.[32] Animals living on the Peaks are also sacred, such as owls and other birds. Owls have a sacred and significant place in Navajo history and are responsible for specific ceremonial actions such as the *Tl'ee'ii* (the Nightway, or *Yeii-bi-cheii).*

Pilles[33] notes that some indication of the importance of the San Francisco Peaks to Navajo in their daily lives can be seen from Vannette and Fearey's study of Navajo uses of the National Forests of northern Arizona. In a specific study of these uses, 37 percent of their informants indicated that they gather medicine from sacred places, 23 percent said they pray to them, and 20

[26] Id.
[27] http://www.lapahie.com/San_Francisco_Peak.cfm; http://www.cpluhna.nau.edu/Places/san_francisco_peaks.htm
[28] Reid, 2001
[29] Vannette and Fearey, 1981:47
[30] Cameron Chapter, 1992; Jensen *et al*, 1998
[31] Vannette and Fearey, 1981:44
[32] Franciscan Fathers, 1910:112, 202
[33] Pilles, 2003

percent said they make offerings at these sacred places.[34] In other words, sacred places, pre-eminently the San Francisco Peaks, play an important role in the lives of at least 37 percent of the Navajo people living in northern Arizona.

Today, ceremonies are conducted on the Peaks by both the Hopi and Navajo people. For example, plants and herbs are gathered and shrines and ancestral dwellings visited. There are numerous medicinal herbs and other plants at several levels of the Peaks that are used in traditional ceremonies and to treat the ailments of Native American people. The tribes have not identified any plants or other natural resource materials gathered within the Snowbowl SUP area. Both tribes (and others as needed) have access to their sacred sites, conduct ceremonies, and gather plants of traditional importance and herbs when needed. These activities are of central importance to the cultural and religious values of both tribes.

Other Tribes

The Hopi and Navajo are most directly associated with the Peaks, and their religious and spiritual connections to the Peaks have been relatively well documented. Therefore, only brief mention of a sample of the other tribes with spiritual connections to the Peaks is offered here.

Apache

The Peaks are a very important and powerful place to many traditional Apache people in San Carlos and elsewhere.[35] Mountains are prayed to because clouds hang on them and Lightning People are on them. As with other tribes in their concepts of the relationship of mountains to water,

> *"When we go up the Mountain we pray as we go. We take every step with prayer. When our prayers are answered we see the water come. There are life-giving waters on the Mountain. The rain that comes sprinkles everyone even in the valley and it blesses everyone. Our prayers go through the Mountain, to and through the top of the Mountain."*[36]

They are prayed to for crops, life, and hunting.[37] Mountains are also considered to be the home of the *ga'an* (mountain spirits) and the San Francisco Peaks have been identified as one of the places of the *ga'an*.[38] Because of this, people did not go far up the San Francisco Peaks, as supernatural beings lived on the top.[39] Their association with mountains is also reflected by their

[34] Vannette and Fearey, 1981:31
[35] Cassa, 1999.
[36] Stanley, 1992: in Spoerl, 2001
[37] Goodwin, 1929-1939:89
[38] Goodwin, 1929-1939:85
[39] Goodwin, 1969:44

dress. They usually have spruce boughs tied to them as well as eagle and turkey feathers - birds that are often associated with the mountains.[40]

Acoma

The San Francisco Peaks are the western boundary marker for the Acoma, and are considered to be their Guardian of the West. The Acomas' protection shrine is on top of the Peaks. They perform ceremonies on the Peaks and collect soil, water, and plants from it for ceremonial and medicinal purposes.

Yavapai

The San Francisco Peaks are recognized as the northeastern boundary of Yavapai territory[41] and contain "a lot of sacred things."[42] The area around the Peaks was used to collect pinyon nuts and grass seeds as well as for hunting, collecting wild plants for food, and other plants for medicines.[43] Songs are sung about the Peaks and relate to various specific places and areas.

Hualapai and Havasupai

The Hualapai and Havasupai perceive the world as flat, marked in the center by the San Francisco Peaks, which were visible from all parts of the Havasupai territory except inside the Grand Canyon. The commanding presence of the Peaks probably accounts for the Peaks being central to the Havasupai beliefs and traditions, even though the Peaks themselves are on the edge of their territory.[44]

Zuni

The San Francisco Peaks are an ancestral site in the Zuni migration narrative. Willow, aspen, and medicinal herbs are collected from the Peaks, as well as soil.

SUMMARY OF CULTURAL RESOURCE INVESTIGATIONS WITHIN THE SUP AREA

CNF Archaeology records indicate that at least 14 cultural resources surveys have been conducted within the Snowbowl SUP area since 1980.[45] These surveys provided cultural resource clearance recommendations for the development of the Snowbowl to its current state

[40] Goodwin, 1929-1939:88
[41] Khera and Mariella, 1983:39
[42] Marquez, 1998
[43] Schroeder, 1959
[44] Id.
[45] Bremer 1987, 1989; Bremer and Holden, 1986; Clements 1981; Dosh, 1997, 1999, 2002; Farnsworth, 1986, 1993; Geib, 1983; Harper, 1995a, 1995b; Kelley, 1980; Pilles, 1988; Stein and Pilles, 1981

under the auspices of the Record of Decision (ROD) that approved the 1979 Final Environmental Statement for the Arizona Snowbowl Ski Area Proposal.[46]

Prior to 1979, Snowbowl had operated the Agassiz Chairlift with two primary trails. Following the 1979 ROD, Snowbowl made plans for the Hart Prairie Chairlift. A cultural resources survey of that lift was conducted by the Northern Arizona University (NAU) Department of Anthropology,[47] recording one cultural property outside the proposed alignment - the site of the original Snowbowl Lodge, which was constructed in 1941 and subsequently burned to the ground in 1952. The Hart Prairie Chairlift alignment was later modified so that the new alignment – as well as the site of a proposed Hart Prairie Lodge, the Sunset and Aspen chairlifts and their associated ski trails, and new trails serviced by the Agassiz Chairlift – was included in the areas surveyed by NAU.[48] At the same time, CNF archaeologists conducted a survey of the existing ski trails.[49] No additional cultural resources were identified. In a letter from Ann A. Pritzlaff, Arizona State Historic Preservation Officer, to Neil R. Paulson, CNF Forest Supervisor, dated September 11, 1981, the site of the original Snowbowl Lodge[50] was determined ineligible for listing on the NRHP and clearance for the first stage of development was granted by the CNF. In 1983, NAU surveyed a small block area between the Snowbowl Road and the Snowbowl maintenance shop road, a power line extending to the south from the maintenance shop, and a right-hand turning lane off of U.S. Highway 180 at the other end of Snowbowl Road.[51] No cultural resources were identified.

From 1986 to 1995, CNF archaeologists conducted all surveys within the Snowbowl SUP area. Farnsworth surveyed for replacement of the Agassiz Chairlift, the construction of the Aspen Chairlift[52], minor trail improvements within *Lower Bowl* (trail #29), *Logjam* (trail #25), and along *Ridge Run* (trail #26), and the road shoulders between Hart Prairie Lodge and Agassiz Lodge.[53] That same year, Bremer reported on a survey of *Pomal*,[54] and the following year, on a survey of proposed telephone and power corridors between Hart Prairie Lodge and the maintenance shop (another survey previously covered by Clements[55] and Geib[56]). In 1988, Pilles provided the documentation, assessment, and recommendations for converting an existing restroom into a locker room.[57] The existing structure was determined ineligible for listing onto the NRHP because it was less than 50 years old. The following year, clearance documentation

[46] USDA Forest Service, 1979
[47] Kelley, 1980
[48] Clements, 1981
[49] Stein and Pilles, 1981
[50] AR-03-04-03-199
[51] Geib, 1983
[52] Clements, 1981
[53] Farnsworth, 1986
[54] Bremer, 1986
[55] Bremer 1987, 1989; Bremer and Holden, 1986; Clements 1981; Dosh, 1997, 1999, 2002; Farnsworth, 1986, 1993; Geib, 1983; Harper, 1995a, 1995b; Kelley, 1980; Pilles, 1988; Stein and Pilles, 1981
[56] Geib, 1983
[57] Pilles, 1988

was provided for additional parking areas (another previously covered survey by Clements)[39] and minor trail improvements at the top of the Sunset Chairlift, along the Agassiz Chairlift, and within *Lower Bowl* (trail #29) and through *Logjam* (trail #25). In 1993, Farnsworth reported on a survey of trail widening from *Lower Bowl* (trail #29) through *Logjam* (trail #25) and *Wild Turkey* (trail # 20), and smaller improvements between *Ridgeway* (trail #22) and *Blackjack* (trail #17).[58] More recently, the two-track road from the maintenance shop to the top of the Sunset Chairlift, the top of the Hart Prairie Chairlift, and an area around Agassiz Lodge was surveyed;[59] soon thereafter followed by a survey of an existing parking area west of the Hart Prairie Lodge (another survey previously covered by Clements),[60] the newly proposed ski trail between *Casino* (trail # 23) and *Logjam* (trail #25), and large block areas between the Hart Prairie Chairlift and *Ridge Run* (trail #26).[61] Harper recorded one historic "dendroglyph" (carved bark of an aspen tree) northeast of Agassiz Lodge, which was inscribed "DANIAL GALAR - Julio 29 1928." It was recorded as an "Isolated Find" and determined ineligible for the NRHP.

In 1997 and 1998, additional survey work was assigned to Northland Research. The first of these surveys included a cellular tower location within the maintenance area, where no cultural resources were recorded. The remaining surveys filled gaps between areas covered by prior surveys, totaling approximately 120 acres and including approximately 15 acres of previously surveyed coverage. In addition, another 95 acres were surveyed within the lower end of the SUP area to complete the survey of the entire SUP area, except for approximately 70 acres of steep, high-altitude areas within the permit area where cultural resources are unlikely to occur. The plan to exclude those 70 acres was accepted by CNF, and the final clearance report for the entire SUP area was completed in 1999.[62] Through all of these surveys, no significant or eligible cultural resources were recorded within the Snowbowl SUP area.

SURVEY OF PROPOSED RECLAIMED WATER PIPELINE ROUTE

An intensive cultural resource survey was conducted within the proposed reclaimed water pipeline route between the City of Flagstaff and the Snowbowl that included all land that had not been previously included in prior surveys. The proposed route traverses both public and private lands, including the CNF, Arizona State Trust land, City of Flagstaff land, and land owned by Lowell Observatory (refer to Figure 2-4). Much of the route lies within the existing rights-of-way of Snowbowl Road and the Transwestern Pipeline Company, Flagstaff Lateral Pipeline. The total length of the proposed pipeline route is 78,012 linear feet. A total of 65,920 feet had been previously surveyed, leaving just 12,092 feet the subject of the new survey. A 50-foot width was surveyed for the proposed reclaimed water pipeline right-of-way.

With the exception of the route through Lowell Observatory, a short segment through Arizona State Trust land located in the adjacent Section 18, Township 21 North, Range 7 East, and a

[58] Farnsworth, 1993
[59] Harper, 1995a
[60] Clements, 1981
[61] Harper, 1995b
[62] Dosh, 1999

paved section along West Birch Avenue in Flagstaff, all of the proposed pipeline route had been included in three prior cultural resources inventory surveys.[63] Previously unsurveyed portions of the route, totaling 2.3 miles of the right-of-way, were surveyed for this analysis resulting in a complete survey of the entire proposed pipeline route. The results of the survey are discussed under "Environmental Consequences."

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

In some cases, indicators were combined throughout the Direct and Indirect Effects section in order to avoid redundancy.

Snowmaking

Issue:

The installation and operation of snowmaking infrastructure as described in the Proposed Action, and the use of reclaimed wastewater as a water source, will impact cultural and spiritual values associated with San Francisco Peaks.

Indicator:

Qualitative Discussion of the Cultural Values of the San Francisco Peaks and the Potential for Incremental Change As a Result of Implementation of the Proposed Action

Alternative 1 – No Action

Under the No Action Alternative no new construction or modification, including snowmaking infrastructure, would occur within the SUP area. The impacts of selecting Alternative 1 on the sacred values of the Peaks are discussed under the next issue heading. Current conditions that allow for the gathering of plants and other forest products, as well as visitation to shrines and other areas, would continue. The spiritual values of the Peaks that are delineated in the cultural background section would continue as they are today. The presence of the ski area on the Peaks would continue in its existing configuration.

Alternative 2 – The Proposed Action

The Hopi believe that the Peaks generate their own weather conditions, forming cumulus clouds that provide the life-giving rain to sustain crops, animals, and human life. The rain also recharges groundwater supplies that result in a number of springs across the Peaks[64] and beyond,

[63] Dongoske, 2003; Purcell, 1992; Stein and Pilles, 1981
[64] Pilles, 2003, section 9:1

to the Hopi Mesas. The Hopi believe that the addition of snowmaking would adversely impact the natural process of precipitation.

The 1975 Hopi Tribal Resolution[65] noted that there are numerous medicinal herbs and other plants at several levels of the Peaks that are used to treat the ailments of the Hopi people. The Forest Service is unaware of any plants or other natural resource material used by the Hopi within the Snowbowl SUP area; however, the addition of new trails, increased parking, and the potential for additional annual visitation within the SUP area and the San Francisco Peaks themselves causes concern among the Hopi and other tribes that their areas of traditional use would be impacted. Specifically, the Hopi make pilgrimages to shrines and use the Peaks for religious reasons such as gathering evergreens and herbs and delivering prayer feathers.

Although the reclaimed water proposed for use in snowmaking fully meets both the EPA and ADEQ water quality standards, it is believed that trace levels of unregulated residual constituents within reclaimed water (e.g., pathogens, pharmaceuticals, hormones, etc.) could negatively impact the spiritual and medicinal purity of resident flora on the Peaks. Several specific concerns have been raised about the impact of snowmaking on the spiritual values of the Peaks.

The Hopi have expressed concern that plants that are used in ceremonies would be affected spiritually in two ways: 1) the increased water would impact the natural growth of plants, and 2) runoff from the Peaks to areas where they collect plants would not be pure, natural rainwater - thus affecting their spiritual content. The Hopis' traditional/medicinal uses of plants and water would therefore be directly affected. An additional concern is that some of the reclaimed water once passed through hospitals or mortuaries could carry the spirits of the dead with it. Those spirits, as part of the water draining from the Peaks, would then infiltrate plants, thus affecting their ritual purity.

From both a Hopi and Navajo perspective, any plants that would come into contact with reclaimed water would be contaminated for medicinal purposes, as well as for use in ceremonies needed to perpetuate their cultural values. The Navajo believe that the plants, rocks, life, and spirit of the Peaks need to be respected, and that the application of reclaimed water – which is believed to be unclean – on the land would desecrate the spirituality of the Peaks. Both groups strongly believe that wastewater cannot be purified in any way, and that the use of reclaimed water would adversely affect the spiritual beings and forces that reside on the Peaks. These concerns are focused on spiritual and cultural issues, not the actual biological purity of the water itself (i.e., to the tribes, it is irrelevant that reclaimed water meets EPA and ADEQ standards).

The Hopi believe that the *Katsinam* are responsible for moisture and that the installation of snowmaking technology within the SUP area would alter the natural processes of the San Francisco Peaks and the responsibilities of the *Katsinam*. As stated at an August 21, 2002 meeting with the Hopi, "if Snowbowl makes their own snow, the *Katsinam* will say: 'they can make their own moisture, they don't need us' and they will leave. Snowmaking would desecrate

[65] The 1975 Hopi Tribal Resolution is explained in more detail below.

our beliefs. Let the *Katsinam* make the moisture." In addition, spruce and Douglas-fir both have important ceremonial associations with moisture and the Peaks. Douglas-fir, is perceived to be a house of the *Katsinam* and a strong attractor of rain. The increased artificial snowpack that would result from snow-making would cause plants to be kept moist at times when the Peaks would normally be dry. This additional "false" moisture would interfere with the natural cycle of these trees, and their role in producing rain

Finally, the Hopi and Navajo need to have access to sacred areas. With an increased snowpack due to snowmaking within the SUP area, a concern was expressed that access to shrines and sacred places would be more difficult. Currently, the Snowbowl provides summer access to Tribal members allowing them to ride the Agassiz Chairlift to the ridgeline making it easier for them to access the high elevation areas, beyond the Snowbowl SUP area, for religious purposes. Other than using the Agassiz Chairlift, it is not known if Tribal members access the Peaks by way of the SUP area or along the Humphreys Trail into the Wilderness. If access for religious purposes does occur through the SUP area, it is likely during the late spring or summer months when snowpack is not an issue. If access were desired over-the-snow, the snowpack on the lower reaches of the ski area if augmented with snowmaking would have a negligible persistence as compared with a natural snowpack.

Thus, the additional ground disturbance and use of reclaimed water that would result from Alternative 2 would further contaminate the spiritual purity of the entire Peaks beyond the historic and existing levels. The Hopi, Navajo, and other tribes have existed in the region of the San Francisco Peaks for thousands of years and have developed their cultures and religious institutions around the natural and cultural landscape of the San Francisco Peaks. Traditions, responsibilities, and beliefs that delineate who they are as a people, and as a culture, are based on conducting ritual ceremonies they are obligated to perform as keepers of the land. These obligatory activities focus on the Peaks, which are a physical and spiritual microcosm of their cultures, beliefs, and values. Snowmaking and expansion of facilities, especially the use of reclaimed water, would contaminate the natural resources needed to perform the required ceremonies that have been, and continue to be, the basis for the cultural identity for many of these tribes.

Under the Proposed Action the Forest Service would work with the Tribes to ensure continued and adequate access to special areas and accessibility for the collection of plants and other materials needed for ceremonies and medicinal purposes. Monitoring of areas important to the Tribes would be conducted to protect them from other impacts such as public visitation or construction. Efforts would be made to provide the Tribes the opportunity to conduct their religious activities in an uninterrupted manner.

Alternative 3

Under Alternative 3 no snowmaking would occur within the SUP area. Without snowmaking, Alternative 3 addresses the concerns expressed by the Tribes about the integrity of the

natural/sacred landscape and plants as a result of the addition of reclaimed water and machine-produced snow.

Scarring of the Sacred Mountain

Issue:

Proposed ground disturbances and vegetation removal may result in permanently evident, visible alterations (i.e., "scarring") of the San Francisco Peak's landscape.

Indicators:

Narrative Description of Existing and Historic Vegetation and Ground Disturbance Within the SUP Area

Quantification of Existing and Additional Proposed Temporarily and Permanently Evident Vegetation Disturbances/Removals

Quantification of Existing and Additional Proposed Temporary and Permanently Evident Ground Disturbances

Qualitative Discussion of the Cultural Significance of Proposed Ground and Vegetative Disturbances and Removal Within the SUP Area

Alternative 1 – No Action

Since approximately 1938, development of the Snowbowl has evolved with chairlifts, lodges, paved roads, parking lots, and ski and hiking trails. Since that time, approximately 100 acres of overstory vegetation have been cleared throughout the Snowbowl's SUP area, along with additional ground disturbance, for terrain and related infrastructure.

While numerous changes to lands within the boundary of the Snowbowl SUP area have occurred, comments made to Forest Service personnel over the years indicate that the Peaks in fact retain an integrity of condition related to the traditional religious, cultural, natural, and social values that make the Peaks significant to the Tribal people of the region.[66] However, from an ethnographic landscape perspective (as defined by the National Park Service – see Existing Conditions) historic ground and vegetation disturbance within the SUP area may have visually impacted the entirety of the Peaks, even if the disturbance did not occur in specific areas of ethnographic usage. Therefore, selection of Alternative 1 may represent a continued impact on the Peaks' spiritual character and the ability of rituals to perform their intended function.

It should be noted that the tribes have always objected to the Snowbowl's presence, due to their belief that any disturbance of the Peaks is sacrilegious. Therefore, the continued use of the Peaks for a developed ski area continues to have negative impacts on its sacred values and related

[66] Pilles, 2003

cultural values. Comments made at a Hopi public meeting indicate a belief that recent years of drought have been caused by the "misuse" of the Peaks by the Snowbowl's existence and continued operations; however, there is also an enduring belief that the Peaks still retain their spiritual values.

In 1975, through a Tribal Resolution, the Hopi Tribal Council objected to the development of the Snowbowl. Their objection[67] was based on a basic precept of Hopi religious and cultural values that the land is sacred, and the San Francisco Peaks are a most sacred part of the land. Their sacred nature is evidenced by the existence of shrines within and around the Peaks, Hopi ceremonies are regulated by astronomical relationships with the Peaks, traditional religious practitioners gather medicinal herbs and other plants at several levels on the Peaks, and, most importantly, the Peaks are the home of the *Katsinam*. In 1984, The Hopi Tribal Council passed another resolution[68], which noted concerns about the development of trails by the CNF on parts of the San Francisco Peaks within the federally designated Wilderness area; their objection was based on the same issues as in the 1974 resolution - that the Peaks are sacred. Both Hopi and Navajo oral testimonies emphasize the importance of the Peaks to their cultural integrity and religion. Disruption of the natural presence of the Peaks disturbs the spiritual beings and forces that exist there. As the natural qualities of the Peaks are modified and disturbed, so will the quality of life in general be adversely affected.[69]

While the No Action Alternative would not change the current configuration of the Snowbowl and would cause no additional ground or vegetation disturbance to the area, the Hopi and other tribes remain in opposition to the Snowbowl's continued presence on the sacred San Francisco Peaks landscape because of the negative impact on the religious beliefs and related cultural values of their people.

Alternative 2 – The Proposed Action

Ground disturbance associated with the Proposed Action is provided in Table 3A-1.

Table 3A-1
Proposed Action Ground and Vegetation Disturbance

Type of Disturbance	Amount of Disturbance (acres)
Overstory Vegetation Removal	76.3
Permanent Ground Disturbance	10.4
Temporary Ground Disturbance	235.7[a]

[a] Approximately 64 acres of temporary ground disturbance are associated with construction of the water pipeline between Flagstaff and the Snowbowl.

Alternative 2 includes snowmaking infrastructure, construction of a 10 million gallon water impoundment, a reclaimed water pipeline extending from the City of Flagstaff to the ski area, a snowplay facility, additions to the lift and trail networks, additional parking lots and other

[67] Hopi Tribal Resolution H-31-75.
[68] Hopi Tribal Resolution H-125-84.
[69] Carothers and House, 1985

infrastructural additions. The permanent nature of these projects would be significant to the cultural landscape of the Peaks.

The reader is specifically referred to the Aesthetic Resources section (Section D), within this chapter, for a detailed description and quantification of the anticipated temporarily and permanently evident ground disturbances and vegetation removal associated with the Proposed Action.

The Peaks are perceived by some traditional religious practitioners as a sacred, living entity that would be physically harmed by any ground disturbances or vegetation removal. Not only would the Peaks be scarred, but also there would be additional noise and activity, that would impact the Peaks' ability to rest and recuperate for the forthcoming year's religious ceremonies. An example of the Hopi perspective on additional development within the SUP area can be gained from the December, 2002 public meeting, in which Mr. Raleigh Pooyouma noted that these are the only sacred peaks the Hopis have. He noted that every month they go there for prayers. In January and July they go to collect greens and herbs for the Bean Dance and Home Dance (*Powamuy* and *Niman* ceremonies). He stated, "Development is like cutting the heart and blood vessels of a living being."

The sacred qualities are manifested by the undisturbed appearance of the Peaks as a landmark upon the horizon as viewed from the traditional or ancestral lands of the Hopi, Zuni, Acoma, Navajo, Apache, Yavapai, Walapai, Havasupai, and Paiute[70].

From a landscape perspective, additional ground and vegetation disturbance within the SUP area associated with the Proposed Action could further impact the visual quality, as well as spiritual integrity, of the Peaks beyond the existing conditions (Alternative 1). This could impact the effectiveness of rituals conducted by traditional religious practitioners.

Although no traditional religious practitioners have indicated that plants of traditional importance are collected within the Snowbowl SUP area, the removal of 76 acres of vegetation would affect the integrity of the Peaks and therefore impact its sacred values. Ground disturbance within the SUP area, especially the 10 acres of permanent ground disturbance, would impact the sacred values of the Peaks and their spiritual nature.

The Hopi are farmers, for whom agriculture is a cornerstone of their culture that is integrally related to the *Katsinam* and the San Francisco Peaks. The *Katsinam* are believed to depart the San Francisco Peaks after the conclusion of the winter solstice to reside with the Hopi until they return to the Peaks after the summer solstice. During their time at Hopi the *Katsinam* are involved in ritual dances in which they chant and pray for the needs of the people, especially for rain, fertility, good crops, and abundance for all. The *Katsinam* and associated ceremonies are an integral part of Hopi agricultural concerns and needs. The disturbance of their home could

[70] Pilles, 2003, section 8:1

have a direct impact on the *Katsinam*, and, as a result, successful harvests for the Hopi and their importance for perpetuation of Hopi culture.

There is no way to quantify the amount and types of plants that are gathered by the Hopi and others for their ceremonies and medicinal use. This information is private and only available to Hopi religious practitioners. It is known, however, that pilgrimages do occur at specific times of the year for the purpose of visiting shrines and gathering certain plant materials such as Douglas-fir and evergreen plants. At this time, as far as the Forest Service knows, plants are gathered outside the Snowbowl SUP area. The tribes have not identified any plants or other materials that are gathered or used from within the SUP area.

Should the Proposed Action be selected, the Forest Service would work with those tribes actively using the area to identify any culturally significant plants within the Snowbowl SUP area that may potentially be disturbed by facilities construction and use. If present, these plants could be relocated to new areas on the Peaks. The Forest Service could also require the reintroduction of any plants that would be impacted. The Forest Service would continue to work with the Tribes to promote and protect plants used for religious and tradition purposes outside of the permit area. Such a "habitat exchange" is one way to mitigate physical impacts to the Peaks. In addition, feathering the forest canopy to minimize the visual impact of any new trails would help mitigate tribal concerns. Neither of these methods would completely mitigate the spiritual impact to the Peaks, but could help alleviate direct impacts to vegetation.

Survey of Proposed Reclaimed Water Pipeline Route

All sections of the proposed reclaimed waterline route corridor, except those portions through Lowell Observatory, the State land in Section 18, and West Birch Avenue were previously surveyed and no archaeological resources were found during those surveys. For planning purposes, a survey of the remaining locations of the proposed water pipeline corridor was conducted in 2003 to ascertain whether or not there are any archaeological resources present and to provide information for the Snowbowl EIS and the development of alternatives. There are no archaeological resources present within the water pipeline route outside the Peaks TCP that cannot be avoided or mitigated. Further, the proposed waterline right-of-way would not affect any significant contributing elements within the *Lowell Observatory National Historic Landmark* or *Flagstaff Townsite Historic Residential District.*[71]

[71] A Memorandum of Agreement (MOA) has been prepared that stipulates survey, consultation, and mitigating actions for the entire Snowbowl project, including the waterline and any modifications to the project as presently described. The MOA is contained in Appendix D of this FEIS.

Alternative 3

Table 3A-2
Alternative 3 Ground and Vegetation Disturbance

Type of Disturbance	Amount of Disturbance
Overstory Vegetation Removal	64.4 acres
Permanent Ground Disturbance	1.7 acres
Temporary Ground Disturbance	130.3 acres

Alternative 3 also reduces ground and associated vegetation disturbance with elimination of the snowplay facility and parking lot. As compared to the Proposed Action, Alternative 3 reduces ground disturbance by approximately 114 acres[72] and vegetation removal by approximately 12 acres.

While Alternative 3 includes a reduced amount of ground and vegetation disturbance than the Proposed Action, the overall impact to the sacred nature of the Peaks is estimated to remain the same. The issue of disturbance to the Peaks is essentially not one of how much land is disturbed, but that any land is disturbed at all. From the perspective of the Tribes, any additional disturbance to the landscape is adverse and would harm the spiritual nature of the Peaks, the effectiveness of the Tribes' prayers to the Peaks and the spiritual beings that reside there, and the relationship between those beings and human-kind. As with the Proposed Action, from an ethnographic landscape perspective, ground and vegetation disturbances within the SUP area could further impact the visual quality of the Peaks. In addition to the Snowbowl's existing facilities and trails, Alternative 3 may further impact the spiritual character of the Peaks and the ability for rituals to be effective.

The Navajo consider the Peaks to be a living entity, the home of "the Mountain People," that is, the wildlife, the plant people, people of the rocks, people of the underbrush, people of the water, and people of the sky, as well as being the source of rain.[73] To alter the landscape then would harm this living being. The amount of harm is not an issue; any harm to the Peaks will affect all the living things that reside there.

The major issue with Alternative 3 concerns the effects related to vegetation removal and their visual impacts. While the tribes have not identified any plants or other materials of traditional importance that are gathered from the Snowbowl SUP area, because they relate to the Peaks as a whole, as an ethnographic landscape, they are still concerned about plant and ground disturbance within the SUP area. Should Alternative 3 be selected, the Forest Service would work with the Tribes to help mitigate their concerns by minimizing the visual impact of approved projects through feathering and prompt revegetation. While these actions would not completely mitigate the spiritual impacts to the Peaks, they could help alleviate direct impacts to vegetation.

[72] Approximately 64 acres of this reduction in ground disturbance are associated with off-site construction of the reclaimed water pipeline between the Snowbowl and Flagstaff.
[73] Pilles, 2003, section 8:1

National Register Nomination

Some people feel the effects of the Proposed Action cannot be adequately described until the significant qualities of the San Francisco Peaks are identified as part of the National Register nomination process.

Indicators:

Narrative Discussion Why the Proposed Action is Not Dependent Upon Completion of the National Register Nomination/Designation Processes

Narrative Discussion of the Ability for the Proposed Projects to Coexist With a National Register Designation If Nomination Is Approved

Alternative 1 – No Action

The San Francisco Peaks is a TCP as defined in National Register Bulletin 38: *Guidelines for Evaluating and Documenting Traditional Cultural Properties.* The Peaks have also been determined eligible for inclusion in the National Register of Historic Places as part of the White Vulcan Mine Settlement Agreement and Mine Closure in August 2000. As a result of its determination of eligibility, the Forest Service is required to consult with Tribes and interested parties regarding the effect of the Proposed Action upon the Peaks, regardless of whether the Proposed Action occurs.[74] The Forest Service is in the process of completing a National Register nomination for the Peaks as a TCP. The area to be designated as a TCP would be inclusive of the Arizona Snowbowl SUP and would encompass 74,380.5 acres of NFS lands.

Alternative 2 – The Proposed Action

The Proposed Action would have no impact on the National Register status of the San Francisco Peaks as a TCP. Completion of a National Register nomination is underway by the Forest Service and will occur regardless of whether the Proposed Action is approved. The Arizona State Historic Preservation Office, San Carlos Apache, Yavapai-Apache, Hualapai, and Yavapai-Prescott Tribes have reviewed drafts of the nomination. The Hopi are in the process of reviewing and commenting on the draft nomination. The Snowbowl SUP area accounts for one percent of the area being nominated to the National Register,[75] and it is assumed that the cultural values of the Peaks would be retained, even if the religious values were adversely effected as a result of the Proposed Action.

Alternative 3

The impacts of selection of Alternative 3 on the National Register eligibility of the San Francisco Peaks as a TCP are assumed to be identical to those of the Proposed Action - the cultural values that pertain to the Peaks would be retained, even if the religious values were adversely affected.

[74] 36 CFR Part 800, Protection of Historic Properties.

[75] Calculation based on the 74,381-acre area included in the TCP nomination and the existing 777-acre SUP area.

CUMULATIVE EFFECTS

Scope of Analysis

Spatial Bounds

In considering the cumulative actions that have affected cultural resources in the past, and could potentially effect them in the future, the entirety of the San Francisco Peaks within the TCP boundary were evaluated. As a result, past, present, and reasonably foreseeable future actions both within and beyond the Snowbowl SUP Area were considered in this cumulative effects analysis.

Temporal Bounds

The Peaks have maintained a cultural and religious role in the lives of indigenous peoples in the Four Corners area for centuries – well before the establishment of the Snowbowl in 1938. Therefore, for the purposes of this cumulative effects analysis, it is assumed that effects to cultural resources on the Peaks began well before 1938, with impacts such as logging, mining, and fires, dating back to the latter half of the 19th Century.

Past, Present and Reasonably Foreseeable Future Actions

A review of past, present, and reasonably foreseeable future actions is important when considering effects to the religious and cultural values of the Peaks. Past actions include a number of activities which have occurred on, and in the vicinity of, the San Francisco Peaks, both within and beyond the Snowbowl SUP area. Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Within SUP Area

1. Development of ski area infrastructure over the past six decades, including: aerial and surface lifts, approximately 139 acres of developed trails, two guest lodges, paved and dirt roads, and parking facilities
2. Year-round visitation and activities including skiing, the summer Sky Ride program, weddings, and occasional concerts.
3. Snowbowl Wireless Communications Site (approved but yet to be constructed)

Outside of SUP Area

1. Development of the Inner Basin Well Field
2. Ongoing improvements and maintenance to the Inner Basin Water Pipeline
3. Adjacent private land development
4. Kachina Peaks Wilderness designation
5. Snowbowl Road parking restrictions
6. San Francisco Mountain Mineral Withdrawal

7. White Vulcan Mine Settlement and Reclamation
8. Peaks Segment of the Arizona Trail
9. Miscellaneous/ongoing recreational uses
10. Bebbs Willow Restoration Project
11. Peaks Nomination to National Register
12. Fort Valley Restoration Project

Considered individually, none of these projects has been regarded as posing, adverse effects on the spiritual or cultural values of the Peaks. However, when considered cumulatively, these individual projects may have already affected these values to an unknown degree.

Alternative 1 – No Action

From an ethnographic landscape perspective, over time, the previously-noted historic ground and vegetation disturbances have individually and cumulatively effected, or "scarred," the Peaks. Visual impacts on shrines and trails used for traditional religious and cultural purposes may affect the integrity and effectiveness of tribal ceremonies and prayers directed to the Peaks. As indicated, when considered individually, none of these projects has been determined to have caused, adverse indirect effects to the Peaks. However, when considered cumulatively, they may have affected the Peaks' spiritual character and its centrality to traditional religious and cultural perspectives.

While the tribes have indicated concern and dissatisfaction with the existing conditions of the Peaks due to historic projects and activities, they have not indicated that past actions and the continued existence of permitted activities within the Snowbowl SUP area would have any additional effects on their abilities to continue conducting their religious ceremonies. Some statements, including one made on December 9, 2002 by Bucky Preston at the Kykotsmovi public meeting, indicate concern with the existing conditions: *"that the drought may be a result of the developments and activities that have occurred on the Peaks. This is the way the spirits tell the people that something is wrong; by not providing much needed moisture."* In 1981, former Hopi Tribal Chairman Abbott Sekaquaptewa stated,

> *"…Hopis believe that continued or expanded commercial use of the home of the Katsinam (the Peaks) for a ski area or any other similar commercial or recreational purpose, would constitute a direct affront to the Katsinam and to the Creator, thereby resulting in severe adverse consequences to the Hopis and all mankind…."*

While these statements indicate concern over the effects of commercial use of the Peaks upon Hopi culture and quality of life for humanity, under the No Action Alternative, on-going religious practices would continue.

Past, present, and reasonably foreseeable projects that could have a negative effect on the spiritual integrity of the Peaks due to scarring and increased human/infrastructural presence include: construction of the Inner Basin Well and Pipeline; increased recreational use of the

mountain; the construction and operation of the White Vulcan Mine; past and present mining operations on patented mining claims; construction of various utility corridors; adjacent private land development; and special uses such as weddings and family reunions in the area.

However; positive effects have been identified as well. Closing of the Snowbowl Road to winter parking and thereby dispersed Snowplay activities has had a positive effect on the San Francisco Peaks and traditional uses as Native Americans have safer and improved access to areas along the road and are now able to conduct traditional practices in a more uninterrupted/private manner. Forest restoration projects have also had a positive effect on the Peaks. Aspen exclosures, wildlife closure areas, road closures, Hart Hill restoration, the Kachina Peaks Wilderness designation, Fort Valley Ecosystem restoration, White Vulcan Mine Settlement and Restoration, and trails that concentrate previously dispersed use have all had positive effects on the Peaks because they are helping to restore the area to a more natural state through ecosystem restoration and limiting dispersed, public use. Determining the Peaks eligible for the National Register of Historic Places has provided the Peaks additional protection in that any undertaking on the Peaks now requires specific tribal consultation.

Alternative 2 – The Proposed Action

In a cumulative context, all alternatives would result in adverse, long-term effects to the cultural and spiritual values of the Peaks. While the Proposed Action would ultimately have a greater cumulative effect, due to the introduction of snowmaking and reclaimed water, under either action alternative the development of additional facilities would further affect the current physical and spiritual condition of the Peaks when assessed with other past, present and reasonable foreseeable future projects.

According to Daniel Peaches, member of the *Dine'* Medicine Man's Association,

> *"Once the tranquility and serenity of the Mountain is disturbed, the harmony that allows for life to exist is disrupted. The weather will misbehave, the ground will shift and tremble, the land will no longer be hospitable to life. The natural pattern of life will become erratic and the behaviors of animals and people will become unpredictable. Violence will become the norm and agitation will rule so peace and peacefulness will no longer be possible. The plants will not produce berries and droughts will be so severe as to threaten all existence."*[76]

Native American inhabitants of the area believe not that they own the land, but that they are only custodians responsible for passing the resource on to the next generation – unimpaired. Both Hopi and Navajo traditions emphasize the importance of the Peaks to the cultural integrity of their people. All tribes consulted indicate that disruption of the natural presence of the Peaks is a disturbance to the guiding spiritual forces that reside there, and as the natural quality of the Peaks

[76] Peaches, 1998

succumbs to the manipulations of humans, it is believed that the cultures of the tribes also will perish, and that all life will be adversely affected.[77]

Many tribal members believe the ground and vegetation disturbance that would occur as a result of implementing the Proposed Action, in addition to past ground-disturbing activities, could lead to the following cumulative impacts to the San Francisco Peaks:

- Further destroys the reciprocal relationship between humans and spiritual forces needed to maintain the traditional cultures of the tribes.
- Further impact the visual quality of the San Francisco Peaks.
- Additional scarring of the Peaks further disturbs the spiritual forces and beings who reside in the Peaks and, as a result of this disturbance, impairs the effectiveness of ceremonies needed to maintain the harmony of life and existence of all living things.
- With better facilities, the ski area would receive increased annual visitation. As a result, there may be more opportunity for conflicts with traditional use of the mountain and an overall disturbance of the Peaks' tranquility and serenity.

Therefore, beyond the previously-identified direct/indirect impacts of machine-produced snow and reclaimed water use on the spiritual integrity of the Peaks, from a Tribal perspective, additional vegetation and soil disturbance related to construction of additional developed trails, roads, parking lots, buildings and snowmaking infrastructure would further affect the cultural landscape of the San Francisco Peaks, potentially causing additional physical harm through scarring. In addition, implementation of Alternative 2 would increase total annual visitation to the Peaks, thereby disturbing its tranquility and serenity. As noted, from an ethnographic landscape perspective, additional ground and vegetation disturbance, use of reclaimed water and the increased moisture that would result from machine-produced snow within the SUP area combined with other past, present, and reasonably foreseeable future projects could further cumulatively impact the visual quality and spiritual integrity of the entirety of the Peaks.

The positive effects would be the same as they are for the No Action Alternative. Additionally, more opportunity for monitoring special places may result. The development of a Cultural Center within the SUP area could offer tribes the opportunity to educate the general public about the sacred nature of the Peaks. Increased public awareness, when considered cumulatively with other previously-identified positive impacts may then help minimize future impacts on the religious and cultural values of the Peaks.

Alternative 3

Ground and vegetation disturbance that would occur as a result of implementation of Alternative 3 are essentially the same as under the Proposed Action, minus that associated with the snowmaking system and snowplay area.

[77] Pilles, 2003

As with the Proposed Action, when considered with other past, present and reasonably foreseeable future actions, implementation of Alternative 3 would result in adverse, long-term cumulative effects to the cultural and spiritual values of the Peaks, as described in the previous pages.

The positive cumulative impacts would be the same as they are for the No Action Alternative and Alternative 2.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There are three potential impacts that would have long-term and lasting effects on the Peaks from a cultural perspective: 1) the addition of snowmaking technology (adding moisture to the Peaks at times when it is otherwise dry); 2) the use of reclaimed water rather than relying on natural precipitation to create snow; and 3) the removal of vegetation and ground disturbance for the construction of trails and other infrastructure. Under all alternatives, the spiritual and cultural values of the Peaks as they relate to the tribes would continue to be impacted and are perceived by many tribal members as irretrievable for as long as the current and proposed facilities exist within the Snowbowl SUP area.

Alternative 1 – No Action

While the historic and present impacts to the cultural and spiritual qualities of the Peaks are believed to be irretrievable in nature, with time, the SUP area could technically be reclaimed by removing the buildings, equipment, and other infrastructure at the Arizona Snowbowl and rehabilitating the area to return it to a near-natural appearance. Therefore, historic and present cultural and spiritual impacts are not considered irreversible under the No Action Alternative

Alternative 2 – The Proposed Action

With implementation of the Proposed Action, it is assumed that there would be much greater disruption to the spiritual and cultural values of the tribes than currently exists and the impacts would be longer lasting.

It is difficult to assess whether the impacts are irretrievable or irreversible in the case of snowmaking, as tribal members believe it is the spiritual beings and forces who create precipitation. Many Hopi believe that with the addition of snowmaking technology on the Peaks, there is the possibility that the *katsinam* would leave or stop making snow because they would no longer be needed (i.e., “if people can make their own moisture, they do not need the *katsinam*…”). Many Hopi believe that even if snowmaking is suspended or removed for a period of time, it is impossible to determine for certain whether or not the *katsinam* would return or renew the production of moisture. While there is no means to assess how religious values would be permanently impacted with the use of snowmaking technology, based on the belief systems of many of the tribes, at least a portion of these impacts must be considered as a potentially irreversible impact to these tribes’ religious and cultural foundations. In addition, the use of reclaimed water is believed by the tribes to be impure and would have an irretrievable

impact on the use of the soil, plants, and animals for medicinal and ceremonial purposes throughout the entire Peaks, as the whole mountain is regarded as a single, living entity.

Additional vegetation and ground disturbance due to the construction of new parking lots, trails, lifts and infrastructure under the Proposed Action would impact the Peaks, as indicated in the analysis of direct and indirect effects. When viewed from the tribal perspective the impacts of vegetation removal to the spiritual and cultural qualities of the Peaks can be regarded as irretrievable in nature, since they effect values based upon faith and cultural beliefs. However; a literal interpretation of the terminology implies that historic and proposed ground/vegetation disturbance could be considered *reversible* because ecological, visual, and aesthetic functions of the landscape of the Peaks (within and outside of the SUP area) could be restored in the long term if facilities were removed and disturbed areas allowed to recover. Regardless, the Forest Service acknowledges the tribal perspective of the effects of "scarring" on the sacred landscape and that the associated spiritual and cultural impacts may in fact be considered *irreversible* in nature.

Alternative 3

Ground and vegetation disturbance on the Peaks would be reduced in Alternative 3 as compared to those of the Proposed Action. Overstory vegetation removal is reduced by 11.9 acres, permanent ground disturbance is reduced by 8.7 acres, and temporary ground disturbance is reduced by 105.4 acres.

Under Alternative 3, from some tribal perspectives, additional ground and vegetation disturbance may represent an irretrievable impact to the spiritual integrity of the Peaks and to the use of soils, plants, and animals for medicinal and ceremonial purposes. However, with time the SUP area could, theoretically, be reclaimed and infrastructure dismantled. Therefore, these impacts are not considered irreversible.

3B. NOISE

SCOPE OF THE ANALYSIS

This noise analysis was conducted within, and adjacent to, Snowbowl's SUP area. This analysis was conducted in four phases:

1. **Ambient[78] noise level monitoring:** Sound level measurements were performed to help determine the existing ambient noise levels for this area.

2. **Noise Level Prediction:** Based on sound level data, and locations for the various equipment proposed to be used, noise levels were calculated and predicted for closest/worst-case receiving locations.

3. **Determined/Developed Acceptable Noise Level Limits:** Applicable studies, codes, and standards were researched in order to determine the acceptability of the potential noise levels from the proposed operations.

4. **Conclusions:** Noise level predictions were compared with existing ambient noise levels and acceptable noise level limits.

EXISTING CONDITIONS

AMBIENT NOISE LEVELS

Based on professional judgment, ambient noise level measurements in the vicinity of the Snowbowl were collected at three locations: 1) the northwest section of the Snowbowl's base area – near the bottom terminal of the Hart Prairie Chairlift; 2) just off of Snowbowl Road, approximately ¼ mile southwest of the base area; and 3) in the Hart Prairie/The Nature Conservancy area, along Forest Road 151 (and east of the road at the Kachina Peaks Wilderness boundary). Measurements were taken at the Snowbowl in order to obtain a baseline ambient noise level at the "source" location. The other measurement sites were selected to determine the ambient noise level at the "receiving" locations of concern (i.e., the nearest Wilderness and residential areas). Measurements were performed on Sunday night the 24th of August, 2003. Sunday night was selected because it was assumed that it would give the most conservative (i.e., the quietest) ambient levels. Weather during the measurement period was calm and clear with no wind.

The ambient noise levels are highly dependant on the amount of wind on a given night. Based on the noise level measurements, the ambient noise level at each of the three sampling locations

[78] *Ambient* - (As used in this report) Typical background noise associated with a given environment excluding the specific noise under investigation and the transient noise from isolated identifiable sources.

could be 30 (dBA)[79], or lower, on a calm, clear night. However, with 10 mile per hour winds, the ambient could exceed 43 dBA.

The existing noise sources in the area include snowmobiles, passenger vehicles, and wind. The existing noise impacts from these sources to the receiving locations could range from 43-85 dBA. This is based on the following typical sound levels:

Table 3B-1
Typical Sound Levels from Various Sources

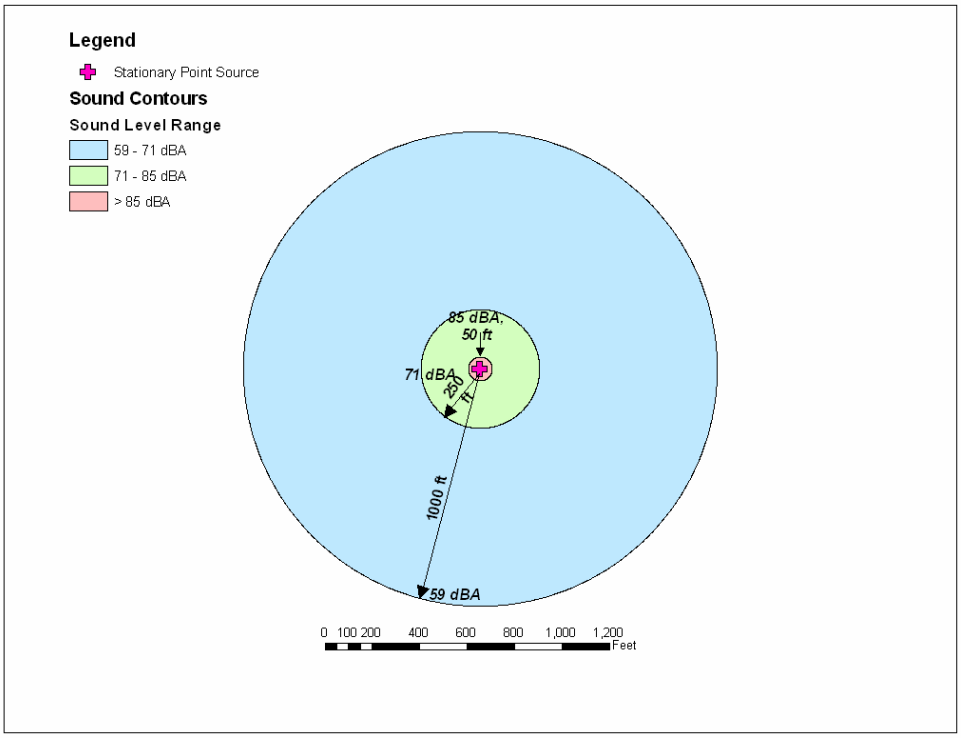
	50 Feet	250 Feet	1,000 Feet
Snowmaking Tower Gun	85 dBA	71 dBA	59 dBA
Snowmobile (1)	85 dBA	71 dBA	59 dBA
Passenger vehicle (1)	67-71dBA	53-57dBA	41-45dBA
Wind	43+ dBA	43+ dBA	43+ dBA

Source: Acoustical Consulting Services, 2003.

A contour plot portraying the behavior of sound level versus distance for the stronger sources outlined in Table 3B-1 (the snowmaking tower gun and the snowmobile) is shown in Figure 3B-1.

[79] *dBA* - Sound pressure level expressed in decibels, filtered or weighted at the various frequencies to approximate the response of the human ear.
Decibel - A unit for measuring the intensity of sound. The human hearing range is from 0 dB (the theoretical threshold of audibility) to 130 dB (the average pain threshold). The sound pressure level in decibels is equal to 10 times the logarithm (to the base 10) of the ratio between the pressure squared divided by the reference pressure squared. The reference pressure used in acoustics is 20 microPascals.

Figure 3B-1
Sound Level versus Distance



EXTERIOR NOISE STANDARDS

There are no Coconino County or State of Arizona noise codes. Because the Snowbowl is outside of the city limits of Flagstaff, the ski area is not subject to Flagstaff's noise nuisance codes.

Typical municipal ordinances set not-to-exceed limits and consider instantaneous noise levels below 50 to 55 dBA at night and 60 to 65 dBA during the day to be acceptable. Some suburban and rural municipalities have set nighttime limits as low as 45 dBA.[80]

The only applicable national noise code is established in the US Housing and Urban Development Department (HUD) regulations. The potential noise from Snowbowl is not subject to HUD but is still in compliance. HUD sets forth the following exterior noise standards:

[80] Cowan, J.P., 1994

Table 3B-2
HUD Regulations for Exterior Noise

Rating	Threshold
Acceptable	65 L_{dn}[a] or less
Normally Unacceptable	Exceeding 65 L_{dn} but not exceeding 75 L_{dn}
Unacceptable	Exceeding 75 L_{dn}

[a] L_{dn} - Day Night average sound level (DNL) is the 24-hour average sound level, in decibels, obtained after the addition of 10 decibels to the sound levels occurring between 10:00 p.m. and 7:00 a.m.
[b] To achieve an acceptable status, appropriate sound attenuation measures must be provided

INTERIOR NOISE STANDARDS

HUD's regulations do not contain standards for interior noise levels. Rather a goal of 45 dBA is set forth and the attenuation requirements are designed to achieve that goal. It is assumed that with standard construction, any building will provide sufficient attenuation so that if the exterior level is 65 L_{dn} or less, the interior level will be 45 L_{dn} or less. According to the Environmental Protection Agency (EPA), the approximate national average Sound Level Reduction for homes is 25 dB.

TYPICAL AUDIBILITY OF COMMON NOISE SOURCES

The following table provides a reference for audibility and the typical sound pressure levels associated with common noise sources:

Table 3B-3
Noise Levels (dBA) for Common Noise Sources

Common Noise Source	Sound Pressure Level (dBA)	Subjective Evaluation
Human breathing at three feet	8-10	Just Audible
Quiet rural area or a bedroom at nighttime	25-30	Very Quiet
Wind in trees at 10 mi/hr or soft stereo music in a residence	40-45	Quiet
Birds at 10 feet or normal conversation at three feet	55-60	Moderate
Electric shaver at 1.5 feet	+/- 68	
Vacuum cleaner at 10 feet or a large dog barking at 50	70-75	Loud
Alarm clock ringing at five feet	+/- 80	
Lawn mower at five feet, food blender or garbage disposal at three feet	85-90	Very Loud
Train pulling hard at 100 feet	+/- 94	
Train siren at 50, motorcycle at 25 feet, car horn at 10 or a chain saw at two feet	100-110	Extremely Loud
Thunder nearby	+/- 115	
Hard rock band at 16 feet or a jet aircraft at 300 feet during takeoff	120-130	Painful
Jet aircraft at 75 feet or a long range gun at 0 feet	140	Deafening

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

The proposed snowmaking system would increase noise levels potentially disturbing residents, recreationists, and/or wildlife.

Indicators:

Modeled Analysis of Snowmaking-Related Noise Emissions Above Ambient Background Levels (Dba)

Modeled Analysis of Noise Dispersion to Define Audible Areas

Alternative 1 – No Action

The No Action Alternative would not result in any additional noise levels within, or in the vicinity of, the Snowbowl's SUP area. The existing noise sources in the area include snowmobiles, passenger vehicles, and wind. The existing noise impact from these sources to the northwest of the Snowbowl base area, south of the Snowbowl near Snowbowl Road; and in the Hart Prairie/The Nature Conservancy currently ranges from 43-85 dBA. Noise levels would not be expected to increase above existing levels.

Alternative 2 – The Proposed Action

With the Proposed Action, existing noise sources would remain, and would be compounded by the following potential noise sources:

- temporary construction vehicles and equipment
- snowmaking fan and tower guns
- water transmission pump stations
- snowmaking control building noise emissions

Temporary Construction Noise

Construction of the proposed projects, including: installing the reclaimed water pipeline between Flagstaff and the Snowbowl base area, snowmaking infrastructure, lift terminals and towers, buildings, and terrain modifications could include temporary noise sources such as heavy equipment (72-93 dBA at 50 feet), rock drills (81-98 dBA at 50 feet), and helicopters (65 dBA at 1,300 feet).

Fan Guns & Tower Guns (Snowmaking Equipment)

With implementation of the Proposed Action, there could be as many as 25 fan guns and 25 tower guns in operation at any one time. The proposed snowmaking system would likely be operating at 100 percent during the early season (late November through December), or as soon as ambient temperatures drop to suitable levels for making snow. Because of Snowbowl's irregular climate (as compared to other ski areas with snowmaking technology), all or part of the snowmaking system could be brought on-line at any time throughout the season to compensate for a lack of natural precipitation. During the pre- and early season, snowmaking would likely

occur at night, when temperatures drop. However; as daytime temperatures decrease throughout the season, the length of time over a 24-hour period in which snow could be made would increase.

Each tower gun produces an average noise level of 73 dBA at 200 feet and each fan gun produces an average noise level of 62 dBA at 200 feet.

Booster Stations

There is no specific noise data available for the booster station equipment. However, each of the pump stations would be enclosed in a concrete vault which would decrease exterior audibility of the pump substantially. According to the pump manufacturer the noise emissions from booster stations should not be audible beyond 100 feet.

Snowmaking Control Building

The proposed snowmaking control building would house additional pumps and air compressors. All equipment would be electrically powered and contained within the building. Due to the low noise emissions of the equipment and their containment within the building, the control building equipment is not expected to be audible beyond 100 feet from the building.

Potentially Disturbed Areas

With the addition of potential noise emission sources, the following areas were investigated for potential to be affected: Hart Prairie residences, Fort Valley, and surrounding northern goshawk/Mexican spotted owl habitat.

Hart Prairie/The Nature Conservancy

The Hart Prairie area is located approximately 1.5 miles west (downhill) of the Snowbowl base area. Based on very conservative noise propagation modeling, this area could be affected by nighttime snowmaking noise levels as high as 38 dBA under certain atmospheric conditions.[81] At these distances, atmospheric conditions such as temperature and humidity can influence sound propagation. The projected 38 dBA is based on worst-case noise levels for various combinations of temperature and humidity.

During the construction period, Hart Prairie/The Nature Conservancy area could be temporarily impacted by rock drills (37-54 dBA) and backhoes (28-49 dBA) and helicopters (65 dBA at 1,300 feet).

Although this potential temporary and permanent noise levels could exceed the existing minimum ambient noise level of ≤ 30 dBA (see Existing Conditions) in the Hart Prairie/The Nature Conservancy area, it would be well below the on-going noise sources in the area, such as snowmobiles, passenger vehicles, and wind. As previously described, existing ambient noise levels currently range from 43-85 dBA.

[81] Outdoor sound propagation models accounted for variables including distance, air absorption, ground attenuation, and vegetation. The projected noise impact assumes all 50 snowmaking guns would be operating simultaneously.

Although the potential noise impacts to the Hart Prairie/The Nature Conservancy area may be audible outdoors, the levels should not exceed typical noise standards. The projected maximum potential *outdoor* noise impact of 38 dBA detectable in Hart Prairie/The Nature Conservancy area from snowmaking would be in compliance with the HUD standards provided in the Existing Conditions section.

Based on the HUD and EPA assumptions provided in the Existing Conditions section, the potential maximum *interior* noise level should not exceed 13-18 dBA at the Hart Prairie/The Nature Conservancy area. The projected *indoor* maximum potential noise impact of 18 dBA would also be in compliance with HUD and all known interior noise standards.

As compared to the common noise sources presented in Table 3B-3, the subjective audibility of the operation of the snowmaking system would be "very quiet" to "quiet" with the temporary audibility of construction activities being subjectively characterized as "quiet" to "moderate."

Fort Valley Area

The Fort Valley residential area is located approximately four miles to the south of the Snowbowl SUP area. Given this distance and the attenuation of noise emissions, it is easily determined that operation of the proposed snowmaking system will not be audible within the Fort Valley area. The area may be temporarily affected by audible noise during the construction of the water transmission line from Flagstaff to the Snowbowl.

Northern Goshawk/Mexican Spotted Owl Habitat

An assessment of the effects of noise to both northern goshawk and Mexican spotted owl and their habitat areas was conducted as a portion of this analysis. Details of this analysis and a determination of effects are presented in the Wildlife Section of this document.

Alternative 3

The potential noise sources described within the Proposed Action are all dependant on the addition of snowmaking. With the elimination of snowmaking from the Proposed Action, (with the possible exception of temporary construction activities for the installation of lifts and building construction) noise levels would not increase above existing levels, as described for Alternative 1.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

Proposed snowmaking infrastructure would increase the amount of noise generated throughout the Snowbowl winter operating season both during the day and at night for an indefinite amount of time (i.e., for as long as Snowbowl is in operation). Snowmaking operations would typically take place at night when ambient temperatures are lower than during the day. However, snowmaking would occur whenever ambient temperatures permit, especially during the pre- and early season.

Spatial Bounds

The affected environment relevant to a discussion of cumulative affects on "natural quiet" includes the area where noise generated by both construction activities (short-term) and normal operations (long-term) is heard by people. Similar to the aesthetics analysis, the ridge system that encloses the Snowbowl facilities also encloses sounds generated by ongoing activities at the ski area. Louder noises generated by ongoing Snowbowl activities, such as outdoor concerts, can be heard as far away as Humphreys saddle at the upper end of the Humphreys Trail. Such noises diminish rapidly as topographic screening intervenes between the noise source and the listening receptor; though specific climatic conditions can cause such noises to travel well beyond the prominent topographic screening features. As noted in the discussion of direct/indirect effects, noise projected to the west of the Snowbowl SUP area, which is not bounded by topographic features, rapidly diminishes and approaches ambient noise levels by the time it reaches FR 151. Based on modeling conducted for this analysis, sound levels from normal snow gun operations (assuming 25 tower guns and 25 fan guns) are in operation simultaneously) should be well below ambient natural sound by the time it reaches U.S. Highway 180, just over three miles from the sound source. Noise from construction would be louder than general operational noise and would carry farther, but would be short-term and intermittent and would only be heard during specific construction activities. Likewise noise from pipeline construction would be generated from outside the Snowbowl operational area but would only occur during construction of the project.

Past, Present, and Reasonably Foreseeable Future Actions

Past, present, and reasonably foreseeable projects that could cumulatively affect natural quiet include:

1. Bebbs Willow Restoration project in Hart Prairie
2. Residential and summer home development in Hart Prairie
3. Assorted and ongoing utility line clearing and maintenance
4. Snowbowl cellular tower (approved but not yet built)
5. Hart Hill restoration
6. Transwestern lateral pipeline construction
7. Arizona Trail – Peaks segment

Appendix C includes the full list of past, present, and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

With the exception of minor residential and summer home development and use in lower Hart Prairie, noise generated from all of these sources is anticipated to be intermittent and/or short-term (related to construction activities) in nature. None of the past, present, or reasonably foreseeable activities identified above are anticipated to cumulatively combine with activities included under any of the alternatives analyzed within this document to result in measurably cumulative noise levels.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

With the exception of temporary, construction related disturbance to wildlife (which would be considered irretrievable), no other irreversible or irretrievable commitments of resources have been identified in this noise analysis.

3C. TRAFFIC AND SKI AREA ACCESS

SCOPE OF THE ANALYSIS

The scope of this traffic analysis is limited to U.S. Highway 180 (between the Snowbowl and Flagstaff) and the Snowbowl Road.[82]

EXISTING CONDITIONS

SKI AREA ACCESS

Snowbowl Road is a seven-mile long Forest System road that is maintained by the Forest Service and the ski area. While the entire length of the 28 foot-wide Snowbowl Road is paved, curves and steep grades make for a necessarily slow approach to, and exit from, the ski area.[83] The present Snowbowl Road was designed in the mid-1980s following a snowy winter with high ski area attendance. While the Road was not constructed to a documented design capacity, it has been reviewed and is considered adequate to accommodate existing and peak day attendance at the ski area.[84]

Once guests reach the main base area, they have two options for parking. The Hart Prairie base area offers five parking lots. Approximately ¼-mile further up the road, four more lots are located adjacent to the Agassiz base area. Just past the Hart Prairie parking lots, vehicles often encounter skiers walking across the road to and from the Hart Prairie Lodge from the base of the Sunset Chairlift. The nature of multiple parking lots offered between two base areas, combined with a mix of pedestrian and vehicular traffic, provides for a less-than-ideal situation in terms of safety and general circulation.

PARKING

Guest parking is provided in nine lots (totaling approximately 10.3 acres) which collectively accommodate approximately 1,200 cars (116.5 cars/acre, allowing for snow storage). The parking areas are allocated with approximately 436 spaces in the upper lots adjacent to the Agassiz base area and 764 spaces in the lower lots proximate to the Hart Prairie base area. Applying an average occupancy rate of 2.5 passengers per vehicle, Snowbowl's parking areas currently have a capacity of approximately 3,000 guests. This parking capacity is more than adequate to accommodate Snowbowl's existing CCC of 1,880 guests but becomes the constraint to total visitation on peak days.

On peak days, attendance far exceeds the ski area's CCC. An analysis of the ten highest attendance days for each year between the 1992/93 and 2002/03 seasons indicates that the Snowbowl averaged 3,434 guests on peak days. Thus, peak days have historically averaged over

[82] In conjunction with this analysis of traffic and ski area access, the Forest Service completed a Roads Analysis (RAP) to assist in making decisions concerning the lands contained within the Arizona Snowbowl permit area. The Roads Analysis is contained in the project file.
[83] The posted speed limit is 30 mph for dry conditions.
[84] Standing, Paul, 2003

180 percent of Snowbowl's current CCC,[85] which tax the ski area's available parking capacity. Buses transporting guests from the Phoenix area park at the overflow lots, as well. In assessing Snowbowl's current infrastructure, parking is currently the constraint limiting overall attendance.

TRAFFIC

The Snowbowl is accessed via Snowbowl Road (Forest Service Road #516), seven miles north of Flagstaff off of U.S. Highway 180. Traffic on U.S. Highway 180 related to Snowbowl's seasonal operations primarily occurs between Flagstaff and the Snowbowl Road, as there are essentially no population centers north of the Snowbowl Road that significantly contribute to attendance at the ski area.

The Data Section of the Arizona Department of Transportation's (ADOT) Transportation Planning Division is responsible for road and highway use data throughout the State. With some exceptions, Arizona's State Highway System consists of all roadways identified by wayside route number signing with an Interstate, U.S., or State shield. Traffic counting locations are marked along these roads by a small blue or white "TCS" (Traffic Counting Station) sign. Portable electronic vehicle counting and classifying equipment at these TCS stations is used to collect raw traffic volumes.

While ADOT has made many changes to Highway 180 over the past decade to improve safety and visibility, traffic typically spikes during the morning and evening rush (i.e., ingress and egress) between Snowbowl and Flagstaff. This is especially true on busy weekends and good snow days, and results in traffic being backed up on portions of Highway 180. This particularly affects residents from Coconino Estates, Cheshire, and Fort Valley.

Average Annual Daily Traffic

Raw data is processed and converted to average annual daily traffic (AADT) volumes. AADT is defined as the total volume of traffic on a road segment for one year, divided by 365 days. Both directions of traffic volumes are reported. AADT can be adjusted to compensate for monthly and daily fluctuations in traffic; the basic intent being to provide traffic volumes which best approximate the use of a given highway section for a typical day of the year.

Seasonal adjustment factors are developed from a network of automatic traffic recorders (ATRs). Currently, ADOT's Data Section operates 69 ATR stations statewide, which monitor vehicular traffic twenty-four hours per day each day of the year. These ATR stations are polled daily via telemetry and computer software to report the previous day's traffic activity. Traffic data polled from ATRs are stored and processed in both monthly and annual cycles, which are subsequently applied to raw counts taken on all highway segments that are assigned to a particular set of ATR stations.

While historic traffic volume data for U.S. Highway 180 between Flagstaff and the Snowbowl is somewhat limited, it has been collected at two locations: 1) between Schultz Pass Road and Snowbowl Road (approximately 3.5 miles south), and 2) between Snowbowl Road and Curley

[85] As indicated in Chapter 1, ski areas typically design facilities to accommodate up to 125 percent of CCC.

Seep Spring (approximately 13.5 miles north). AADT data for these two locations is presented for 1998 through 2002 in Table 3C-1.

Table 3C-1
AADT for U.S. Highway 180 in the Vicinity of Snowbowl
1998 - 2002

Location	AADT 1998	AADT 1999	AADT 2000	AADT 2001	AADT 2002
Schultz Pass Road to Snowbowl Road (TCS MP[a] #222.80)	3,396	3,721	3,858	3,944	2,237
Snowbowl Road to Curley Seep Spring (TCS MP #223.00)	2,934	3,644	3,778	3,863	2,100

[a] Traffic Count Section Milepost Number
Source: Arizona Department of Transportation, 2004

Skier visitation at Snowbowl between 1998/99 and 2002/03 is provided in Table 3C-2.

Table 3C-2
Snowbowl Skier Visits
1998/99 – 2002/03

Season	Visits
1998/99	35,205
1999/00	66,152
2000/01	162,175
2001/02	2,857
2002/03	88,000

Table 3C-2 provides a typical range of annual visitation at the Snowbowl which, incidentally, is directly related to annual snowfall (i.e., higher annual snowfall equates to higher annual visitation – refer to the Recreation Section of this chapter for more information). While a direct correlation between annual visitation at the Snowbowl and AADT for U.S. Highway 180 is difficult to make based on this limited data, it is logical to assume that fluctuating annual attendance at the Snowbowl has little direct impact on AADT for U.S. Highway 180. Correspondence with ADOT engineers confirmed that Snowbowl's wintertime operations, irrelevant of high or low attendance levels, have little impact on AADT for U.S. Highway 180.[86]

Average Daily Traffic

Average Daily Traffic (ADT) counts are typically useful in analyzing seasonal traffic patterns. ADT counts for U.S. Highway 180 at its intersection(s) with Peak View, Aspen, and Navajo are periodically collected by the City of Flagstaff, and are provided in Table 3C-3. In Snowbowl's case (due to the limited amount of data collected), this data is only marginally useful because the 2002 season was one of the worst on Snowbowl's records (48 inches of snow and just 2,850 total visits). Therefore, due to less snow and intuitively better driving conditions, ADT during

[86] Gillick, July 2003; Flaherty, June 2003

February of 2002 (the only winter month collected) is assumed to reflect much lower than average Snowbowl traffic and likely higher than average Grand Canyon traffic.

Table 3C-3
ADT on U.S. Highway 180

Intersection with Peak View Road		
ADT	**Month**	**Year**
5,497	June	2001
3,283	February	2002
4,295	July	2002
4,464	October	2002
4,952	October	2003
4,580	August	2003
(Humphrey's Street) Intersection With Aspen Street		
ADT	**Month**	**Year**
8,700	June	2001
10,728	July	2002
Intersection with Navajo		
ADT	**Month**	**Year**
18,765	August	2001
14,155	November	2002
15,967	July	2002
14,570	March	2002
15,197	March	2003
16,454	April	2003
12,998	August	2003
13,765	October	2003

Source: City of Flagstaff, 2004.

In addition to U.S. Highway 180, ADT counts have been collected for Snowbowl Road. This data is provided in Table 3C-4.

Table 3C-4
ADT for Snowbowl Road

ADT	Month	Year
158	August	2000
572	June	2001
231	February	2002
146	August	2002
710	October	2002
703	October	2003
117	August	2003

Source: City of Flagstaff, 2004.

Data provided by the Flagstaff Metropolitan Planning Organization indicates that ADT for U.S. Highway 180 typically peaks during the summer months, and tapers off considerably during the

wintertime.[87] This is due to use of U.S. Highway 180 by summertime travelers as the primary access route to the Grand Canyon.

By applying the average occupancy rate of 2.5 Snowbowl guests per vehicle discussed above, a generalization as to the Snowbowl's contribution to wintertime traffic volumes on U.S. Highway 180 can be made. Based on an exceptional season, such as 2000/01, in which annual visitation approached 163,000, approximately 65,000 vehicles on U.S. Highway 180 could be attributed to the Snowbowl's operations. On the opposite end of the spectrum, during a poor year such as the 1998/99 season, in which annual visitation only reached 35,000 guests, approximately 14,000 vehicles on U.S. Highway 180 and Snowbowl Road could be attributed to the Snowbowl's operations. A conservative estimate, in which these raw vehicular counts are converted to ADT between the months of December and March (four months) would equate to approximately 540 vehicles per day on the high end and approximately 115 vehicles per day on the low end. However, on peak days, which have historically occurred on a handful of days (approximately 10) each year as attributable to good snow conditions, holidays, and long weekends, attendance at the Snowbowl has been shown to average 3,400 guests; the Snowbowl's contribution to ADT on U.S. Highway 180 could approach 1,360 vehicles per day.

SNOWPLAY TRAFFIC

While in the past, snow on the San Francisco Peaks brought large crowds to NFS lands to snowplay (defined as sledding, tubing, saucering, or building snowmen), this activity is not permitted within the Snowbowl SUP area. Prior to the 2002/03 winter season, the general public was attracted to the areas along the Snowbowl Road for dispersed snowplay activities. These activities created ongoing public safety issues including: snow sliding on non-directional equipment (sleds, saucers and trash bags) in wooded or steep areas, pedestrian/vehicular encounters, sanitation, and refuse concerns, and difficulties for emergency vehicles passing through congested areas. During periods of abundant snow as many as 300 vehicles per day may have been parked along the Snowbowl Road belonging to visitors engaged in dispersed snowplay activities. Beginning with the 2002/03 winter season, the Forest Service has prohibited parking along the Snowbowl Road and initiated an active enforcement program. Although signs have been posted at the bottom of the Snowbowl Road informing visitors that snowplay is not allowed, scores of cars continue to drive up the road in search of snowplay opportunities. The majority of these visitors reach the Snowbowl base area only to be turned back by the ski area parking staff. On a peak day with good snow conditions, the Snowbowl parking staff may turn away as many as 500 cars full of visitors seeking an opportunity to play in the snow.[88] Unable to consistently discern skiing guests from snowplay visitors, the Snowbowl staff frequently is required to ask visitors found snowplaying in and adjacent to the parking areas and on the ski trails to leave. This creates an unfortunate and contentious situation for all involved.

[87] City of Flagstaff, 2000-2002

[88] Personal Communication with Snowbowl Management, 2003

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

The Proposed Action could affect traffic volumes and/or congestion on U.S. Highway 180 and/or the Snowbowl Road.

Indicators:

Historic and Projected Traffic Counts for U.S. Highway 180

Comparison of Anticipated Winter Traffic Volumes With Existing Winter Traffic Volumes and the Design Capacities Of U.S. Highway 180 and the Snowbowl Road

Relative Comparison of Existing And Anticipated Winter Traffic With Current Summer Traffic Volumes

Alternative 1 – No Action

Traffic

Generally speaking, future annual visitation levels under the No Action Alternative would be expected to resemble historic visitation, with possible slight increases attributable to regional population growth (refer to the Socio-Economic section for more details). Selection of the No Action Alternative, therefore, would not be expected to have any major impact on current or future traffic volumes for either U.S. Highway 180 or Snowbowl Road. Seasonal traffic attributable to Snowbowl's operations under the No Action Alternative would continue to be dictated primarily by weather conditions (i.e., better natural snow conditions would be expected to increase visitation and associated Snowbowl-related traffic). Conversely, poor natural snow conditions (and therefore better driving conditions) on U.S. Highway 180 would likely lead to increased vehicular traffic between Flagstaff and the Grand Canyon.

As indicated in the Recreation and Socio-Economics sections of this chapter, if the No Action Alternative were implemented, during the first eleven seasons the average annual wintertime attendance at the Snowbowl would be expected to hover around the historic average (as based on the past 22 seasons), which is approximately 105,000 visits. Applying 2.5 guests per vehicle, this equates to approximately 350 vehicles per day on U.S. Highway 180 between December and March (120 days) of each year that could be attributable to the Snowbowl's wintertime operations. Peak days, which have historically averaged approximately 3,400 guests, would be expected to occur on a handful of days each year under the No Action Alternative and could contribute as many as 1,360 vehicles per day on U.S. Highway 180.

As indicated, ADT on U.S. Highway 180 during the summer months is presumed to be much higher than during the winter. Under the No Action Alternative, Snowbowl's summertime operations would be expected to draw an insignificant amount of traffic, as no changes are proposed to the Sky Ride program. The summer Sky Ride program would be expected to continue to draw approximately 30,000 visitors each year between Memorial Day and Labor Day under the No Action Alternative, which would equate to approximately 95 vehicles per day on U.S. Highway 180 (at 3.5 persons/vehicle). Table 3C-5 provides recent as well as projected

AADT for US Highway 180 in the vicinity of Snowbowl Road. The No Action Alternative is not anticipated to affect projections for 2020.

Table 3C-5
AADT for U.S. Highway 180

Location	AADT 1998	AADT 1999	AADT 2000	AADT 2020
Schultz Pass Road (MP 218.55) to Snowbowl Road (MP 222.94)	3,396	3,721	4,150	5,935
Snowbowl Road to Curley Seep Spring (238.58)	2,934	3,644	4,065	5,825

Source: Arizona Department of Transportation, June 2003.; Flaherty, June 2003.

No modifications or upgrades to the Snowbowl Road would be necessary under Alternative 1.

As described within the Recreation analysis (Section F), a demonstrated demand exists for dispersed snowplay activities and would continue to go unmet under the No Action Alternative. The areas along the Snowbowl Road would remain closed to parking, and therefore snowplay activities. Despite efforts to inform the public of the parking and snowplay prohibitions, it is anticipated that numerous visitors (up to 500 vehicles per day, in some instances) would continue to drive up the Snowbowl Road only to be turned away by the parking staff.

Parking

Under the No Action Alternative, parking capacity (approximately 3,000 guests) would continue to constrain daily visitation at the Snowbowl. Peak days would likely continue to contribute guest parking demand in excess of 180 percent of CCC of 1,880.

Alternative 2 – The Proposed Action

Traffic

While average peak day attendance levels are not anticipated to increase under the Proposed Action, the frequency of these peak days is anticipated to increase throughout Snowbowl's winter operating season – which would be expected to contribute commensurate increases in seasonal traffic on U.S. Highway 180. Therefore, wintertime ADT associated with more consistent attendance at the Snowbowl would be projected to increase under the Proposed Action, as attributable to a more consistent snow pack (due to the installation of snowmaking), increased lift capacity, increased terrain, small increases in parking, and the snowplay facility.

As indicated in the Recreation and Socio-Economics sections, if the Proposed Action were implemented, during the first eleven seasons following implementation, annual wintertime attendance at the Snowbowl would be expected to average approximately 185,000 visits. Applying 2.5 guests per vehicle, this equates to approximately 500 vehicles per day on U.S.

Highway 180 between November 15 and April 15 (150 days) of each year[89] that could be attributable to the Snowbowl's operations. Peak days, which have historically averaged approximately 3,400 guests, would be expected to occur on a more frequent basis under the Proposed Action (due to more reliable and consistent snow conditions) and could contribute as many as 1,360 vehicles per day on U.S. Highway 180 and Snowbowl Road.

The snowtubing facility has been designed with a capacity of 600 tubers-at-one-time. However, it is assumed that the snowtubing facility would only approach full capacity on weekends and during holiday periods. The snowtubing facility's contribution to additional wintertime attendance at Snowbowl has been projected to fluctuate from 34,000 to 42,000 annual users.[90] While an average of 2.5 persons/vehicle is used to calculate parking and traffic for skiers, an examination of snowtubing guests at other ski area facilities indicates that the ratio for snowtubers per vehicle is higher - at three persons/vehicle. Based on a 100 day operating season for the snowtubing facility, this equates to an ADT of approximately 113 to 143 vehicles on U.S. Highway 180 and Snowbowl Road. Peak day snowplay usage could approach as many as 1,680 guests[91] which would result in approximately 560 additional peak day vehicles.

As detailed within the Existing Conditions section, although signs have been posted at the bottom of the Snowbowl Road informing visitors that snowplay is not allowed, Snowbowl parking staff may turn away as many as 500 cars full of visitors seeking opportunities to play on a snowy day. In light of the current and on-going volume of snowplay traffic on the Snowbowl that is turned away at Snowbowl's base area, and assuming that many of these vehicles would patronize the Snowbowl's snowplay facility, it can be reasoned that the proposed snowplay facility would contribute only a minor incremental increase in traffic on U.S. Highway 180 or Snowbowl Road.

Given a combination of peak day skier and snowplay facility attendance, peak day traffic on both the Snowbowl Road and U.S. Highway 180 may total approximately 1,920 vehicles. This total would represent an incremental increase above the base line condition of approximately 560 vehicles per day on a peak day. These totals would remain well below the summer and winter ADT for U.S. Highway 180. While design capacities for U.S. Highway 180 could not be obtained for this analysis, the Snowbowl Road was designed and constructed following a wet winter with high ski area visitation. The Snowbowl Road's ability to accommodate increased, more consistent, peak day traffic associated with the Proposed Action is not in question.[92] While overall peak day traffic is not anticipated to increase significantly under the Proposed Action, the frequency of busy days would increase across the course of the winter season.

As indicated, ADT on U.S. Highway 180 during the summer months is much higher than during the winter. Therefore, with implementation of the Proposed Action, Snowbowl's summertime operations would be expected to draw an insignificant amount of traffic on U.S. Highway 180, as

[89] The season length under the Proposed Action is assumed to be extended by approximately one month over Alternatives 1 and 3 due to the installation of snowmaking infrastructure.

[90] Snowtubing would only operate on weekends from Thanksgiving until December 22. At that point, the operation would begin daily operations. It is expected that the facility would operate until the third Sunday in March.

[91] Assuming four, two-hour sessions per day at a 70 percent use rate.

[92] Standing, Paul, October 2003

only minor modifications are proposed to the Sky Ride program (i.e., the opportunity for guests to hike down from the top of the Agassiz Chairlift). The summer Sky Ride program would be expected to continue to draw approximately 30,000 visitors each year between Memorial Day and Labor Day under the Proposed Action, which would equate to an average of approximately 95 vehicles per day on U.S. Highway 180 (at 3.5 persons/vehicle).

Parking

Under the Proposed Action, skier parking would increase by approximately 0.3 acre, providing for an additional 35 vehicles. This would bring total spaces at the Snowbowl to approximately 1,235, accommodating roughly 3,087 skiers. In addition, construction of the 3.3-acre snowplay parking lot would provide roughly 400 spaces *for snowplay use only*. While the snowplay facility has been designed with a capacity of 600 guests-at-one-time, the arrival and departure of guests in advance of and following a snowplay session will involve a considerable overlapping of parking needs. Additionally, by its nature, snowplay activities attract a high percentage of non-participating attendants such as parents/grandparents accompanying children.

However, even with modest increases in *skier* parking called for in the Proposed Action, skier parking would continue to constrain overall skier attendance at Snowbowl.

Under the Proposed Action, no upgrades or modifications to the Snowbowl Road would be necessary, other than routine maintenance.

Alternative 3

Traffic

Under Alternative 3, wintertime attendance at the Snowbowl, and therefore associated traffic, is anticipated to increase slightly above the No Action Alternative, but far below that of the Proposed Action. Alternative 3 does not include snowmaking or installation of the snowtubing facility which are the two key components of the Proposed Action that would be expected to generate additional wintertime visitation and traffic. Therefore, projected traffic attributable to Snowbowl's operations under Alternative 3 would be significantly constrained by unreliable natural snowfall. However, small increases in projected traffic volumes in Alternative 3 (beyond the No Action Alternative) may be realized as a result of regional population growth, potential construction of the Humphreys Pod (additional lift capacity and terrain), small additions to parking, as well as trail grading projects. The trail grading projects included in Alternative 3 are designed to allow Snowbowl to open trails under reduced natural snow conditions, and thereby would be expected to contribute to incremental increases in annual visitation (assuming adequate natural snowfall) as compared to the No Action Alternative. Essentially the same year-to-year fluctuations in visitation, and therefore traffic, as presented in the No Action Alternative remain applicable to Alternative 3.

As with the No Action Alternative, seasonal traffic volumes attributable to Snowbowl's operations under Alternative 3 would be primarily dictated by weather conditions (i.e., better natural snow conditions would be expected to induce visitation and associated Snowbowl-related traffic). Conversely, poor natural snow conditions, and therefore better driving conditions, on U.S. Highway 180 would likely equate to increased travel between Flagstaff and the Grand Canyon.

As indicated in the Recreation and Socio-Economics sections, if Alternative 3 were implemented, during the first eleven seasons following implementation the annual wintertime attendance at the Snowbowl would be expected to average approximately 110,000 visits. Applying 2.5 guests per vehicle, this equates to approximately 365 vehicles per day on U.S. Highway 180 and Snowbowl Road between December and March (120 days) of each year. Similar to the No Action Alternative, peak days, which have historically averaged approximately 3,400 guests, would be expected to occur on a handful of days each year under Alternative 3 and could contribute as many as 1,360 vehicles on U.S. Highway 180 and Snowbowl Road.

As indicated, ADT on U.S. Highway 180 during the summer months is much higher than during the winter. Under Alternative 3, Snowbowl's summertime operations would be expected to draw an insignificant amount of traffic on U.S. Highway 180, as only minor changes are proposed to the Sky Ride program (i.e., the opportunity to hike down from the top of the Agassiz Chairlift). The summer Ski Ride program would be expected to continue to draw approximately 30,000 visitors each year between Memorial Day and Labor Day under Alternative 3, which would equate to approximately 95 vehicles per day on U.S. Highway 180 (at 3.5 persons/vehicle).

As described within the Recreation analysis (Section F), a demonstrated demand exists for dispersed snowplay activities and would continue to go unmet under Alternative 3. Under Alternative 3, the Snowbowl Road would remain closed to parking, and therefore to snowplay activities. Despite efforts to inform the public of the parking and snowplay prohibitions, it is anticipated that numerous visitors would continue to drive up the Snowbowl Road only to be turned away by the parking staff.

Under Alternative 3, skier parking would increase by approximately 0.3 acre, providing for an additional 35 vehicles. This would bring total spaces at the Snowbowl to approximately 1,235, accommodating roughly 3,087 skiers. Even with the modest increases in skier parking called for in Alternative 3, skier parking would continue to constrain overall skier attendance at Snowbowl.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of this cumulative effects analysis extend from the late 1930s, when Snowbowl was first established and began to draw vehicular traffic, into the foreseeable future in which the ski area can be expected to continue to draw summer and winter visitation.

Spatial Bounds

The spatial bounds of this cumulative effects analysis are limited to U.S. Highway 180, between the Snowbowl and Flagstaff, and along the Snowbowl Road.

Past, Present, and Reasonably Foreseeable Future Actions

Past, present, and reasonably foreseeable activities that could cumulatively affect traffic flows on U.S. Highway 180 and/or Snowbowl Road include:

1. Miscellaneous Facilities and trail construction within Snowbowl's SUP area
2. Snowbowl Road Parking Restrictions
3. Private land development
4. Miscellaneous/ongoing recreational uses
5. Snowbowl Road paving
6. Miscellaneous improvements projects along U.S. Highway 180[93]
7. Grand Canyon traffic
8. Continued growth of the Phoenix metropolitan area
9. Reconstruction of approximately five miles of Highway 180 from Cheshire to Snowbowl Road in 1994 to address safety issues and increased traffic attributed to the Snowbowl.[94]
10. Historic traffic on Highway 180 related to dispersed snowplay and the Nordic Center

Appendix C includes the full list of past, present, and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 - No Action

The previously mentioned past, present, and reasonably foreseeable future activities have, and will, cumulatively affect seasonal traffic patterns along U.S. Highway 180 and the Snowbowl Road. Paving of the Snowbowl Road and parking restrictions along it have altered access and circulation. Likewise, miscellaneous improvement projects along U.S. Highway 180 over the past decade have increased visibility, safety, and speed. While selection/implementation of the No Action Alternative would not increase traffic numbers, private land development and miscellaneous/ongoing recreational uses in the vicinity of the Snowbowl that are accessible from U.S. Highway 180 can be expected to continue to increase traffic. However, as indicated in the Existing Conditions section, data indicates that ADT for U.S. Highway 180 typically peaks during the summer months, and decreases considerably during the winter – as attributable to reduced Grand Canyon traffic.

Alternative 2 – The Proposed Action

Selection and full implementation of the Proposed Action would increase winter traffic on U.S. Highway 180 between Flagstaff and the Snowbowl. As noted in the direct/indirect effects analysis, average peak day skier attendance levels are not anticipated to increase under the Proposed Action. However; the frequency of these peak days is anticipated to increase throughout Snowbowl's winter operating season – attributable to a more consistent snow pack, increased lift capacity, increased skiable terrain, small increases in parking, and the snowplay facility. When considered with other past, present, and reasonably foreseeable future actions

[93] Correspondence with the City of Flagstaff's Traffic Engineering division indicated that there are no current or future projects (scheduled through 2008) that may affect seasonal traffic patterns on U.S. Highway 180.
[94] This project was addressed in Forest Plan Amendment #10. The highway improvement projects involved tree clearing, wider shoulders, and a turn-lane to specifically accommodate Snowbowl-related traffic and safety issues.

within the study area, this could lead to increased/more frequent congestion at the intersection of Snowbowl Road and Highway 180 and could further affect residents of Coconino Estates, Cheshire, and Fort Valley during the winter months.

In terms of ADT, seasonal Grand Canyon traffic would still be expected to overshadow Snowbowl-related traffic in the winter. This also holds true for the other noted past, present, and reasonably foreseeable future projects.

Alternative 3

Under Alternative 3, winter attendance at the Snowbowl, and therefore associated traffic, is anticipated to increase slightly above the No Action Alternative, but below that of the Proposed Action. When considered with other past, present, and reasonably foreseeable future actions, Alternative 3 would represent a very slight cumulative increase in traffic patterns on U.S. Highway 180 and the Snowbowl Road.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

No irreversible and/or irretrievable commitments of resources in relation to traffic have been identified in association with any of the alternatives analyzed in this document.

3D. AESTHETIC RESOURCES

SCOPE OF THE ANALYSIS

The analysis area for aesthetic resources is the foreground, middle ground, and background views[95] of Snowbowl's SUP area.

While a general overview of the existing SUP area is provided in the Existing Conditions section, the aesthetics analysis for proposed activities has been based on the views from four representative viewpoints which were determined by the Forest Service ID Team:

- Hart Prairie (151 Road) – Summer
- U.S. Highway 180 at the Flagstaff Nordic Center – Summer
- Humphreys Trail (Wilderness Area) – Summer
- Interstate 40 East of Williams – Winter

The Environmental Consequences portion of this analysis provides a series of photographs taken from the representative viewpoints identified above. Each of the photographs depicts the existing condition and a simulation of the proposed changes.

The four selected view points represent those likely to be viewed by Forest visitors and serve as representative bench marks of aesthetic effects of the Proposed Action.

FOREST PLAN DIRECTION

FOREST SERVICE LANDSCAPE MANAGEMENT

The goal of landscape management on all NFS lands is to manage for the highest possible visual quality, commensurate with other appropriate public uses, costs, and benefits. Since the mid-1970s, the Forest Service has operated under the guidance of the Visual Management System (VMS) for inventorying, evaluating, and managing scenic resources on NFS lands. The VMS is defined in National Forest Landscape Management, Volume 2.[96] The VMS provides a system for measuring the inherent scenic quality of any forest area as well as a measurement of the degree of alteration for use in inventory and management.

VMS Visual Quality Objectives and Distance Zones

This aesthetics analysis uses Visual Quality Objectives (VQOs) as defined within the VMS. VQOs are based on the physical characteristics of the land and the sensitivity of the landscape setting as viewed by humans. VQOs define how the landscape will be managed, the level of acceptable modification permitted in the area, and under what circumstances modification may be allowed.

[95] Foreground, middle ground and background, as defined by the Forest Service, are detailed later in this section.
[96] USDA Forest Service, 1974

Viewing distance is important in determining how change is perceived across a landscape. Therefore, in addition to VQOs, the VMS uses distance zones to describe the part of a characteristic landscape that is being inventoried or evaluated. The three distance zones are described below.

> *Foreground*: The limit of this zone is based upon distances at which details can be perceived. Normally in foreground views, the individual boughs of trees form texture. The foreground is limited to areas within and not to exceed ½ mile of the observer, but it must be determined on a case-by-case basis, as any distance zoning should be. Generally, detail of landforms and special landscape features (including human alteration) are more pronounced when viewed within the foreground.
>
> *Middle ground*: Alterations in the middle ground (½ to four miles from the observer) become much less distinct. Texture normally is characterized by the masses of trees in stands or uniform tree cover. Individual tree forms are discernable in very open or sparse stands only.
>
> *Background*: As the perspective shifts to the background, distance has a modifying and diluting effect to both landscape texture and color. This zone extends from the middle ground (minimum of four miles between the observer and the area being viewed) to infinity. In very open or sparse timber stands, textures begin to be lost. Shape, however, may remain evident beyond 10 miles, especially if it is inconsistent with other landscape forms. Beyond 10 miles, alteration in landscape character becomes obscured.

FOREST PLAN DIRECTION

As per the Forest Plan, visual resource planning and inventory on the forest (pertinent to Snowbowl's operations) includes "Reviewing the VQO inventory as a part of project planning and making necessary corrections/refinements following field checking" and "Using the VQO inventory to analyze impacts to VQO classes due to management activities."[97]

Visual management direction specific to Management Area 15 includes managing for VQOs of *Retention* or *Partial Retention* with the exception of the Snowbowl. Visual resource management Standards and Guidelines specific to the Snowbowl SUP area are provided in the Forest Plan and direct that management activities meet the standards defined by the prescribed *Modification* and *Maximum Modification* VQOs at a minimum because of the ski area developments (such as roads, parking areas, buildings, and lifts) and cleared runs.[98]

[97] USDA Forest Service 1987: 60
[98] USDA Forest Service 1987: 188-189

The *Modification* VQO is defined as:[99]

> Management activities may visually dominate the original characteristic landscape. However, activities of vegetation and land form alteration must borrow from naturally established form, line, color, or texture so completely and at such a scale that their visual characteristics are those of natural occurrences within the surrounding area of character type. Activities which are predominately introduction of facilities such as buildings, signs, and roads, should borrow naturally established form, line, color, and texture so completely and at such scale that its visual characteristics are compatible with the natural surroundings.

The *Maximum Modification* VQO is defined as:[100]

> Management activities of vegetative and landform alterations may dominate the characteristic landscape. However, when viewed as background, the visual characteristics must be those of natural occurrences within the surrounding areas or character type. When viewed as foreground or middle ground, they may not appear to completely borrow from naturally established form, line color, or texture. Alterations may also be out of scale or contain detail which is incongruent with natural occurrences as seen in foreground or middle ground.

SCENERY MANAGEMENT SYSTEM

In 1995 an updated landscape management system - the Scenery Management System (SMS) – was introduced by the Forest Service. The SMS was developed to eventually replace the VMS; its principles and premises are based not only research findings but on over 20 years experience with implementing the VMS. In October 1996, the manual, Landscape Aesthetics: A Handbook for Scenery Management[101] was released to begin the transition to the new SMS. National direction has been given to incorporate, as applicable, the methods and philosophy of the SMS with each new planning project.[102] The Handbook was accompanied by direction from the Forest Service's Washington Office to "begin using the concepts and terms contained in this Handbook as you work on new projects or initiate forest plan revisions."

As indicated, full adoption of the SMS is to occur as each National Forest revises its land and resource management plan.[103] Direction for scenery management is contained within Forest Plan goals, objectives, standards, and guidelines. For Forests not currently undergoing the forest plan revision process, or for those requiring extensive time for revision, application of the SMS will occur at the sub-forest or project level.

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[99] USDA Forest Service, 1974
[100] USDA Forest Service, 1974
[101] USDA Forest Service, 1995
[102] USDA Forest Service, 1994; 1996; 1997; and 1998
[103] At this time Coconino Forest Plan is scheduled to begin Revision in 2006 and be completed by 2010.

The 1987 Forest Plan predates the 1995 SMS and therefore the SMS has not been formally integrated into CNF management direction. Until the CNF Forest Plan is revised, the VMS will continue to be used for inventorying, evaluating, and managing scenic resources on the Forest. Therefore, this aesthetics analysis provides the following brief description of the SMS to determine consistency both with the current visual management system and its future successor.[104] This dual assessment will determine both the level of VQO that will be achieved and the estimated equivalent SIL to be expected from the proposed activities in order to facilitate the eventual transition from the VMS to the SMS.

SMS terminology differs from the VMS, and updated research findings are incorporated. Conceptually, the SMS differs from the VMS in that it increases the role of constituents throughout the inventory and planning process and borrows from, and is integrated with, the basic concepts of Ecosystem Management. The SMS pertains primarily to the social/cultural dimension of ecosystem management – but also has links to the biological and physical.

The SMS measures the degree of "intactness" and "wholeness" of the landscape with "scenic integrity." SMS uses Scenic Integrity Levels (SILs) in much the same way that the VMS uses VQOs. The frame of reference for measuring achievement of SILs is the valued attributes of the "existing" landscape character "being viewed." The VQOs of *Modification* and *Maximum Modification* directly correspond to the SILs of *Low* and *Very Low*, respectively. The two SILs are defined below:

SIL: *Low* (corresponds to *Modification* VQO):

> Refers to landscapes where the valued landscape character "appears moderately altered." Deviations begin to dominate the valued landscape character being viewed, but they borrow valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed but compatible to the character within.

SIL: *Very Low* (corresponds to *Maximum Modification* VQO):

> Refers to landscapes where the valued landscape character "appears heavily altered." Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles within or outside the landscape being viewed. However, deviations must be shaped and blended with the natural terrain (landforms) so that elements such as unnatural edges, roads, landings, and structures do not dominate the composition.

The SMS uses the same distance zones as the VMS, however an immediate foreground distance zone is added in SMS which extends to 300 feet beyond the viewer.

[104] Because the Forest Plan revision process for the CNF has not yet begun as of the publication of this EIS, this aesthetics analysis can only determine consistency with the SMS on a relative basis. Revised Forest and Management Area standards and guidelines, using the SMS, have not yet been established.

EXISTING CONDITIONS

AESTHETIC CHARACTERISTICS OF THE SAN FRANCISCO PEAKS

The San Francisco Peaks are the remnants of a large, heavily vegetated composite volcano that last erupted roughly two million years ago. Rising more than a mile above the surrounding pine forests and grasslands of the northern Arizona landscape, the San Francisco Peaks exhibit a rich diversity of past geologic events such as lava flows, volcanic eruptions, glaciation, and erosion. The Peaks is an outstanding example of past volcanic activity and preserves the best example of Ice Age glaciation in Arizona in lateral and medial moraines and former streambeds.[105]

With its peaks reaching the highest elevation in Arizona, the San Francisco Peaks are a prominent feature of the southern Colorado Plateau. The three main peaks are Humphreys Peak (12,633), Agassiz Peak (12,356 feet), and Fremont Peak (11,969 feet). The other peaks are Doyle, Reese, and Aubineau. Views from the summit of the San Francisco Peaks stretch northwest to the Grand Canyon's North Rim; northeast across the painted desert (including Sunset Crater); and over eighty miles to the north. On a clear day, the Peaks are visible from over 100 miles away.

AESTHETIC CHARACTERISTICS OF THE SNOWBOWL SUP AREA

NFS lands within Snowbowl's 777-acre SUP area have been used for developed winter recreational use since 1938, when the ski area's original base area was established in Hart Prairie. Since that time, developed recreation at the Snowbowl has evolved and grown with the creation of additional trail systems, buildings, lifts, and infrastructure.

Snowbowl's SUP area is located on the western face of the San Francisco Peaks, and is defined by a prominent, V-shaped valley. The majority of Snowbowl's formal and gladed terrain can be found on this valley's north/northwest-facing aspects, with the exception of the Hart Prairie area, which has a predominantly west-southwest aspect. In all, the Snowbowl has 32 developed trails and approximately 130.4 acres of formal,[106] lift-served terrain within its SUP area. NFS lands within and immediately adjacent to the SUP area are defined by open bowls (at higher elevations), dense stands of spruce-fir throughout and well mature aspen stands in the lower elevations.

Snowbowl's base area facilities and parking areas are located at the Agassiz and the Hart Prairie lodges, located at 9,550 and 9,350 feet elevation, respectively. With the exception of chairlifts and the ski patrol head quarters (located at the top of the Agassiz Chairlift), no ski area infrastructure or services are located above the Agassiz Lodge.

With the exception of the Hart Prairie area (approximately 40 acres), which is a natural alpine meadow, approximately 100 acres of overstory vegetation have been removed throughout Snowbowl's development history. For the most part, cleared vegetation breaks have been "feathered" throughout the history of development in an attempt to avoid hard edges and to mimic natural breaks in the vegetation across the San Francisco Peaks. With some exceptions

[105] USDA Forest Service, 1987: 101

[106] This does not account for undeveloped, skiable terrain (i.e., glades and naturally-open/hike-to terrain) within the SUP area.

(noted below), the feathering technique has successfully reduced the potential visual effects of the developed terrain as compared to the surrounding, undisturbed natural landscape. The most obvious vegetation break in the SUP area is the corridor that was cut for the Agassiz Chairlift. The Agassiz Chairlift corridor, in particular, introduces a long linear element that that is absent from the surrounding natural landscape of the San Francisco Peaks.

Compliance with VQOs/SILs

Inevitably, the lift and trail network within Snowbowl's SUP area introduces some elements that are unrelated to features in the adjacent, natural landscape on the San Francisco Peaks. Despite the best efforts of the Forest Service and Snowbowl to blend the lift corridors and trails into the natural landscape, some unnatural vegetation breaks are quite obvious, particularly in the foreground view. However, once the observer moves to the middle ground and, especially, background views, the Snowbowl's trail and lift network begins to blend into the natural surrounding and becomes more difficult to distinguish.

Within the foreground view, the Snowbowl facilities are most frequently viewed by guests visiting the ski area. Therefore, developed facilities, trails, and lifts represent the anticipated landscape and are not a deviation from what most ski area visitors expect and value. The majority of viewsheds from which the Snowbowl can be seen from along the U.S. Highway 180 corridor fall into the middle ground and background views. However, the Snowbowl can be seen in the foreground view in certain instances. Because in Arizona developed winter ski areas are rare, these types of facilities are not expected by the majority of travelers who pass the Snowbowl on U.S. Highway 180. Therefore, in some cases Snowbowl's developed facilities are visible to those who may not expect or value the appearance of such facilities.

Nonetheless, the analysis completed indicates that Snowbowl's existing facilities, trails, and lifts corridors currently meet the established VQOs of *Modification* and *Maximum Modification*, and are consistent with Forest Plan direction. Therefore, when compared to the corresponding SILs of *Low* and *Very Low*, the analysis also concluded that the existing facilities are consistent with the SMS.

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

Proposed ground disturbance and vegetation removal within the SUP may incrementally affect the aesthetic quality of the west face of the San Francisco Peaks.

Indicator:

The Incremental Aesthetic Effects of the Proposed Projects Compared to Historic Landscape Alterations Within the SUP Area

Alternative 1 – No Action

Selection of the No Action Alternative would not directly or indirectly change Snowbowl's current operations, trail/lift network, or infrastructure. From an aesthetics standpoint, no changes to Snowbowl's SUP area would occur under the No Action Alternative and its facilities would continue to comply with Forest Plan VQOs of *Modification* and *Maximum Modification*. The

description of existing conditions within this section describes both the history of landscape modifications and the present conditions which would persist with selection of the No Action Alternative.

Alternative 2 – The Proposed Action

Temporary Aesthetic Impacts

Some ground disturbing activities contained in the Proposed Action would be considered temporary in nature, since these areas would be promptly revegetated. These direct, temporary ground disturbing activities include: 1) installation of snowmaking pipelines on existing trails; 2) terrain grading on existing trails; 3) utility line installation; and development of the proposed snowplay facility. As quantified in Table 2-4 (located in Chapter 2), temporary ground disturbances under the Proposed Action would total approximately 236 acres. During construction periods, ground disturbances would be temporarily visible. As revegetation matures over a period of a few years, these disturbances would ultimately return to a condition similar to the present.

Permanent Aesthetic Impacts

Direct, permanent aesthetic impacts are associated with components of the Proposed Action that, whether occurring in new or previously disturbed areas, would represent long-term visible elements of the ski area's presence within the SUP area when perceived in either the foreground, middleground or background views. These elements include:

- Construction of the snowmaking water impoundment above the top terminal of the existing Sunset Chairlift
- Installation and realignment of chairlifts/surface lifts throughout the SUP area
- Construction of a 400-space snowtubing parking lot
- Construction of a hiking trail between the mid-station and the top terminal of the Agassiz Lift
- Construction of a 6,000 square foot addition to the Hart Prairie Lodge for a total of 24,900 square feet
- Construction of a 10,000 square foot guest services facility adjacent to the Agassiz Lodge
- Replacement of existing on-mountain ski team buildings with three new buildings
- Removal of approximately 76.3 acres of existing overstory vegetation associated with the development of skiing terrain, lift corridors, and tree thinning for construction of glades[107]
- Construction of a halfpipe (with a dirt form) below the bottom terminal of the Sunset Chairlift
- Construction of a snowtubing facility in the lower portion of Hart Prairie
- Construction of the 14.8 mile reclaimed water pipeline between Flagstaff and the SUP area

Under the Proposed Action, permanent ground disturbances would total approximately 10.4 acres. While essentially all of these proposed projects would be visible in the immediate foreground view (i.e., from within the SUP area and isolated points from within the surrounding

[107] Construction of gladed areas would required minimal removal of overstory vegetation (approximately 20 percent) and would concentrate on dead and dying timber. Therefore, construction of glades is not anticipated to substantially impact visual quality in the SUP area.

Kachina Peaks Wilderness), once the viewpoint extends further into the foreground view and into middle ground/background views, the dominating, permanent features of Snowbowl's Proposed Action become the lift and trail network. While vegetation removal associated with these projects can be considered permanent in nature, and would obviously incrementally add to the developed character of the SUP area, the visual simulations (see next section) conducted for this analysis indicate that visual mitigation techniques incorporated into the design of the proposed elements were successful in blending with the form and texture of the surrounding landscape. This analysis determined that the proposed landscape alterations can be implemented while maintaining full consistency with the VQOs of *Modification* and *Maximum Modification*.

For the most part, construction of the reclaimed water pipeline between Flagstaff and the SUP area would occur within previously-disturbed corridors. Therefore, construction of the pipeline would not cause additional visual disturbances. An exception includes portions of the corridor that cross property owned by the Lowell Observatory.

Alternative 3

Alternative 3 eliminates temporary ground disturbance associated with snowmaking line installation, but includes (essentially) all of the lift and trail additions contained in the Proposed Action. While Alternative 3 increases temporary ground disturbance associated with trail grading – necessary to provide for increased skiability under reduced natural snow conditions – overall temporary ground disturbances would be reduced to approximately 130 acres. Permanent ground disturbances are reduced under Alternative 3 by excluding the snowmaking water impoundment, snowtubing facility, snowtubing parking lot, and the Aspen Chairlift realignment and would total approximately 1.7 acres. Additionally, Alternative 3 would result in the removal of approximately 64.4 acres of existing overstory vegetation associated with the development of skiing terrain, lift corridors, and tree thinning for construction of glades.

Overall, the aesthetic impacts are slightly reduced between Alternatives 2 and 3. However, for the purposes of this analysis, they can be considered virtually identical, especially when perceived in the middle ground and background distance zones.

Indicator:

Visual Simulations, from Identified Representative Viewpoints, of the Proposed Landscape Alterations as Compared to the Existing Condition.

The reader is directed to Figures 3D-1 through 3D-4 for photographs taken from the identified representative viewpoints. Each unaltered photograph is accompanied by an identical photograph that has been photo-simulated to depict proposed project elements which are anticipated to remain visually evident. For the purposes of this analysis, the Proposed Action and Alternative 3 can be considered identical when observed from these viewpoints, and are thus analyzed together.

Simulated views were analyzed from the following viewpoints:

- Hart Prairie (151 Rd) – Summer
- Highway 180 at the Flagstaff Nordic Center – Summer
- Humphreys Trail (Wilderness Area) – Summer
- Interstate 40 East of Williams – Winter

Photo Simulation Methodology

Photo simulations represent a visually accurate method of realistically portraying proposed project elements on the existing landscape. These simulations are accomplished using a combination of GIS (Geographic Information Systems) and photo-editing software applications and the following techniques.

The first step in this process involved identifying the representative viewpoints from the surrounding landscape based on locations with high exposure and/or close proximity to the project area. These viewpoints are then photographed during the desired season to capture the baseline or existing conditions. The photographs are converted to digital images for simulation purposes.

Once the locations have been identified, the corresponding GIS data, such as trails, structures, vegetation lines, and proposed elements, are assembled. Once the pertinent data has been gathered, these GIS files are used to build a three-dimensional model specific to the scene portrayed in the image. The three-dimensional model identifies the viewable project elements for the selected perspective accounting for topography and vegetation which may lie between the observation point and the target view.

The three-dimensional model is converted and imported into an image editing software application. Using the digital image, the model is overlain and referenced to the original image. Using the proposed elements from the model as reference, a copy of the image is created simulating the proposed elements and features. The result is a spatially accurate, photo realistic simulation of the proposed project elements from the desired viewpoint. Additional consideration is given for the contrast between snow covered ground and dark tree cover that will occur in winter throughout the project area; even though this contrast is shown in only one of the four simulations.

Alternative 1 – No Action

Alternative 1, the No Action Alternative, represents the Arizona Snowbowl in its existing condition. No changes to the visual landscape would occur under this alternative. The existing condition, and therefore the No Action Alternative is represented in the photo simulations as the baseline condition.

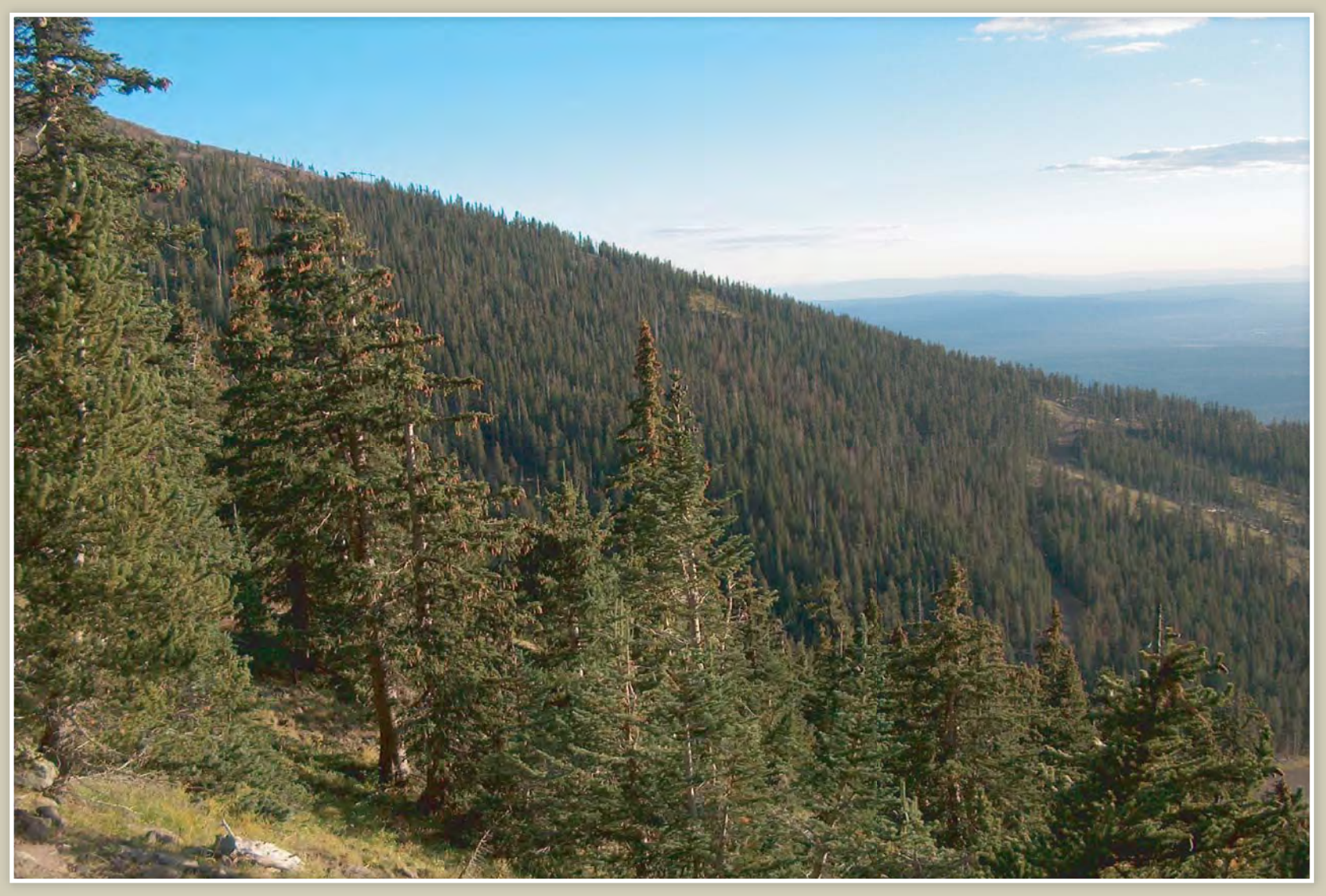
Alternatives 2 and 3

Figure 3D-1 displays the Snowbowl SUP area in the foreground distance zone looking south from the Humphreys Trail in the Kachina Peaks Wilderness. This viewpoint is representative of all views of the Snowbowl facility seen from this primary route into the Wilderness and is one of the best sites for viewing the proposed facilities and trails.

This middleground viewpoint presently falls within the basic standards of a “partial retention” VQO (Moderate SIL). The proposed developments would introduce additional elements (such as portrayed in the simulation) that in total would fall within the standards for a modification VQO as seen from all viewpoints along the Humphrey’s Trail.

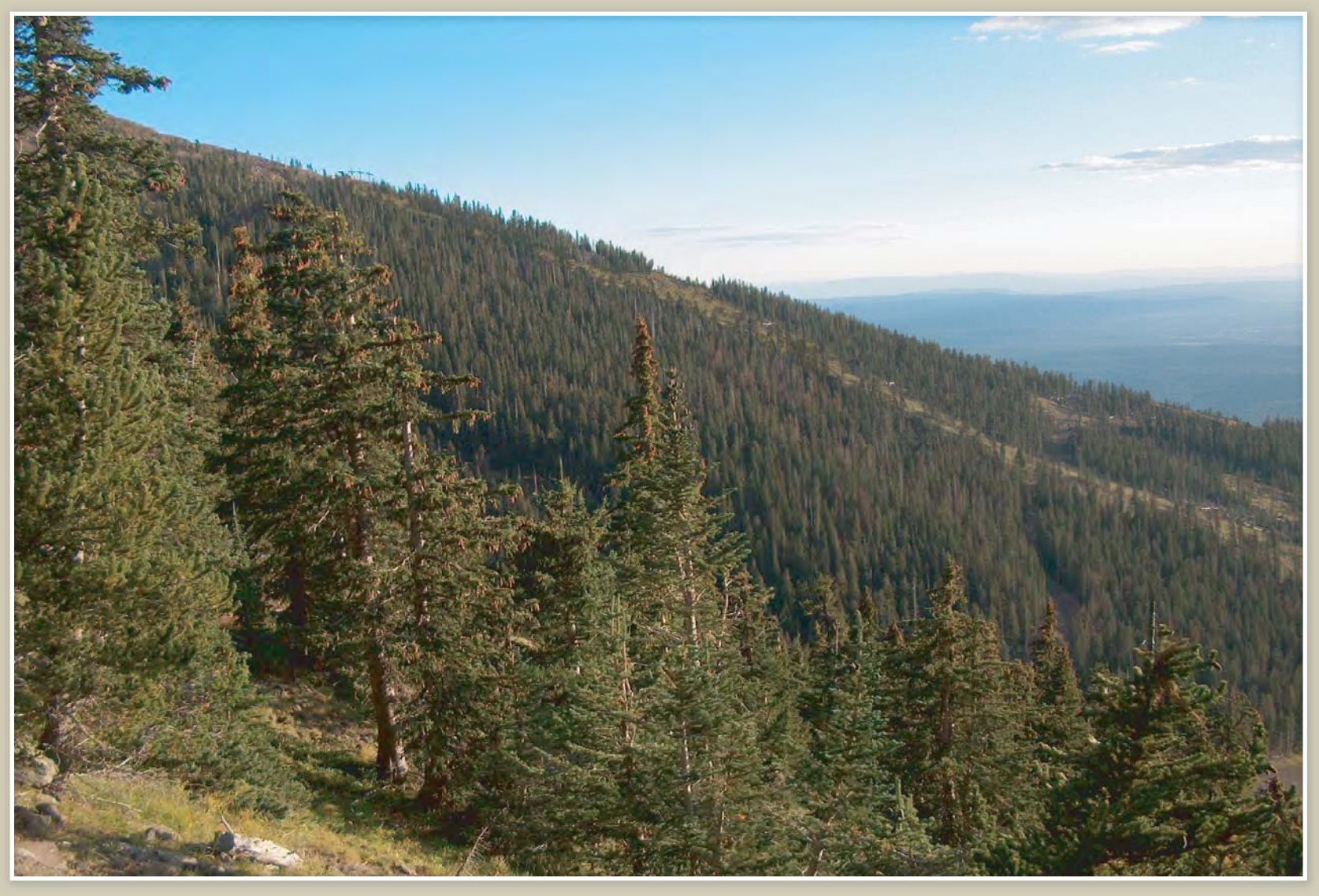
In the “Existing” view, although two existing trails - *Volcano* and *Casino* (trail #43a and #23*)* - are visible from this location, they remain partly obscured by existing vegetation that occurs along the trail edges. The *Midway Catwalk* and *White Lightning* (trails #24 and #28) appear as dark openings in the vegetation overstory and are essentially unnoticed. In the “Proposed” view, the proposed vegetation clearing from planned Trail 43b becomes moderately apparent as it causes the existing vegetative opening to continue uphill of *Volcano* (trail #43a) to the edge of the treeline occurring near the top of the Agassiz Chairlift. However, the portion of proposed Trail 43b that comes off of *Upper Ridge* (trail #26) across the existing Agassiz Chairlift corridor creates a gap in the existing vegetation that becomes visible due to its northwest aspect and location near the crest of Agassiz Ridge. A similar incidence occurs at the location of proposed Trail 38. Though not as noticeable, the trail clearing from Trail 38 occurs near the crest of Agassiz Ridge creating another depression in the existing vegetation. Although trail widening is proposed for *White Lightning* (trail #28), the impacts are not evident.

Existing



View of the Arizona Snowbowl looking Southwest from the Humphrey's Peak Trail in the Kachina Peaks Wilderness.

Proposed



View of the Arizona Snowbowl looking Southwest from the Humphrey's Peak Trail in the Kachina Peaks Wilderness showing the proposed trails and clearing.

ARIZONA SNOWBOWL

Figure 3D-1

Figure 3D-2 depicts the entire western face of the San Francisco Peaks in the middle ground distance zone. The picture was taken from the top of a small hill just west of Forest Road 151, looking east, from approximately 1.5 miles away. From this viewpoint, existing trails and lift corridors are easily distinguishable, particularly the Agassiz Chairlift and the following trails: *Lower Ridge* (trail #21); *Upper Ridge* (trail #26); *Rattlesnake* (trail #13); *Volcano* (trail #41a) and *Casino* (trail #23). In the "Proposed" view, the anticipated Sunset Chairlift corridor, terrain park, and trails 37, 38, 39, and 43b become most apparent due to their locations in the densely vegetated southern portion of the SUP area. The proximity of proposed trails 37, 38, and 39 to existing trails, combined with their direct western exposure, create a mosaic of new vegetative openings that become visible along the lower portions of Agassiz Ridge from this viewpoint. The proposed Humphreys Pod, located just uphill of Hart Prairie, is also visible from this location. However, the proposed vegetation clearing in the Humphreys Pod is absorbed well due to the braided trail design and existing stands of tree islands that would remain.

The view from this middleground viewpoint presently falls well within the basic standards of the Modification VQO (low SIL) with the diagonal linear element of the Agassiz Chairlift being the most noticeable unnatural element visible. The proposed development would introduce additional elements that in total would fall well within the standards for the Maximum Modification VQO" (Very Low SIL) but would fall somewhat short of the Modification VQO standard.

Existing

View of the Arizona Snowbowl looking East, taken just West of Forest Road 151.

Proposed

View of the Arizona Snowbowl looking East with proposed trails and clearing, taken just West of Forest Road 151.

ARIZONA SNOWBOWL

Figure 3D-2

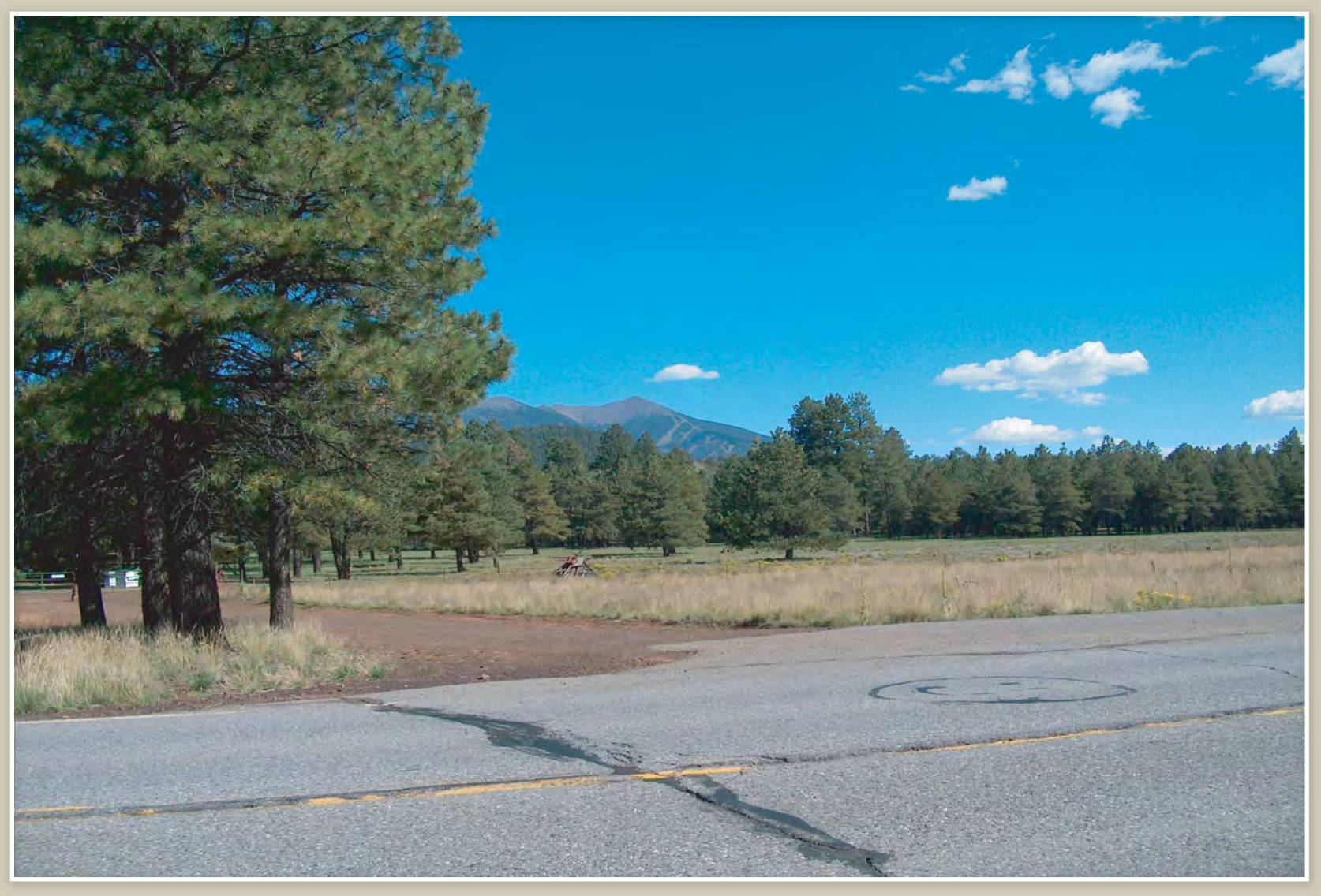
Figure 3D-3 shows the western face the San Francisco Peaks, with Agassiz Peak prominently displayed, in the background distance zone. The picture was taken from U.S. Highway 180 at the junction of the Nordic Center entrance road from a distance of approximately five miles. The bottom half of the Snowbowl's SUP area is obscured by foreground trees and vegetation from this viewpoint. Only existing and proposed trails with north and west orientations are visible from this location. Portions of the existing Agassiz Chairlift corridor and *Upper Ridge* (trail #26) and *Volcano* (trail #43a) are visible. In the "Proposed" view, proposed trails 37, 38, 39, 42, 43b, and a portion of the Sunset Chairlift corridor become visible. While in a comparative format the proposed alterations are distinguishable, viewers at this distance are unlikely to notice a substantial change.

Alterations seen from this viewpoint meet standards for the Modification VQO (Low SIL).

Existing

Southeast view of the Arizona Snowbowl from the junction of Highway 180 and the Nordic Center entrance road.

Proposed



Southeast view of the Arizona Snowbowl from the junction of Highway 180 and the Nordic Center entrance road showing proposed trails and clearing.

ARIZONA SNOWBOWL

Figure 3D-3

Figure 3D-4 again shows the western face of the San Francisco Peaks in the background distance zone. The picture was taken during winter conditions on Interstate 40 East of Williams, approximately 16 miles away. From this distance only *Upper Ridge* (trail #26) can be distinguished while the remaining existing trails blend well with the surrounding natural vegetation. The "Proposed" view displays the addition of Trail 39 and the Humphreys Pod trail network. However, the location of the Snowbowl SUP area in the background zone makes the visual impact of the proposed trails virtually indiscernible when compared to the surrounding forest and canopy openings.

Alterations seen from this viewpoint meet standards for a Partial Retention VQO (Moderate SIL).

Existing

View of the Arizona Snowbowl from I-40 East of Williams

Proposed

View of the Arizona Snowbowl from I-40 East of Williams with proposed trails and clearing

ARIZONA SNOWBOWL

Figure 3D-4

This analysis indicates that construction of all proposed projects could be accomplished while meeting the VQOs for *Modification* and *Maximum Modification*. In addition, implementation of these projects would be consistent with SILs of *Low* and *Very Low*.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

For the purpose of this cumulative assessment, it is assumed that visual impacts to the San Francisco Peaks landscape began with construction of the original ski area facilities in the late 1930s, increased with approval of projects analyzed in the 1979 ES, continue to the present day and extend into the foreseeable future (i.e., as long as the Snowbowl operates).

Spatial Bounds

Table 3D-1 defines the spatial bounds of this cumulative effects analysis and identifies potentially effected viewers within each distance zone, as per the VMS.

Table 3D-1
Viewshed

VMS Distance Zone	Potentially effected Viewers
Foreground (out to ½ mile)	1. Snowbowl visitors/employees (large majority of users; expect to see ski area facilities) – view from access road and from Snowbowl 2. Local residents – (small number but growing and with high concern for scenic quality) – view from access roads and from summer homes in Lower Hart Prairie 3. Forest visitors other than Snowbowl visitors and residents. Includes Wilderness trail/trailhead, Arizona Trail/trailhead and those driving for pleasure
Middleground (½ mile out to four miles)	1. (see #1. above) 2. (see #2. above) 3. Forest visitors (majority of users affected), using U.S. Highway 180, FR 151, and other Forest roads and trails, people using Forest areas away from roads and trails (i.e. hunters/ cross country hikers)
Background (Four miles to infinity)	1. Forest visitors/travelers through the Forest – mostly people driving along Highways 180 and 89 north of the Peaks with moderate to high concern for scenic quality. 2. Travelers along I-40 from just west of Flagstaff out to Williams

The affected environment relevant to a discussion of cumulative affects for aesthetic resources includes the extent of locations from which the analysis area is visible. This area extends from the Snowbowl generally to the north and west and diminishes as viewer distance increases and detail of alterations to the natural landscape diminishes. This also includes areas from which the proposed reclaimed water pipeline (that follows the existing Transwestern Lateral Natural Gas Pipeline corridor and existing roads) is visible. Areas to the south and east of the Snowbowl within the Kachina Peaks Wilderness have limited visibility into the Snowbowl SUP area up to

the surrounding ridgelines and peaks including views through tree cover along the upper part of the Humphreys Trail up to Humphreys saddle. Locations outside of the ridge system that encloses the Snowbowl facilities are screened from these affects by the mountainous topography and are not visible to the viewer on the ground. The existing facilities are visible to the discerning viewer from I-40 near Williams, approximately 25 miles away, when snow on the ground maximizes the contrast between the trail and lift corridors and the surrounding tree cover (referred to figure 3D-4). The area is also visible from the north side of Kendrick Park from U.S. Highway 180, about eight miles distant, but becomes undetectable due to topographic screening as the road proceeds north. The SUP area is not visible from Highway 89.

Past, Present, and Reasonably Foreseeable Future Actions

Past, present, and reasonably foreseeable projects which could cumulatively affect scenic resources include:

1. Bebbs Willow Restoration project in Hart Prairie
2. Residential and summer home development in Hart Prairie
3. Assorted and ongoing utility line clearing and maintenance
4. Snowbowl cellular tower (approved in August 2000 but not yet built)
5. Hart Hill restoration
6. Ongoing utility line construction and maintenance (on- and off-Forest)
7. Arizona Trail construction and designation

Of the above-mentioned projects, Hart Hill restoration, Bebbs Willow Restoration, and the Arizona Trail are all within the spatial extent of the cumulative impact area, but are not of an extent or development scale/character to cause appreciable degradation to the natural appearing environment. The Hart Hill and Bebbs Willow Restoration projects will restore elements of the natural appearing landscape thereby creating long term positive changes with possible short-term minor negative impacts to scenic quality during the activities implementation.

Of the projects listed, projects most relevant to a discussion of cumulative effects to scenic resources include:

Residential and Summer Home Development in Hart Prairie

Ongoing development in Hart Prairie has introduced features not inherent to a natural appearing landscape within the middle ground viewshed seen by people using the Snowbowl facilities and by others making use of the general area. Some of the developments occur as foreground elements from FR 151 with the Snowbowl facility seen behind the residences in the middle ground. Residential developments in the area generally borrow from naturally occurring materials and color and occur at such a scale as to not contribute significantly to the area's overall visual quality.

Residential and summer home development exists on private lands in Hart Prairie, below the Snowbowl facility. While generally borrowing from naturally occurring color and materials found in the area, the existence of these structures adds to the extent of the area where the natural

appearing landscape has been altered. Alterations to the natural appearing landscape within the residential/summer home area are less severe than within the Snowbowl facility due to the smaller scale of individual residential/summer home structures. While not bound by visual quality standards provided in the Forest Plan, these residential facilities generally fall within the guidelines for *Partial Retention* and *Modification* VQOs (*Moderate* to *Low* SIL).

Snowbowl Cellular Tower

Installation of a cellular tower near Snowbowl's maintenance shop was approved via a Decision Notice in August 2000.[108] However, it has not yet been constructed. If constructed, this facility will introduce an incongruous element to a natural appearing landscape in the foreground viewshed of the Snowbowl facility as seen from the Snowbowl Road. This facility, if constructed, would meet a VQO standard of *Modification* (*Low* SIL) from foreground views and would meet the *Retention* VQO from FR 151 (middleground).

Ongoing Utility Line Construction and Maintenance

Ongoing utility line and pipeline clearance and maintenance highlights the contrast between utility and pipeline corridors and facilities and the natural appearing forest landscape. Clearing and maintenance activities will continue to produce unnatural appearing linear elements.

Appendix C includes the full list of past, present, and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 - No Action

The addition of residential/summer home development in the area, the cellular tower, and ongoing utility and pipeline operation/maintenance to the original extent of the Snowbowl development extends the area meeting *Partial Retention* and *Modification* VQO standards (SIL *Moderate* to *Low*) from within the foreground view of the Snowbowl facility to the foreground view as seen from FR 151. From middleground and background views the effect of all of the cumulative elements discussed, except for the ski runs and lift tower corridors, diminishes and disappears for most forest visitors. As shown in the "before" photos (3D-1 through 3D-4) from middleground and background views, some of the existing ski trails and chairlift corridors are presently visible as unnaturally appearing shapes on the otherwise natural appearing landscape. The background and middleground views of the ski area facilities fall within the standard for a *Partial Retention* VQO (*Moderate* SIL) from the background to a *Modification* VQO (*Low* SIL) from middleground views.

Alternative 2 – The Proposed Action

Above and beyond those described in the No Action Alternative, the addition of facilities identified in the Proposed Action would have the following cumulative effects to aesthetic resources in the area:

[108] A review of current circumstances and documentation according to FSH 1909.15, Chapter 18 will need to occur before implementation may proceed due to the length of time that has passed since the decision was made (3 to 5 years).

- Foreground views from within the Snowbowl SUP area of snowmaking equipment, the water impoundment, snow tubing facilities, additional parking, lift installations, and new buildings
- Middle ground and background views of addition linear and feathered corridors. These corridors would cut diagonally through the existing tree canopy in contrast to the generally homogenous tree cover occurring on adjacent slopes of the San Francisco Peaks.
- Short-term ground disturbance within the existing Transwestern Lateral Natural Gas Pipeline corridor and along the access road corridor and the long-term effect of a wider corridor (in some locations) to accommodate Snowbowl's proposed reclaimed water pipeline. These effects are confined to the foreground of the pipeline, occur mostly outside of the viewshed affected by most of the other Proposed Action elements, and are not seen by most visitors to the area.

Alternative 3

The effect of adding facilities proposed with this alternative would be virtually identical to the PA excluding the effect of the reclaimed water pipeline and the snowtubing facility.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Additional developed terrain and infrastructure in previously undisturbed portions of the SUP area would represent irretrievable effects to visual resources for the life of the Snowbowl. However, this commitment of the visual resource is not irreversible because facilities and lifts could be removed and, in time, the area could be reclaimed and revegetated, restoring its natural appearance.

3E. SOCIAL AND ECONOMIC RESOURCES

SCOPE OF THE ANALYSIS

The development elements contained in the Snowbowl's proposal have the potential to affect not only the physical aspects of the project area's physical environment, but also the socioeconomic environment. Development of the proposed facilities has the potential to attract more skiers and other recreationists, to generate employment and to require additional public services. This analysis targets the specific issues within this broad framework as identified during scoping.

A correlation exists between the consistent operation of the ski area and the Flagstaff/Coconino County economy. This correlation encompasses; seasonal tourism; employment and income levels; and tax revenues. The strength of this correlation needs to be assessed and disclosed.

Socially, Snowbowl provides a source of wintertime recreation for a large number of people in northern and central Arizona. The relative importance of this local source of wintertime recreation needs to be assessed.

EXISTING CONDITIONS

POPULATION, HOUSING AND THE ECONOMY

In contrast with a number of other ski resorts in the Rocky Mountain region, the Arizona Snowbowl is not a dominant driver of growth and the economy in its host community. Coconino County and more particularly the City of Flagstaff have economies that draw upon a number of elements – including tourism and recreation – to maintain viability. Thus, while the Arizona Snowbowl's business activity is not the singular driver of the area economy and growth, the ski area's business activity does have a positive economic impact on the community and any major change in ski area activity – to the positive or negative – would be expected to have effects in the area.

Population, housing and the area economy are usually regarded as the most significant indicators of growth and are important to the Arizona Snowbowl from several perspectives:

- A growing population provides more potential customers for the Snowbowl's business.
- The regional housing stock provides housing for Snowbowl employees and, to a lesser extent, seasonal housing for Snowbowl visitors.
- A positive economy provides discretionary dollars for local residents and is likely to spur increases in recreational spending.

Further, these indicators are significant to a host community as measures of desired growth and ability to provide adequate housing for residents. The indicators are assessed below, with a focus

on Coconino County and the City of Flagstaff.[109] In addition, statewide data is shown for Arizona to provide comparative rates of change.

Population

The table below shows total population for Arizona, Coconino County and the City of Flagstaff for 1990 and 2000. In addition, estimated population is shown for 2002, along with absolute and percentage statistics regarding rate of growth.[110]

Table 3E-1
Total Population Change
Arizona, Coconino County, Flagstaff (1990 – 2002)

	1990	2000	Absolute Change 1990-2000	Percentage Change 1990-2000	Est. 2002	Absolute Change 2000-2002	Percentage Change 2000-2002
Arizona	3,665,228	5,130,632	1,465,404	40.0%	5,472,750	342,118	6.7%
Coconino Co.	96,591	116,620	19,729	20.4%	125,420	9,100	7.8%
Flagstaff	45,857	52,894	7,037	15.3%	59,160	6,266	11.8%

During the 1990s, the State of Arizona had a *strong* population growth rate of 40 percent. This compares to a U.S. population growth rate during the same period of 12.8 percent. While Coconino County and Flagstaff experienced solid population growth, their rates of growth were well below those for the state as a whole. However, it appears that recent growth rates for the county and city (2000 through 2002) have accelerated and that they are now experiencing population growth at rates exceeding that for the state as a whole.

Comparative distributions of populations by race in 1990 and 2000 are shown for Arizona, Coconino County and Flagstaff in the table below. The table shows the number and percentage of total population for each racial group.[111]

[109] City of Flagstaff is the only political entity for which data is consistently available within Coconino County and which is near the Arizona Snowbowl. Data is available for other communities that are remote from the Snowbowl's location. The Snowbowl is located within an unincorporated portion of the county.
[110] U.S. Bureau of the Census, Arizona Dept. of Employment Security-Population Statistics Unit.
[111] U.S. Bureau of the Census. Note that the Bureau used different systems for classifying race in the 1990 and 2000 censuses. In 2000, respondents were permitted to designate multiple racial backgrounds. The data in the table only includes figures for those who reported one race. Over 97 percent of all respondents indicated only one race in each of the three areas.

Table 3E-2
Racial Distribution of the Population[a]
Arizona, Coconino County, Flagstaff (1990, 2000)

		White		Black		American Indian, Eskimo or Aleut		Hispanic or Latino (of any race)	
		Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Arizona	**1990**	2,963,186	68.1%	110,524	2.5%	203,527	4.7%	688,338	15.8%
	2000	3,873,611	60.3%	158,873	2.5%	255,879	4.0%	1,295,617	20.2%
Coconino County	**1990**	61,836	58.2%	1,419	1.3%	28,233	26.6%	9,696	9.1%
	2000	73,381	56.9%	1,215	1.0%	33,161	25.7%	12,727	9.9%
Flagstaff	**1990**	36,519	69.1%	1,135	2.1%	4,210	8.0%	6,972	13.2%
	2000	41,214	67.1%	927	1.5%	5,284	8.6%	8,500	13.8%

[a] Data does not represent total population or every group accounted for in 1990 and 2000 census

Coconino County population has a substantially higher percentage of minorities than the state or Flagstaff populations. American Indians make up almost 26 percent of the county's population.

The table below shows population projections for 2005, 2010 and 2015 for Arizona, Coconino County and the City of Flagstaff.[112] In addition, comparative percentage change is shown for 2000 to 2005, 2000 to 2010, and 2000 to 2015.

Table 3E-3
Population Projections
Arizona, Coconino County, Flagstaff (2000 – 2015)

	2000	2005	Percentage Change 2000-2005	2010	Percentage Change 2000-2010	2015	Percentage Change 2000-2015
Arizona	5,130,632	5,553,849	8.2%	6,145,108	19.8%	6,744,754	31.5%
Coconino Co.	116,320	135,595	16.6%	147,352	26.7%	158,753	36.5%
Flagstaff	52,894	66,552	25.8%	71,981	36.1%	77,133	45.8%

While the state's population grew at a faster rate during the 1990s, projections call for above average population growth in Coconino County and City of Flagstaff for the period 2000 through 2015. It is expected that the city would grow at a particularly strong rate during the next 15 years. For purposes of comparison, projected rates of population for the U.S. as a whole are:[113] 2000 to 2005 - 2.2 percent, 2000 to 2010 – 6.6 percent and 2000 to 2015 – 11.0 percent.

Overall, it is clear that Arizona as a whole, and Coconino County and Flagstaff in particular, would experience well above average rates of population growth during the coming years.

[112] U.S. Bureau of the Census, Arizona Dept. of Employment Security. 2000 figure based on Census figure, all other figures Arizona projections.
[113] U.S. Bureau of the Census, Population Estimate Series, Middle Series

Housing

The table below shows total housing units for Arizona, Coconino County and Flagstaff for 1990 and 2000, as well as statistics on absolute and percentage change.[114]

Table 3E-4
Total Housing Units
Arizona, Coconino County, Flagstaff (1990, 2000)

	1990	2000	Absolute Change	Percentage Change
Arizona	1,659,430	2,189,189	529,759	31.9%
Coconino Co.	42,914	53,443	10,529	24.5%
Flagstaff	16,313	21,396	5,083	31.2%

Although Coconino County and Flagstaff population growth rates fell well below that for the entire state during the 1990s, Flagstaff's rate of housing increase matched that for the state, while the county's rate of increase did not fall substantially behind that for the state.

The table below contains more detailed data regarding year 2000 housing stocks for Arizona, Coconino County and Flagstaff including, total units, occupied units and owner and renter-occupied units.[115] In addition, comparative statistics are shown regarding the detailed data.

Table 3E-5
Housing Stock Details
Arizona, Coconino County, Flagstaff (2000)

	Arizona	Coconino County	Flagstaff
Total Housing Units	2,189,189	53,443	21,396
Occupied Units	1,901,327	40,448	19,306
% of Total	86.9%	75.7%	90.2%
Owner-Occupied	1,293,556	24,835	9,304
% of Occupied	68.0%	61.4%	48.2%
Renter-Occupied	607,771	15,613	10,002
% of Occupied	32.0%	38.6%	51.8%

A review of the data reveals the following; 1) Almost 25 percent of Coconino County's housing stock is classified as vacant (see below); 2) The rate of housing ownership is lower than average in Coconino County and; 3) The rate of housing ownership is particularly low in Flagstaff. However, this is consistent with an urbanized center.

[114] U.S. Bureau of the Census
[115] Id.

The table below contains more detailed data on 'vacant' housing stocks in Arizona, Coconino County and Flagstaff.[116] This includes total vacant units (and as a percentage of total housing stock) and vacant units classified as 'for seasonal, recreational or occasional use.'

Table 3E-6
Vacant Housing Stock
Arizona, Coconino County, Flagstaff (2000)

	Arizona	Coconino County	Flagstaff
Total Housing Units	2,189,189	53,443	21,396
Vacant Housing Units	287,862	12,995	2,090
% of Total	13.1%	24.3%	9.8%
For Seasonal, Recreational or Occasional Use	141,965	9,155	977
% of Total	6.5%	17.1%	4.6%
% of Vacant	49.3%	70.5%	46.7%

As noted above, Coconino County has an above average percent of vacant housing, while Flagstaff's vacant housing falls below the statewide average. A more detailed examination of the vacant housing stocks makes it clear that a substantial portion of the county's vacant stock (70.5 percent) is being held for seasonal, recreational or occasional use. There are over 9,100 housing units in the county that are held as vacation or second homes – accounting for 17.1 percent of the county's total housing stock. In comparison, only 6.5 percent of the state's total housing stock is held for the same purpose. This is an indication that the county is a significant draw to people seeking strong scenic and recreational values. Just as significantly, with 17.1 percent of the total housing stock held for seasonal use, there is substantial population fluctuation in the county dependent on the level of occupancy in these units. These non-local homeowners bring additional dollars to the local economy.

The Economy

With a population of over 115,000 persons and an urban center in Flagstaff, the Coconino County economy is driven by a number of elements. While the Arizona Snowbowl alone is not a dominant force in the economy, tourism, of which the Snowbowl is a part, is usually identified as the Flagstaff area's primary industry. While a number of factors play a part in tourism, it is clear that the presence of the Grand Canyon roughly 60 miles north of Flagstaff brings a substantial number of persons through the area. A summary of major economic indicators follows.

The table below shows the distributions of Coconino County and Arizona employment by industry, as well as average wages by industry.[117]

[116] Id.
[117] Arizona Dept. of Employment Security. Figures for 2001.

Table 3E-7
Distribution of Employment by Industry and Average Wages
Coconino County, Arizona

	Coconino County			Arizona		
	Employment	**% of Total**	**Average Annual Wages**	**Employment**	**% of Total**	**Average Annual Wages**
Agriculture	349	0.7%	$22,680	56,853	2.5%	$18,404
Mining	108	0.2%	$24,480	5,365	0.2%	$48,892
Construction	2,689	5.3%	$28,388	164,771	7.3%	$35,628
Manufacturing	2,779	5.4%	$39,992	198,521	8.8%	$48,352
Trans/Utility	1,412	2.8%	$33,808	106,604	4.7%	$41,632
Wholesale Trade	942	1.8%	$41,400	108,228	4.8%	$49,168
Retail Trade	13,179	25.8%	$15,648	432,253	19.1%	$20,108
Fin/Insurance/RE	1,268	2.5%	$33,000	150,077	6.6%	$44,512
Services	14,770	28.9%	$27,200	662,640	29.3%	$34,676
Government	13,582	26.6%	$37,340	372,033	16.5%	$35,764
Non-Classified	14	0.0%	$23,500	2,782	0.1%	$43,592
Totals	***51,092***		***$28,224***	***2,260,127***		***$34,648***

An examination of the data shows that the Coconino County economy differs from the statewide economy in several ways. Most notably, the segment of workers employed in the Retail Trade and Government industries is notably higher in the county than in the state. The emphasis on Retail Trade is reflective of an economy dependent on tourism. Conversely, a comparatively smaller segment of Coconino County's workers are in Manufacturing and Finance/Insurance/Real Estate. The data also shows that county wage rates are significantly lower than statewide averages.

Labor force trends are also significant, as they reflect overall growth and the demands that jobs are creating for workers. From an employer's perspective, a growing labor force creates a pool from which to draw new workers. The table below shows changes in labor force and unemployment rates for the City of Flagstaff, Coconino County, the Flagstaff Metropolitan Statistical Area (MSA) and Arizona for the period 1998 through 2003.[118]

[118] Arizona Dept. of Employment Security. All figures with exception of 2003 are annual averages. 2003 figures averages through July. The Flagstaff MSA is virtually the same geographic area as Coconino County.

Table 3E-8
Labor Force and Unemployment Rates
Flagstaff, Coconino County, Flagstaff MSA, Arizona (1998 – 2003)

	City of Flagstaff		Flagstaff MSA		Coconino County		Arizona	
	Labor Force	Un-employment	Labor Force	Un-employment	Labor Force	Un-employment	Labor Force	Un-employment
1998	30,512	5.8%	59,469	7.2%	56,850	7.3%	2,254.9	4.1%
2000	34,459	4.6%	66,855	5.7%	64,000	5.8%	2,480.0	4.0%
2001	35,324	4.3%	68,382	5.4%	65,525	5.4%	2,579.5	4.7%
2002	36,250	4.6%	70,202	5.8%	67,325	5.8%	2,671.7	6.2%
2003*	35,468	5.3%	68,898	6.6%	66,000	6.7%	2,660.0	5.8%
Change 1998-2002	*18.8%*		*18.0%*		*18.4%*		*18.5%*	

Labor forces in all of the comparative areas grew by similar amounts between 1998 and 2002. However, it should be noted that the Flagstaff MSA and Coconino County (similar areas) have generally experienced above average unemployment rates while the City of Flagstaff has enjoyed below average unemployment rates in recent years. 2003 data for all areas reflects the national and regional economic downturn of recent years.

Tourism

Tourism is a significant industry in the State of Arizona and in Coconino County/Flagstaff area. A recent report noted the following points:[119]

- By various estimates, two-to-five million visitors travel to Flagstaff on an annual basis.
- For Coconino County as a whole, it is estimated that over eight million persons visit on an annual basis.
- Tourism is estimated to account for 12 percent of the county's total income – this is four times the national average.

A year 2000 examination of the impact of tourism on the Flagstaff area economy indicated the following:[120]

- Tourism is the most significant economic activity in Coconino County.
- During the latter part of the 1990s, approximately 13,345 Coconino County residents were employed in the tourism industry.
- Of the 17 economic sectors in which tourism plays an employment role, 'Miscellaneous Amusement & Recreation Services,' was the fifth most important. This sector includes ski areas.

[119] Morlock, B., 2001
[120] Morrison Institute for Public Policy, January 2000

The table below shows total estimated visitors (Domestic and International) to Arizona on an annual basis for the period 1996 through 2001. In addition, total tourism related employment (Direct and Indirect) as well as the total economic impact of statewide tourism is shown.[121]

Table 3E-9
Visitation and Economic Impacts of Tourism Activity
Arizona (1996 – 2001)

	Visitors in Millions					
	1996	**1997**	**1998**	**1999**	**2000**	**2001**
Domestic Visitors	23.70	25.60	25.10	26.80	26.80	27.1
International Visitors	2.47	2.54	2.55	2.62	2.73	***NA***
Total Visitors	26.17	28.14	27.65	29.42	29.53	
Tourism Related Employment (Direct & Indirect)	326,542	347,202	358,685	366,236	375,502	377,621
Economic Impact ($Billions)	$11.1	$11.4	$12.3	$12.7	$13.8	***NA***

In recent years, Arizona has attracted almost 30 million visitors on an annual basis. Just as significantly, direct and indirect tourism employment totals over 375,000 jobs and creates almost $14 billion in annual economic impact.

With two major tourism attractions – Grand Canyon National Park and Glen Canyon National Recreation Area – Coconino County attracts a substantial segment of Arizona's tourism activity. Recent estimates have placed total estimated visitation in the county in the eight-to-nine million range, or approximately 30 percent of Arizona's total activity level.[122]

In summary, it is clear that tourism is critical to the Coconino and Flagstaff area economies and that the Arizona Snowbowl is one of a number of regional attractions that play a role in attracting tourism activity. The Snowbowl is a unique attraction in that it is a winter oriented facility in a region that is commonly perceived as being oriented toward warm weather activities.

Skiing

From a statistical perspective, Alpine skiing accounts for a minor segment of the State of Arizona's travel activity. With an average of just under 300,000 skier visits during the most recent seven seasons, skiing volume does not have a major impact on statewide visitation.[123] However, skiing's impact is more significant from several qualitative perspectives, as explored in more detail below. Skiing brings winter-oriented travel activity to the state – a group that otherwise might not make travel expenditures in Arizona. Further, based on historical usage records at the Snowbowl, it is apparent that there is strong demand for skiing; the Snowbowl is typically used at or near its capacity level on days when there is good or excellent quality skiing.

[121] Arizona Office of Tourism, Office of Tourism Research Library
[122] Bureau of Business & Economic Research, College of Business Administration, Northern Arizona University
[123] Skier visits include Alpine skiers, telemarkers and snowboarders.

The table below shows annual skier visits for the U.S., the Pacific West region (includes Arizona), all of Arizona, and for the Arizona Snowbowl for the 1996/97 through 2002/03 seasons.[124] The table also shows year-to-year percentage change in total visits.

Table 3E-10
Annual Skier Visit Totals
U.S., Pacific West Region, Arizona, Arizona Snowbowl
(1996/97 – 2002/03)

	Annual Skier visits						
	1996/97	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
U.S. (Millions)	52.52	54.12	51.96	51.65	57.34	54.40	57.60
% Change		3.1%	-4.0%	-0.6%	11.0%	-5.1%	5.9%
Pacific West (Millions)	9.84	11.17	11.08	10.61	11.28	12.13	10.60
% Change		13.5%	-0.8%	-4.3%	6.3%	7.5%	-12.6%
Arizona (State)	365,787	384,665	246,941	243,685	355,780	214,135	277,305
% Change		5.2%	-35.8%	-1.3%	46.0%	-39.8%	29.5%
Arizona Snowbowl	153,176	180,082	35,205	66,152	162,175	2,857	87,354
% Change		18%	-80%	88%	145%	-98%	2,958%

While there has been much discussion of a 'flat market,' U.S. skier visit trends have generally been positive in recent years, with the 2002/03 season setting an all-time record. While there are fluctuations, the overall trend has also been positive for the Pacific West region – which represents a *broad* geographic spectrum, from Alaska to Arizona. The data also makes it clear that the level of fluctuation in the Arizona market is much more significant that at the regional or U.S. level and that the level of year-to-year fluctuation in skier visits is *extreme* at the Arizona Snowbowl. Roughly 82 percent of the ski areas in the U.S. have snowmaking facilities that allow them to more consistently provide a skiing product.[125] Because the Snowbowl does not have snowmaking, its ability to provide a skiing product is far less consistent. Not surprisingly, operational records for the Snowbowl indicate that the number of days of operation in any season is closely related to skier visit totals.

The table below shows total Arizona skier visits as a percentage of the Pacific West market and Arizona Snowbowl skier visits as a percentage off the Arizona market for the 1996/97 through 2002/03 ski seasons.

[124] National Ski Area Association (NSAA) *Kottke National End-of-Season Surveys* and the Arizona Snowbowl. The Pacific West region, as defined by NSAA, includes Nevada, Arizona, California, Oregon, Washington and Alaska.
[125] Based on respondents to NSAA annual survey 2002/03.

Table 3E-11
Arizona and Arizona Snowbowl Skier Visits as Percentage of Larger Markets (1996/97 – 2002/03)

	1996/97	1998	1999	2000	2001	2002	2003
Arizona as % of Pacific West Market	3.7%	3.4%	2.2%	2.3%	3.2%	1.8%	2.6%
Arizona Snowbowl as % of Arizona Market	41.9%	46.8%	14.3%	27.1%	45.6%	1.3%	31.5%

During the past seven seasons, total Arizona skier visits have averaged only 0.5 percent of the U.S. market as a whole. While Arizona's share of the Pacific West market is more significant, it remains at a relatively low level, with a fair amount of variability. Over the past seven seasons, Arizona Snowbowl skier visits have averaged 29.8 percent of the Arizona market. However, market share has varied dramatically – from 1.3 to 46.8 percent – again pointing to the variability of the Snowbowl's business due to lack of consistent snow. The Snowbowl's highly variable share of the Arizona market makes it clear that the ski area's competitors within the state enjoy a more stable flow of business from year-to-year.

Arizona Snowbowl Employment

Ski operations at the Arizona Snowbowl create a significant amount of employment. During the past seven seasons of operation (1996/97 through 2002/03) the Snowbowl employed an average of 22.1 persons on a full-time, year-round basis, 272.4 persons on a full-time seasonal basis and 204.3 persons part-time, seasonal basis. During the same seven seasons, the average number of persons employed during the peak week of employment was 370.3. For purposes of this analysis, the employment values have been converted to Full-Time-Equivalents (FTEs) for comparisons with projections of future employment levels.[126] During the past seven seasons, the Arizona Snowbowl provided an average of 172.0 FTE jobs.

Although the Arizona Snowbowl does not 'drive' the Flagstaff area economy, it is apparent that the ski area is a provider of jobs and that ski area visitors are positive contributors to the area economy.

[126] One Full-Time-Equivalent is sufficient work to employ one worker on a full-time basis for one year. Total employed to FTE conversion rates used for this analysis are as follows: Full-Time Year-Round = 1.0 FTE, Full-Time Seasonal = 0.4 FTE and Part-Time Seasonal = 0.2 FTE.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF ENVIRONMENTAL CONSEQUENCES AND CONCLUSIONS

Major conclusions and determinations of this Social and Economic Resources analysis are summarized below. A more detailed analysis of the direct and indirect environmental consequences – from which this summary was derived – follows.

- The City of Flagstaff and Coconino County have experienced solid growth in recent years. Further, their rates of growth appear to have accelerated since 2000. Economic data makes it clear that tourism is a significant component of the Flagstaff area economy. It is estimated that over 24 percent of the Flagstaff economy is generated by tourism activity. While local events and weather do have short-term impacts on tourism volume, year-to-year totals are primarily driven by events in the U.S. macro economy. The significance of recreational activity and scenery in Coconino County is further established by an assessment of the housing stock; 17.1 percent of the county's total housing stock is held for seasonal or recreational purposes. This compares to 6.5 percent for all of Arizona.

- The Arizona Snowbowl is a positive contributor to area tourism and thus, the Flagstaff area economy. The Snowbowl generates jobs, draws dollars to the local economy via visitor expenditures at area businesses and is significant to the area in that it offers a winter attraction in a region that is typically oriented toward summer tourism. However, in an economy of this size, and with countywide tourism drawing over eight million visitors annually, it is unrealistic to think that the Snowbowl would be a significant driver of tourism activity or the economy. This is a positive, as communities in which a ski area is the most significant economic engine are often too affected by the ups and downs of those businesses.

- The Snowbowl has been unprofitable in four of its most recent 11 operating seasons. Without question, variability in natural snowfall and the lack of a snowmaking system have been the primary factors resulting in unprofitable seasons. Moreover, net cumulative profits, during those 11 seasons have been more than exhausted by on-going maintenance needs and small capital investments in the ski area. These capital investments have only been sufficient to maintain the ski area at its current level of quality and maintenance, and have not included any major improvements to increase competitiveness. Under these circumstances, continuation of the current operation as a for-profit business may not be sustainable; the ski area would likely decrease expenditures on maintenance and non-essential services leading to an overall reduction in the quality of the services offered.

- With an annual average of less than 300,000 skier visits, Arizona's ski industry is not a major player in the U.S. ski market. However, the state's ski areas are significant to the state's recreational offerings in that they offer a snow-based attraction in a state that is primarily oriented toward warm weather activities. The Arizona ski industry shows more variability in year-to-year skier visit totals than does the U.S. industry. Year-to-year skier visit totals at the Snowbowl are *extremely* variable when compared to the industry as a whole. This is a factor of absolute reliance on natural snowfall. For the industry as a whole, the installation of snowmaking systems is the standard for mitigating the impacts of variable snowfall.

- The Snowbowl currently *averages* 98,000 skier visits annually, but the annual figure varies dramatically, dependent on natural snowfall. The major positive economic impact of the Snowbowl is triggered by visitor expenditures – both at the Snowbowl and at other area businesses. Any significant change in the Snowbowl's economic impact – either to the positive or negative – will be triggered by changes in visitation levels. Further, the consistency of the ski area's economic impact would be affected by changes that would reduce the variability in year-to-year visitation totals.

- Currently, Snowbowl visitors average direct expenditures of $9.79 million annually in Coconino County, including spending at the Snowbowl and at other area businesses. This spending directly supports 190 full-time job equivalents (FTEs). When the Snowbowl's full range of direct and indirect economic impacts are considered, the ski area currently supports 232 FTEs and $12.08 million in economic output in the private sector.

- The Snowbowl's current public sector inputs include an annual average of $90,000 in fee payments to the U.S. Treasury of which approximately 25 percent is provided to Coconino County, $257,000 in state and county sales taxes and $36,000 in county personal property tax. These payments help to support a number of local programs and services, including: schools, libraries and the fire district.

- The Snowbowl is a significant recreational/social asset to the Flagstaff area:

  - The Snowbowl is the primary winter recreational attraction in the area.
  - The Snowbowl provides access to an Alpine environment to those who would otherwise not be able to visit this area.
  - The Snowbowl provides support – both programmatic and financial – to a number of area groups.

Alternative 1 – No Action

- Under this alternative, the ski area would continue operations with the existing facilities. While the Snowbowl has operated in its current form for a number of years, the financial analysis makes it clear that this may not be a viable business model – the business has been unprofitable in four of 11 years and the required capital investment has more than exhausted profits over that period. Thus, a continuation of the current operation and level of services would probably not be regarded as sustainable by a prudent owner or investor. While there is a demonstrated market for quality skiing in the Flagstaff area, the absence of natural snowfall in a number of years would keep the ski area from achieving a sustainable business position. A prudent owner/investor would eventually be forced to significantly curtail operations by reducing capital investment/maintenance expenditures and the level of services being provided depending on the weather.

- Assuming continued operations, the alternative would result in a small increase in visitation over the 10 year planning period; from an annual average of 98,000 to 110,000, primarily in response to regional population growth. However, annual totals would continue to be highly variable (plus or minus 70 percent from the average) due to variability in natural snowfall.

- Increases in average visitation would result in some additional economic impact. At the end of the 10 year planning period, these added expenditures would support an additional 11 FTEs and $1.47 million in economic output. Thus, the ski area would support a total of 261 FTEs.

- Increases in ski area activity would support minor increases in average annual Forest Service Special Use Permit and sales tax payments.

Alternative 2 – The Proposed Action

- All costs associated with the planning, development, construction, operation and maintenance of all proposed infrastructure would be fully the responsibility of the Arizona Snowbowl or future SUP permittees.

- Under this alternative, the Snowbowl would experience a major improvement in the skiing facility, create an entirely new snowtubing/snowplay area, significantly improve skier services and, put a snowmaking system in place. The snowmaking system is the most significant improvement from an economic impact perspective; snowmaking would allow the ski area to *consistently* operate with quality skiing conditions an average of 125 days per season. With a proven demand for quality skiing in this market, a consistent operating season would allow the ski area to significantly increase total annual visitation. Increases in visitor expenditures are closely correlated with a positive economic impact.

- The alternative would result in a significant increase in total visitation over the 10 year planning period; from an annual average of 98,000 to 257,000 (includes skiers and snowplayers). Year-to-year variations in visitation would be minimized (plus or minus 15 percent) because of the inclusion of a snowmaking system.

- The short-term impacts of the construction of the alternative's improvements would result in the creation of 232 FTEs and $21.24 million in economic output in Coconino County.

- Increases in average visitation would result in a substantial positive economic impact. At the end of the 10 year planning period, these added expenditures would support an additional 331 FTEs and $17.23 million in economic output. Thus, the ski area would support a total of 564 FTEs in Coconino County. This would be a significant result; a substantial number of Flagstaff area residents would gain employment opportunities as a result of increased activity at the Snowbowl.

- This alternative would result in substantial increases in fees and taxes paid to the public sector. At the end of the 10 year planning period, it is projected that the Snowbowl would pay an annual average of $193,000 in Forest Service Special Use Permit fees of which 25 percent (approximately $48,250) would be provided to the County for schools and roads, $650,000 in state/county sales taxes and $455,000 in county personal property taxes. Significantly, these fees/taxes would not vary substantially from year-to-year because ski area visitation would be more consistent in response to the installation of the snowmaking system. These fees and taxes would

be significant sources of support for local programs and services, including schools, libraries and the fire district.

- The Snowbowl's function as a recreational/social facility in the Flagstaff area would be enhanced and secured. With a larger facility and more secure financial base, the Snowbowl would be able to increase its role in the community – both from programmatic and resource perspectives. Further the addition of a snowplay area would enable a new demographic of guests to gain access to snow and the Alpine environment.

Alternative 3

- All costs associated with the planning, development, construction, operation and maintenance of all proposed infrastructure would be fully the responsibility of the Arizona Snowbowl.

- It is highly unlikely that Alternative 3 would ever be fully implemented, either by current or future Arizona Snowbowl owners. Alternative 3 would include significant improvements to ski facilities, but the alternative does not include snowmaking. As such, skier visits and thus revenues would continue to fluctuate dramatically. With a higher break-even resulting from the investment in Alternative 3 improvements, the ski area would be unprofitable a high percentage of the time. Given these circumstances, the prudent owner/investor would likely not make the choice to complete all of the Alternative 3 project elements. At most, an owner/investor might make several of the minor improvements included in the alternative; these improvements would likely have little or no impact on skier visitation and ski area viability. In the event that an owner/investor were to fully complete the Alternative 3 improvements, the ski area could be placed in a highly tenuous financial situation potentially leading to the cessation of business operations within several years depending on the weather.

- Because Alternative 3 is unlikely to be fully accomplished, the effective economic impact would be similar to that for Alternative 1; minor increases in visitor expenditures would support some additional employment and dollar flows in the local economy and small increases in public sector fees and taxes. Further, the Snowbowl would continue to operate in a highly tenuous business situation, one that might not be sustainable over a period of years.

- In the unlikely event that Alternative 3 were to be fully completed, any increases in skier visits and expenditures would be short-term. Because visitation would continue to fluctuate dramatically, and the ski area's break-even level would increase, the operation would be tangibly unprofitable and could potentially cease business operations within several years. Under this situation, a significant number of persons would no longer be employed – both at the Snowbowl and at other area businesses that are supported by visitor spending.

DETAILED ANALYSIS OF DIRECT AND INDIRECT EFFECTS

Issue:

Implementation of the Proposed Action may have social and economic effects on Flagstaff and Coconino County.

Indicator:

The Potential for the Proposed Action to Affect a Change In Key Local Economic Indicators (Population; Long- and Short-Term Employment, Housing, and Tax Revenues, etc.).

Impact Analysis Methods

A variety of information and data sources were utilized to develop the analysis of economic impact. Capital cost estimates for the alternatives were developed in conjunction with Arizona Snowbowl ski area planners. Skier visit projections for the alternatives were developed based on historic data from the Arizona Snowbowl, projections regarding increases in facility scope and information regarding market area growth from the U.S. Bureau of the Census and the Arizona Department of Employment Security. Data on skier expenditures were based on surveys of skier expenditures from several western states (including Utah and Colorado) as well as surveyed expenditures by Arizona Snowbowl skiers from University Associates, Inc. An IMPLAN input-output analysis was conducted to determine total effects from construction, employment, and visitor expenditures.

The economic impact analysis was accomplished in several major steps:

1. *Skier visit Projections* – average level visit projections were prepared for a point 10 years following the completion of each alternative. (In addition, a snowtubing visit projection was prepared for Alternative 2.) The visit projections were based on the improvement – or lack of improvement – that each alternative would offer as well as background factors. The factors that were considered included; change in lift capacity, change in skiing terrain, development of a tubing/snowplay facility, change in parking capacity, development of snowmaking capability and potential population growth in the region.

   Based on the most recent seven seasons of operation, the Arizona Snowbowl averaged just over 98,000 skier visits per season. However, it is essential to note that this is only an average figure and that, due to inconsistent snowfall, the year-to-year figure fluctuates dramatically. During the most recent seven seasons, the skier visit total fluctuated by as much as 97 percent below and 70 percent above the median. In recent seasons, day visitors have accounted for 65.5 percent of the total, while destination skiers accounted for 34.6 percent of the total.[127] Projections for each alternative are summarized below.

   Alternative 1 – Increases in average annual visitation would be minor and would only occur in response to projected population increases in the region. Average visits are

[127] *The Arizona Snowbowl Snow Users Surveys.* Destination skiers are those who stay overnight in the area as part of their trip to the Snowbowl.

projected to increase from the current level of 98,000 to 110,500 in 10 years, a net increase of 12,500 visits. However, because Alternative 1 does not include snowmaking, year-to-year visits can be expected to continue to fluctuate dramatically. Based on historic data, total visits are projected to fluctuate plus or minus 70 percent from the average in three of four years. In one of four years, the fluctuation would be more extreme having reached 97 percent below the median. The breakdown between day and destination skiers is not projected to change from the current level.

Alternative 2 – Increases in average annual visitation would be significant and would occur in response to all of the factors listed above, including the addition of a snowtubing facility. The most significant factor by far would be the addition of a snowmaking system. This system would allow the ski area to consistently average 125 days of operation per season and allow the ski area to consistently offer quality ski conditions on a variety of terrain. Based on past operations, an increase in operating days would clearly result in an increase in total annual visitation. Again, operational records make it clear that the number of days of operation is closely related to skier visit totals. Further, the addition of a snowmaking system would increase consumer confidence in the ski area, resulting in an increase in season pass sales and making the ski area more attractive to destination skiers. Average annual visitation is projected to increase from the current level of 98,000 to 214,500 in 10 years: a net increase of 116,500. These incremental visits will represent significant additional travel activity and a positive contribution to the area economy. Year-to-year fluctuations in visits are projected to be far less significant than under alternatives 1 or 3 and are projected to be on the order of plus or minus 15 percent from the average. Destination visitors are expected to increase as a percentage of the total, to 41.5 percent. In addition, it is projected that the snowtubing operation would generate an annual average of 42,000 visits. The great majority of snowtubers are expected to be day visitors.[128]

Alternative 3 – As documented below under 'Financial Viability,' it is unlikely that the ski area improvements as listed under Alternative 3 would ever be fully achieved. Because of the lack of snowmaking, the investment required to achieve Alternative 3 would have no reasonable opportunity to be repaid and would, in fact, result in a ski area that is less financially viable than the current condition. As such the 'projected increase' in skier visits under this alternative is only a hypothetical that has little chance of every being achieved.

In the unlikely event that Alternative 3 was ever fully achieved, increases in average annual visitation would be minor, but somewhat higher than those projected for Alternative 1. Increases would occur in response to all of the factors listed above, with the exception of two major factors – the addition of snowmaking capability and

[128] Snowtubing would only operate on weekends from Thanksgiving until December 22. At that point, the operation would begin daily operations. It is expected that the facility would operate until the third Sunday in March.

the addition of a snowtubing facility. Average visits would be projected to increase from the current level of 98,000 to 117,750 in 10 years, a net increase of 19,750 visits. However, because Alternative 3 does not include snowmaking, year-to-year visits would be expected to fluctuate dramatically. Based on historic data, total visits would be projected to fluctuate plus or minus 70 percent from the average in three of four years. In one of four years, the fluctuation would be more extreme having reached 97 percent below the median in recent years. A small increase in destination skiers would be anticipated in response to the ski area's increased facility offering.

2. *Visitor Spending* – the economic impact of the alternatives would be primarily dependent on increases in spending generated by additional visits to the Arizona Snowbowl. These expenditures would support additional jobs and wages at the ski area as well as additional jobs and wages at other area businesses where Snowbowl visitors make expenditures. Further, these expenditures would create both indirect and induced employment and economic activity in the impact area. Daily, visitor per capita expenditure levels were estimated in five major categories; Eating-Drinking-Entertainment, Retail, Hotel-Lodging, Services, and Lifts-Ski School. Further, breakdowns were developed for day and destination visitors and for spending within the ski area and outside the ski area. It is significant to note that per capita level spending is higher for destination visitors than for day visitors, primarily because of increased spending on Eating-Drinking-Entertainment, Retail and Hotel-Lodging. Further, destination visitors represent a net inflow to the economy – bringing in dollars from outside the local economy.[129] Thus, an alternative that increases the number of destination visitors would be a positive for the Flagstaff area economy.

   Based on the average annual visitation levels of the past seven seasons, total spending by Arizona Snowbowl visitors (including spending inside and outside of the resort) is $9.79 million on an annual basis. Thus, the Snowbowl currently generates almost $10 million in spending in the local economy. This benefits both the Snowbowl and a number of other area businesses where Snowbowl visitors make expenditures.

3. *Input/Output Analysis* – the projected visitor expenditures were analyzed using an input/output model to project economic impacts to the region. The IMPLAN model was used for making projections regarding prospective employment outside of the resort and employment to be generated on indirect bases.[130] IMPLAN is a broadly accepted model for making projections regarding employment and economic impacts and is commonly used in Environmental Impact Statements prepared as part of the NEPA process.

[129] Per capita spending estimates based on surveys of skier expenditures in several western states including Colorado and Utah and data from *The Arizona Snowbowl Snow Users Surveys.*

[130] IMPLAN Professional is a product of MIG, Inc. and is an economic impact assessment modeling system. IMPLAN allows the user to build economic models to estimate that impacts of economic changes in their states, counties or communities.

Employment economic activity creation is defined in three ways in this report, as defined by the IMPLAN model:

Direct – employment created as a direct impact of the project. On-site construction jobs, resort-based jobs and non-resort jobs generated by visitor expenditures are included in this category. The majority of these jobs would be created in the resort or within the greater Flagstaff area.

Secondary – employment created by industry-to-industry spending. For instance, increased food & beverage spending at the Arizona Snowbowl would cause the ski area to purchase more goods from food suppliers. Increased business levels would allow these food suppliers to create more employment. These are *secondary* jobs. These jobs would be created both locally and throughout the geographic area in which construction contractors and the ski area regularly conducts business.

Induced – employment created by increased household spending. The additional jobs and income created by the alternatives and increased visitation would allow consumers to increase their spending on goods and services. This spending would allow a number of businesses to create more jobs. These are *induced* jobs. Induced jobs would be generated over a relatively broad geographic area.

Within this analysis, the combination of *secondary* and *induced* impacts is referred to as *indirect* impacts. It is essential to note that all employment estimates are shown in terms of 'Full-Time-Equivalents,' (FTEs). One FTE is sufficient work to employ one person on a full-time basis for one year. One FTE often represents more than one job position, particularly in situations where many workers are seasonal or employed on a part-time basis.

IMPLAN also provides an 'Output' statistic, the total dollar value of production by all industries.

The IMPLAN model has been constructed to use a geographic area that includes all of Coconino County. The model's output regarding employment impacts considers economic activity throughout this region.[131] Employment records indicate that a great majority of the Snowbowl's employees live in Coconino County.

The input-output analysis indicates the following regarding Arizona Snowbowl's current economic impact – in terms of FTEs and total output.

Table 3E-12
Current Economic Impact Arizona Snowbowl

	Direct	Indirect	Totals
Employment (FTEs)	189.3	43.1	232
Output ($Millions)	$9.10	$2.98	$12.08

Under current conditions, the Arizona Snowbowl is a clear, positive contributor to the area

[131] It is possible that the economic impacts of the alternatives would extend beyond Coconino County.

economy. In total, the Snowbowl is responsible for generating 232 full-time employment equivalents and just over $12 million and annual economic output.

Assumption

This methodology is based on the following assumptions:

- Existing information provides an adequate basis for analysis and disclosure of the socioeconomic impacts of this proposal; no original research was conducted.

- Cost and revenue projections are expressed in 2003 dollars, without adjustment for inflation. Economic impact projections are oriented toward a 'planning year' ten years after the completion of the chosen alternative.

This analysis focuses on the Alpine skiing and snowtubing impacts that are directly associated with the Arizona Snowbowl proposal, leaving qualitative discussion of other forms of recreation to the Recreation section within this document.

Anticipated Impacts

The table on the following page summarizes the analysis presented within the remainder of this section. The data provided represents the anticipated impacts of each alternative estimated at a point ten years following implementation of the respective alternative.

Table 3E-13
Summary of Impacts of Alternatives

		BUILD-OUT PROJECTIONS - 10 Years		
	BASE 2003	**Alt 1 No-Action**	**Alt 2 Proposed Action**	**Alt 3**
Skier Visitation				
Day Skiers	64,234	72,372	125,685	75,012
Destination Skiers	33,908	38,204	89,015	42,705
TOTAL (Annual Average)	***98,142***	***110,576***	***214,700***	***117,716***
Coconino County Demographics				
Population (2002)	125,420		Year 2015 Projection:	158,753
Housing Units (2000)	53,443			
Development Costs ($Millions)				
Spent within impact area	-	$0.75	$15.45	$5.90
Spent outside impact area	-		$4.32	$4.32
TOTAL	***-***	***$0.75***	***$19.77***	***$10.22***
Visitor Spending ($Millions)				
Food & Beverage	$1.7	$1.9	$4.3	$2.1
Retail	$2.7	$3.0	$6.7	$3.3
Hotel & Lodging	$1.3	$1.4	$3.2	$1.6
Services	$0.8	$0.8	$1.9	$0.9
Lifts & Ski School	$3.3	$3.8	$7.7	$4.0
TOTAL	***$9.8***	***$11.0***	***$23.7***	***$11.9***
Employment (FTEs)				
Short-Term (Construction)		(EIS Process Only)		
Direct	-	7	142	50
Secondary	-	2	43	16
Induced	-	2	47	16
TOTAL Construction Employment	***-***	***11***	***232***	***82***
Long-Term (Expenditures)				
Direct Employment				
On-Site	172	175	211	175
Off-Site	17	38	248	54
Indirect Employment				
Off-Site	43	48	105	52
TOTAL Employment	***232***	***261***	***564***	***282***
Fiscal Considerations				
Forest Service Fees (Average Annual)	$90,000	$99,500	$193,000	$106,000
Property taxes to Coconino County	$36,000	$36,169	$455,833	$245,152
Sales Taxes (County & State)	$257,000	$289,500	$669,000	$308,000

Table data makes it clear that from an economic perspective, Alternative 2's impact would far outweigh either Alternative 1 or 3. As noted, it is unlikely that Alternative 3 would ever be fully developed.

Alternative 1 – No Action

Economic Impacts

During previous seasons, Arizona Snowbowl skier visits have shown no regular pattern of increase or decline, as year-to-year totals fluctuate dramatically in response to weather/snow conditions and the number of days the ski area is able to operate in a given year. Market

response to the Snowbowl's product is strong when quality skiing conditions exist. This is an indication that an increase in the number of available days of quality skiing would increase skier visit totals. Over the course of the 10 year study period, the *average* annual number of skier visits is expected to increase by 12.7 percent under Alternative 1. However, year-to-year totals would continue to fluctuate dramatically with typical variances in the plus/minus 70 percent range from the average level.

No direct construction would take place under Alternative 1. However, the EIS process would have some economic impact, with total direct spending of $750,000 (refer to Table 3E-20 for a comparison of project related capital expenditures by alternative). The employment and economic output impacts of this spending would be short term and are not expected to last beyond the completion of the process. These FTE and economic output impacts are summarized in the table below.

Table 3E-14
Short-Term Impacts
Alternative 1

	Direct	Indirect	Totals
Employment FTEs)	7.0	4.4	11.4
Output ($Millions)	$0.75	$0.28	$1.03

The EIS process would have the short-term impact of creating over 11 FTEs and $1.03 million in output.

In the longer term, average level increases in annual visitation at the Snowbowl would result in longer term impacts on employment and output. However, it is significant to note that under Alternative 1, these impacts would not be consistent, as year-to-year visitation would continue to fluctuate by a substantial amount. The *average* level of visitor increase at the end of the 10 year planning period, incremental expenditures by Snowbowl visitors over the amount spent in recent years would total $1.19 million. This would include $527,000 in additional spending within the ski area and $664,000 in additional spending outside the ski area – in the remainder of Coconino County.[132] When combined with base level (current) expenditures, spending by Snowbowl visitors would total $10.98 million. While this is not a dramatic increase over the current level of economic input, it does emphasize the Snowbowl's current positive contribution to the economy.

Using IMPLAN, the incremental expenditures have been analyzed to determine Alternative 1's incremental impact in terms of direct and indirect employment and output. This is shown in the following table.

[132] 'Outside' the ski area includes other businesses operated by the Arizona Snowbowl, including lodging and Nordic skiing operations.

Table 3E-15
Long-Term Incremental Impacts
Alternative 1

	Direct	Indirect	Totals
Employment (FTEs)	23.1	5.3	29
Output ($Millions)	$1.11	$0.36	$1.47

At the end of the 10 year planning period, Alternative 1 would generate a total of 29 additional FTEs and $1.47 million in additional economic output within Coconino County. Based on the Snowbowl's estimate of the employment that would be created under Alternative 1 (2.8 FTEs), Alternative 1 would generate 26 FTEs outside of the ski area, in the remainder of Coconino County.

In total (current and incremental), the Arizona Snowbowl would generate 261 FTEs at the completion of the 10 year planning period.

Fiscal Impacts

The No Action alternative could have impacts on payments made by the Arizona Snowbowl to governmental entities, such as the U.S. Government, the State of Arizona, Coconino County and the City of Flagstaff. These fees are used for a variety of public purposes, supporting programs at the Federal, state and local levels.

Forest Service Fees

During recent years, Snowbowl made the following annual payments to Forest Service.

Table 3E-16
Arizona Snowbowl Payments
to Forest Service (1998 – 2002)

Year	Forest Service Fees
1998	$159,715
1999	$24,633
2000	$89,912
2001	$103,875
2002	$24,488
Median	*$89,912*

Fees are collected annually, and are based on skier visitation. The Snowbowl has paid the Forest Service an average of approximately $0.90 per skier visit over the past five seasons. These "Receipt Act" payments are generated from fees paid to National Forests by permittees, such as the Snowbowl, and are distributed pursuant to the Receipt Act. Such payments have historically varied according to the level of revenues generated by the permittee, which in the case of the Snowbowl is directly tied to skier visitation. Because Snowbowl visitation fluctuates dramatically, Receipt Act payments have varied by a substantial amount – 78 percent over, and 73 percent under, the median of the values shown in the table. A segment of the Forest Service

fees are allocated to Coconino County. 75 to 80 percent of this allocation is then used to support local schools. As such, the fees are significant to local education.

Annual fees can be expected to increase as the average skier visit level at the Snowbowl increases. However, skier visit totals under Alternative 1 would continue to fluctuate dramatically, so fees would fluctuate from year-to-year. It is projected that at the end of the 10 year planning period, annual Forest Service fees would average $99,500, with a typical variation range from $30,000 to $169,000.

Sales Tax

The Arizona Snowbowl pays sales taxes to the State of Arizona and Coconino County. Sales taxes support a number of state and local programs and services. The sales tax is essentially based on all Snowbowl revenue, with the exceptions of private ski lessons and labor-based revenue for ski repairs in the rental shop. The table below shows Sales Tax paid by the Snowbowl in recent years.[133]

Table 3E-17
Sales Taxes Paid by Arizona Snowbowl
(1998 – 2003)

	Sales Tax (State & County Combined)
1998	$350,590
1999	$98,991
2000	$311,877
2001	$363,352
2002	$100,079
2003*	$202,493
Cumulative	$1,427,382
Median Annual	***$257,185***

Note: 2003 through April only.
Source: Arizona Snowbowl.

Because sales tax is directly related to revenues, the tax paid by the Snowbowl varies significantly dependent on visitation levels. During the years shown in the table, the tax paid varied from 62 percent below to 41 percent above the median.

Over the years shown, sales tax paid to the state/county averaged approximately $2.60 per skier visit. The potential future increment in sales tax to be paid by the Snowbowl under Alternative 1 is based on the projected average increase in skier visits times this per visit figure. Skier visit totals under Alternative 1 would continue to fluctuate dramatically, so sales tax payments would fluctuate from year-to-year. It is projected that at the end of the 10 year planning period, the *incremental increase* in annual sales tax payments would average $32,500, with a typical variation range from $9,750 to $55,000.

[133] Note that during the years shown in the table, the Snowbowl made cumulative sales tax payments to the City of Flagstaff in the amount of $14,754 as a result of the Snowbowl's downtown store.

Personal Property Tax

The Arizona Snowbowl pays an annual Personal Property Tax to Coconino County. The tax supports county operations. The tax is based on an assessed value of personal property at the Snowbowl. Property taxes are allocated the county school district, the library and the fire district. As such, they are essential for supporting local programs and services. Because the Snowbowl is on NFS land, the value is based on 'built' facilities or improvements of possessory rights. Recent Personal Property Tax payments to the county are summarized in the table below.[134]

Table 3E-18
Personal Property Tax Payment Made by Arizona Snowbowl to Coconino County (1998 – 2002)

	Personal Property Tax Payments
1998	$29,266
1999	$37,189
2000	$37,120
2001	$36,367
2002	$36,169

Source: Arizona Snowbowl.

Because Personal Property Tax payments are based on the 'depreciated market' value of built facilities and improvements, they do not fluctuate in response to variation in skier visit totals. The current (2003) 'full value' assessment of the Snowbowl is $1,639,528.[135] The Snowbowl's assessed value is not expected to change under Alternative 1. As such, no significant change in Personal Property Tax payments is anticipated.[136] This is shown in the table below.

Table 3E-19
Estimated Annual Personal Property Payments Alternative 1

	Current Personal Property Value	Added Value + Under Alternative	Total Estimated Personal Property = Value	Annual Estimated Personal Property Tax
Alternative 1	$1,639,528	$0	$1,639,528	$36,169

[134] Values based on tax payments made by the Snowbowl Alpine ski facility alone and do not include payments for property at the Nordic facility.
[135] Based on 'Personal Property Notice of Value' forms from the Coconino County Assessor's office.
[136] Assessments are based on depreciated value of personal property. As such, the assessment would decrease with time unless improvements are completed.

Alternative 2 – The Proposed Action

Economic Impacts

During previous seasons, Arizona Snowbowl skier visits have shown no regular pattern of increase or decrease, as year-to-year totals fluctuate dramatically in response to weather/snow conditions and the number of days the ski area is able to operate in a given year. Over the 10 year study period, the increase in the *average* annual number of skier visits plus the addition of snowtubing/snowplayer visits under Alternative 2 is expected to increase total visitation at the Snowbowl by 162 percent over current annual average visitation and 132 percent over the existing condition. In addition, fluctuation in year-to-year totals would decrease dramatically because of the addition of a snowmaking system. Year-to-year fluctuation is expected to be plus or minus 15 percent from average annual visitation.

As detailed in Table 3E-20, substantial direct construction would take place under Alternative 2. The total construction value of Alternative 2 improvements is estimated at $19,773,000, of which approximately $15,453,000 would be primarily local spending.[137]

Table 3E- 20
Project Capital Expenditures by Alternative[a]

	Alternative 1	Alternative 2	Alternative 3
Snowmaking Infrastructure	n/a	$8,200,000	n/a
Snowplay – Terrain	n/a	$350,000	n/a
Snowplay – Parking	n/a	$300,000	n/a
Snowplay – Facility	n/a	$700,000	n/a
Lifts – Local Construction	n/a	$1,080,000	$1,080,000
Lifts – Non-Local Equipment	n/a	$4,320,000	$4,320,000
Terrain Improvements	n/a	$558,000	$558,000
Guest Service facilities – All	n/a	$2,800,000	$2,800,000
Summer Trails	n/a	$65,000	$65,000
Infrastructure – Sewer	n/a	$350,000	$350,000
Infrastructure – Roads/Underpass	n/a	$200,000	$200,000
Parking, Roads	n/a	$100,000	$100,000
Entitlements	$750,000	$750,000	$750,000
Total for Alternative	***$750,000***	***$19,773,000***	***$10,223,000***

Source: Arizona Snowbowl Management, Landvest, Sno.matic Controls & Engineering, SE GROUP
[a] Recurring capital expenditures for maintenance are not included here, but are discussed elsewhere within this section.

The employment and economic output impacts of this construction spending would be significant, but would be short-term and are not expected to last beyond the completion of the construction activity. The FTE and economic output impacts of Alternative 2 construction are summarized in the table below.

[137] Approximately $4,320,000 would be expended on equipment (primarily ski lifts) that would be manufactured outside of the Coconino County study area.

Table 3E-21
Short-Term Impacts
Alternative 2-The Proposed Action

	Direct	Indirect	Totals
Employment FTEs)	142.0	89.6	231.6
Output ($Millions)	$15.10	$6.14	$21.24

Alternative 2 construction activity would have the short-term impact of creating over 230 FTEs and generating $21.24 million in economic output. While short-term in nature, this would represent a significant number of construction related jobs and economic activity.

In the longer term, average level increases in visitation at the Snowbowl would result in long term impacts on employment and output. These impacts would be relatively consistent under Alternative 2, as visitation at the Snowbowl would not fluctuate significantly due to the introduction of a snowmaking system. In addition, the long-term viability of the Snowbowl would be enhanced under this alternative. At the average level of annual visitor increase at the end of the 10 year planning period, incremental expenditures by Snowbowl visitors over the amount spent in recent years would total $14.00 million. This would include $5.66 million in additional spending within the ski area and $8.30 million in additional spending outside the ski area – in the remainder of Coconino County.

When combined with base level (current) expenditures, spending by Snowbowl visitors would total $23.74 million. This would be a significant positive impact to the area economy, giving a boost to both the Snowbowl and a significant number of other businesses that would draw expenditures from Snowbowl visitors. Most significantly, these expenditures would support additional local employment, as detailed below.

Using IMPLAN, the incremental expenditures have been analyzed to determine Alternative 2's incremental impact in terms of direct and indirect employment and output. This is shown in the table below.

Table 3E-22
Long-Term Incremental Impacts
Alternative 2-The Proposed Action

	Direct	Indirect	Totals
Employment (FTEs)	269.6	61.6	331
Output ($Millions)	$12.97	$4.26	$17.23

At the end of the 10 year planning period, The Proposed Action would generate a total of 332 additional FTEs and $17.23 million in additional economic output in Coconino County. Respectively, these exceed the effects of the No Action Alternative by 303 FTEs and $15.76 million in economic output. Based on the estimate of the employment that would be created under Alternative 1 (38.9 FTEs), Alternative 2 would generate 292 FTEs outside of the ski area, in the remainder of Coconino County.

In total (current and incremental), the Arizona Snowbowl would generate 564 FTEs at the completion of the 10 year planning period. While the Snowbowl would still not be the major drive of the Flagstaff area economy, the importance of 564 full-time equivalent jobs is difficult to overstate.

Fiscal Impacts

Alternative 2 could have impacts on payments made by the Arizona Snowbowl to governmental entities, such as the U.S. Government, the State of Arizona, Coconino County and the City of Flagstaff.

Forest Service Fees

Annual payments to the Forest Service in recent years are shown under Alternative 1 above.

Fees are collected annually, and are based on skier visitation. The Snowbowl has paid the Forest Service an average of approximately $0.90 per skier visit over the past five seasons. These "Receipt Act" payments are generated from fees paid to National Forests by permittees, such as the Snowbowl, and are distributed pursuant to the Receipt Act. Such payments have historically varied according to the level of revenues generated by the permittee, which in the case of the Snowbowl is directly tied to skier visitation. Because Snowbowl visitation fluctuates dramatically, Receipt Act payments have varied by a substantial amount – 78 percent over and 73 percent under the median of the values shown in the table. A segment of the Forest Service fees are allocated to Coconino County. 75 to 80 percent of this allocation is then used to support local schools. As such, the fees are significant to local education.

Annual fees can be expected to increase as the average skier visit level at the Snowbowl increases. Total annual visitation (skiers and snowplayers) would be relatively consistent under Alternative 2, as a result of the introduction of a snowmaking system. As a result, fees can be expected to be relatively steady from year-to-year – only fluctuating within a range of 15 percent plus or minus. It is projected that at the end of the 10 year planning period, annual Forest Service fees would average $193,000, with a typical variation range from $164,000 to $222,000. Average annual fees generated by Alternative 2 would exceed those to be generated by the No Action Alternative by approximately $93,500 and would be consistent from year-to-year. The incremental increase in fees is significant in two ways: 1) it will provide additional funding for programs; and 2) because the fee level will be consistent, will provide stability in program funding.

Sales Tax

The Arizona Snowbowl pays sales taxes to the State of Arizona and Coconino County. The tax supports a number of state and local programs and services. The sales tax is essentially based on all Snowbowl revenue, with the exceptions of private ski lessons and labor-based revenue for ski repairs in the rental shop. Sales taxes paid by the Arizona Snowbowl in recent years are shown under Alternative 1 above. Because sales tax is directly related to revenues, the tax paid by the Snowbowl varies significantly dependent on visitation levels. During the years shown in the table, the tax paid varied from 62 percent below to 41 percent above the median.

Over the years shown, sales tax paid to the state/county averaged approximately $2.60 per skier visit. The potential future increment in sales tax to be paid by the Snowbowl under Alternative 2 is based on the projected average increase in skier visits times this per visit figure. Skier visit totals under Alternative 2 would be relatively consistent as a result of the introduction of a snowmaking system, so sales tax payments would not change significantly from year-to-year. It is projected that at the end of the 10 year planning period, the *incremental increase* in annual sales tax payments would average $412,000, with a typical variation range from $350,000 to $474,000. The incremental increase in sales taxes under Alternative 2 exceeds the incremental increase under the No Action alternative by $380,000 on an annual basis. In total (current plus projected sales tax), it is projected that if Alternative 2 were to be accomplished, the Arizona Snowbowl would generate $650,000 in sales tax on an annual basis. This is a substantial to programs and services funded by the sales tax.

Personal Property Tax

The Arizona Snowbowl pays an annual Personal Property Tax to Coconino County. Property taxes are allocated to the county school district, the library and the fire district. As such, they are essential for supporting local programs and services. The tax is based on an assessed value of personal property at the Snowbowl. Because the Snowbowl is on NFS land, the value is based on 'built' facilities or improvements of possessory rights. Recent Personal Property Tax payments to the county are summarized under Alternative 1 above. The tax supports a number of county programs and services.

Because Personal Property Tax payments are based on the 'depreciated market' value of built facilities and improvements they do not fluctuate in response to variation in skier visit totals. The current (2003) 'full value' assessment of the Snowbowl is $1,639,528.[138] The Snowbowl's assessed value would increase substantially under Alternative 2, as a number of new facilities and improvements would be made under the alternative's construction program. In total, the construction program calls for $19.023 million in new facilities and improvements at the Arizona Snowbowl.[139] As such, annual personal property tax payments would increase substantially. This is shown in the table below.

Table 3E-23
Estimated Annual Personal Property Tax Payments - Alternative 2

	Current Personal Property Value	Added Value + Under Alternative	Total Estimated Personal Property = Value	Annual Estimated PersonalProperty Tax
Alternative 2	$1,639,528	$19,023,000	$20,662,528	$455,833

It is estimated that upon completion Alternative 2 would generate over $450,000 annually in Personal Property Tax payments. This is an increment of $420,000 annually over the current level (Alternative 1) and would be a significant source of support for county programs and services.

[138] Based on 'Personal Property Notice of Value' forms from the Coconino County Assessor's office.
[139] This figure includes the value of ski lifts that would be manufactured outside the study area but does not include the cost of the EIS process.

Alternative 3

It is the conclusion of the analysis that Alternative 3 is highly unlikely to be fully implemented, either by the current or a future owner. This is documented below under "Financial Viability of the Ski Area." Alternative 3 would include significant improvements to ski facilities, but the alternative does not include snowmaking. As such, skier visits and thus revenues would continue to fluctuate dramatically. With a higher break-even resulting from the investment in Alternative 3 improvements, the ski area would be unprofitable a high percentage of the time. Given these circumstances, a prudent owner/investor would likely not fully implement Alternative 3. At most, an owner/investor might make several of the minor improvements included in the alternative; these improvements would have little or no impact on skier visitation and ski area economic impact. In the event that an owner/investor did complete Alternative 3, the ski area could be placed in a highly tenuous financial situation which could potentially lead to the cessation of operations within several years depending on the weather.

Viewed from a realistic perspective, Alternative 3 can be viewed as virtually the same as Alternative 1; if Alternative 3 were to be approved, essentially no change would take place at the Snowbowl.

The analysis of Alternative 3 economic and fiscal impacts below should thus be regarded as unlikely to occur in nature as the analysis concludes that the prudent investor would not fully complete these improvements. In the event that the alternative were fully implemented, it is likely that skier visits and thus revenues would continue to fluctuate dramatically. With a higher break-even resulting from the investment in Alternative 3 improvements, the ski area would be unprofitable a high percentage of the time. The ski area could be placed in a highly tenuous financial situation potentially leading to the cessation of business operations within several years depending on the weather.

Economic Impacts

During previous seasons, Arizona Snowbowl skier visits have shown no regular pattern of increase or decline, as year-to-year totals fluctuate dramatically in response to weather/snow conditions and the number of days the ski area is able to operate in a given year. In the event that Alternative 3 were to be fully accomplished, the *average* annual number of skier visits is expected to increase by 19.9 percent over current average annual visitation and 6.5 percent over Alternative 1 over the 10 year planning period. Year-to-year totals would continue to fluctuate dramatically with typical variances in the plus/minus 70 percent range from the average level. Again, it is unlikely that these changes would fully occur.

Significant direct construction would take place under Alternative 3, if it were to be accomplished. The total construction value of Alternative 3 improvements is estimated at $10,223,000, of which approximately $5,903,000 would be primarily local spending.[140] The employment and economic output impacts of this construction spending would be significant, but would be short-term and would not be expected to last beyond the completion of the

[140] Approximately $4,320,000 would be expended on equipment (primarily ski lifts) that would be manufactured outside of the Coconino County study area.

construction activity. The FTE and economic output impacts of Alternative 3 construction are summarized in the table below.

Table 3E-24
Short-Term Impacts
Alternative 3

	Direct	Indirect	Totals
Employment (FTEs)	50.2	32.1	82.3
Output ($Millions)	$5.55	$2.20	$7.75

Alternative 3 construction would have the short-term impact of creating over 80 FTEs and generating $7.75 million in economic output.

In the hypothetical instance in which the Alternative 3 projects were to be completed, average increases in annual visitation at the Snowbowl would result in impacts on employment and output. However, these impacts would likely only occur until the ski area ceased operations – a likely outcome if Alternative 3 were to be fully implemented. Further, under Alternative 3, these impacts would not be consistent, as year-to-year visitation would continue to fluctuate by a substantial amount. At the *average annual* level of visitor increase at the end of the 10 year planning period, incremental expenditures by Snowbowl visitors over the amount spent in recent years would total $2.09 million. This would include $0.84 million in additional spending within the ski area and $1.25 million in additional spending outside the ski area – in the remainder of Coconino County.[141] When combined with base level (current) expenditures, spending by Snowbowl visitors would total $11.88 million.

Using IMPLAN, the hypothetical incremental expenditures were analyzed to determine Alternative 3's incremental impact in terms of direct and indirect employment and output. This is shown in the table below.

Table 3E-25
Long-Term Incremental Impacts
Alternative 3

	Direct	Indirect	Totals
Employment (FTEs)	40.2	9.2	50
Output ($Millions)	$1.94	$0.64	$2.58

At the end of the 10 year planning period, Alternative 3 would generate a total of 50 additional FTEs and $2.58 million in additional economic output in Coconino County. Respectively, these exceed the impacts of the No Action Alternative by 21 FTEs and $1.11 million in economic output. Based on the estimate of the employment that would be created under Alternative 3 (3.5 FTEs), Alternative 3 would generate 46 FTEs outside of the ski area, in the remainder of Coconino County.

[141] 'Outside' the ski area includes other businesses operated by the Arizona Snowbowl, including lodging and Nordic skiing operations.

Fiscal Impacts

Alternative 3 could have impacts on payments made by the Arizona Snowbowl to governmental entities, such as the U.S. Government, the State of Arizona, Coconino County and the City of Flagstaff.

The analyses below assesses the hypothetical instance in which Alternative 3 projects were to be fully accomplished. This situation is highly unlikely and, if it were to occur, could result in the cessation of business activity by the ski area.

Forest Service Fees

Annual payments to the Forest Service in recent years are shown under Alternative 1 above.

Fees are collected annually, and are based on skier visitation. The Snowbowl has paid the Forest Service an average of approximately $0.90 per skier visit over the past five seasons. These "Receipt Act" payments are generated from fees paid to National Forests by permittees, such as the Snowbowl, and are distributed pursuant to the Receipt Act. Such payments have historically varied according to the level of revenues generated by the permittee, which in the case of the Snowbowl is directly tied to skier visitation. Because Snowbowl visitation fluctuates dramatically, Receipt Act payments have varied by a substantial amount – 78 percent over and 73 percent under the median of the values shown in the table.

Annual fees would be expected to increase as the average skier visit level at the Snowbowl increases. However, in the unlikely event that the alternative was to be fully accomplished, annual skier visit totals under Alternative 3 would continue to fluctuate dramatically, so fees would fluctuate from year-to-year. It is projected that at the end of the 10 year planning period, annual Forest Service fees would average $106,000, with a typical variation range from $32,000 to $180,000.

Sales Tax

The Arizona Snowbowl pays sales taxes to the State of Arizona and Coconino County. The sales tax is essentially based on all Snowbowl revenue, with the exceptions of private ski lessons and labor-based revenue for ski repairs in the rental shop. Sales taxes paid by the Arizona Snowbowl in recent years are shown under Alternative 1 above. Because sales tax is directly related to revenues, the tax paid by the Snowbowl varies significantly dependent on visitation levels. During the years shown in the table, the tax paid varied from 62 percent below to 41 percent above the median.

Over the years shown, sales tax paid to the state/county averaged approximately $2.60 per skier visit. The potential future increment in sales tax to be paid by the Snowbowl under Alternative 3 is based on the projected average increase in skier visits times this per visit figure. Annual skier visit totals under Alternative 3 would continue to fluctuate dramatically, so sales tax payments would fluctuate from year-to-year. It is projected that at the end of the 10 year planning period, the *increment* in annual sales tax payments would average $51,000, with a typical variation range from $15,250 to $86,500. The incremental increase in sales taxes under Alternative 3 would exceed the increment under the No Action Alternative by $18,500 on an annual basis.

Personal Property Tax

The Arizona Snowbowl pays an annual Personal Property Tax to Coconino County. The tax supports county operations. The tax is based on an assessed value of personal property at the Snowbowl. Because the Snowbowl is on NFS land, the value is based on 'built' facilities or improvements of possessory rights. Recent Personal Property Tax payments to the county are summarized under Alternative 1 above.

Because Personal Property Tax payments are based on the 'depreciated market' value of built facilities and improvements, they do not fluctuate in response to variation in annual skier visit totals. The current (2003) 'full value' assessment of the Snowbowl is $1,639,528.[142] The Snowbowl's assessed value would increase if Alternative 3 were to be accomplished, as a number of new facilities and improvements would be made under the alternative's construction program. In total, the construction program calls for $9.473 million in new facilities and improvements at the Arizona Snowbowl.[143] As such, annual personal property tax payments would increase substantially. This is shown in the table below.

Table 3E-26
Estimated Annual Personal Property Payments
Alternative 3

	Current Personal Property Value	Added Value + Under Alternative	Total Estimated Personal Property = Value	Annual Estimated Personal Property Tax
Alternative 3	$1,639,528	$9,473,000	$11,112,528	$245,152

Indicator:

Financial Viability of the Ski Area Under All Alternatives

During the most recent eleven ski seasons (1992/93 to 2002/03) the Arizona Snowbowl's business record has been inconsistent; in seven years, revenues have exceeded costs of operation and the ski area has been profitable. However, in the remaining four seasons, costs have exceeded revenues and the business has lost money. Common sense says that any business that loses money during 36 percent of its operational periods would be regarded as a one of marginal viability. Further, the Snowbowl is in a capital-intensive business, one where capital expenditures are required on a regular basis to offer a quality product, offer an adequate level of guest service and to maintain a reasonable level of competitiveness. Over the past eleven operating years, the Snowbowl has invested a cumulative total of $4.42 million in capital expenditures, all of which has been oriented toward ski area maintenance.[144] These expenditures have merely served to maintain the Snowbowl's existing competitive situation. In the ski

[142] Based on 'Personal Property Notice of Value' forms from the Coconino County Assessor's office.

[143] This figure includes the value of ski lifts that would be manufactured outside the study area but does not include the cost of the EIS process.

[144] The Snowbowl's capital expenditures have been oriented toward maintenance of the current level of quality, including items such as restrooms, groomers, water trucks, and background infrastructure. Capital investment has not been sufficient to add improvements that would be evident to the skier, such as new lifts, lodge space, terrain, etc.

industry, it is generally assumed that at least six percent of gross revenues should be allocated for maintenance capital – capital expenditures sufficient to maintain a ski area at an acceptable level of quality, but not to make significant improvements to the facility. The Snowbowl's capital investment over the past eleven years has equaled 8.87 percent of gross revenues.[145] However, as shown below, this level has expenditure has required the ski area's owners to infuse additional capital as these expenditures have exceeded net revenues. Alternative 2 envisions significant additional capital expenditures, with the intent of improving the offerings and quality of the ski area and, most significantly, allowing the ski area to provide a more consistent operation from year-to-year. While Alternative 3 includes ski area enhancements, it is significantly constrained by a continued reliance upon natural snowfall and is highly unlikely to ever be fully accomplished.

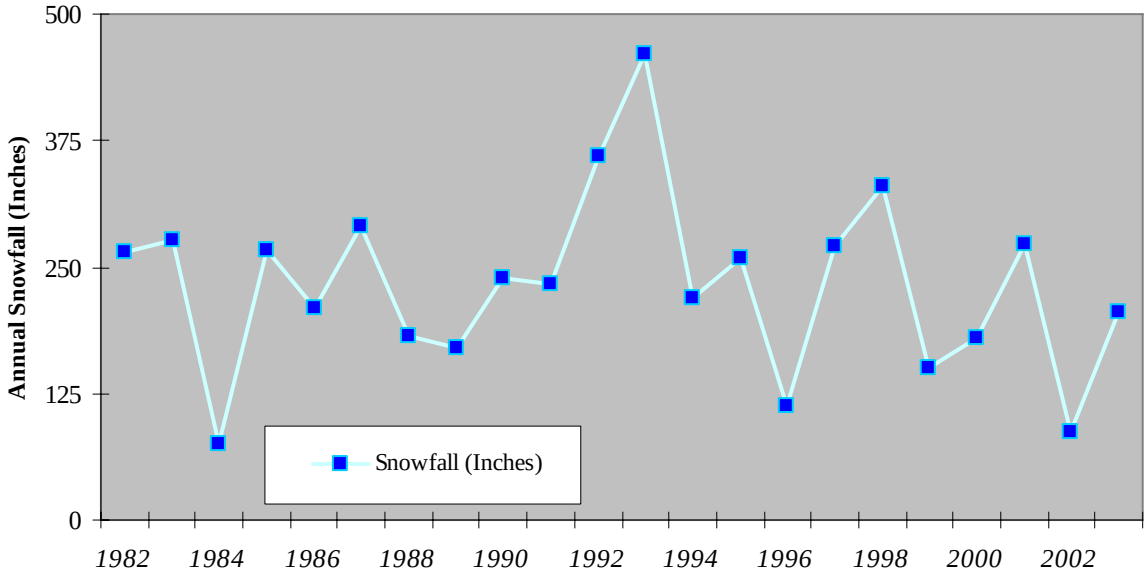
The Snowbowl is dependent on skier visits – and skier expenditures – to generate revenues.[146] As such, the revenue stream is directly related to skier visits from season-to-season. The ski industry is sensitive to weather conditions (snow) and the presence or absence of quality ski conditions. Because the industry is so dependent on the presence of snow, 82 percent of U.S. ski areas have installed snowmaking systems.[147] Snowmaking systems allow ski areas to open earlier in the season and remain consistently open through the length of the season. Just as significantly, snowmaking allows ski areas to offer a quality skiing product during periods when there is no natural snow or when weather conditions would otherwise result in poor skiing conditions or a ski area closing. With no snowmaking system, the Arizona Snowbowl is entirely dependent on the weather and the presence of natural snowfall. Although the climate data presented in Soils Section I details that temperatures are adequate for snowmaking application, natural snowfall at the Snowbowl is highly variable. The graphic below shows total snowfall at the Snowbowl during the past 22 seasons.

[145] 11 year Gross Revenues - $49.78 million. 11 Year Capital Expenditures - $4.42 million. 8.87 percent of Gross Revenues. Source: Arizona Snowbowl Controllers Office.

[146] The Snowbowl also operates a Sky Ride business during the summer months.

[147] Based on respondents to NSAA annual survey 2002/03. Typically, ski areas that do not have snowmaking fall into two categories: 1) Ski areas with locations that enjoy plentiful and consistent natural snow and; 2) Small ski areas (average less than 20,000 skier visits) that do not have the financial resources to install snowmaking.

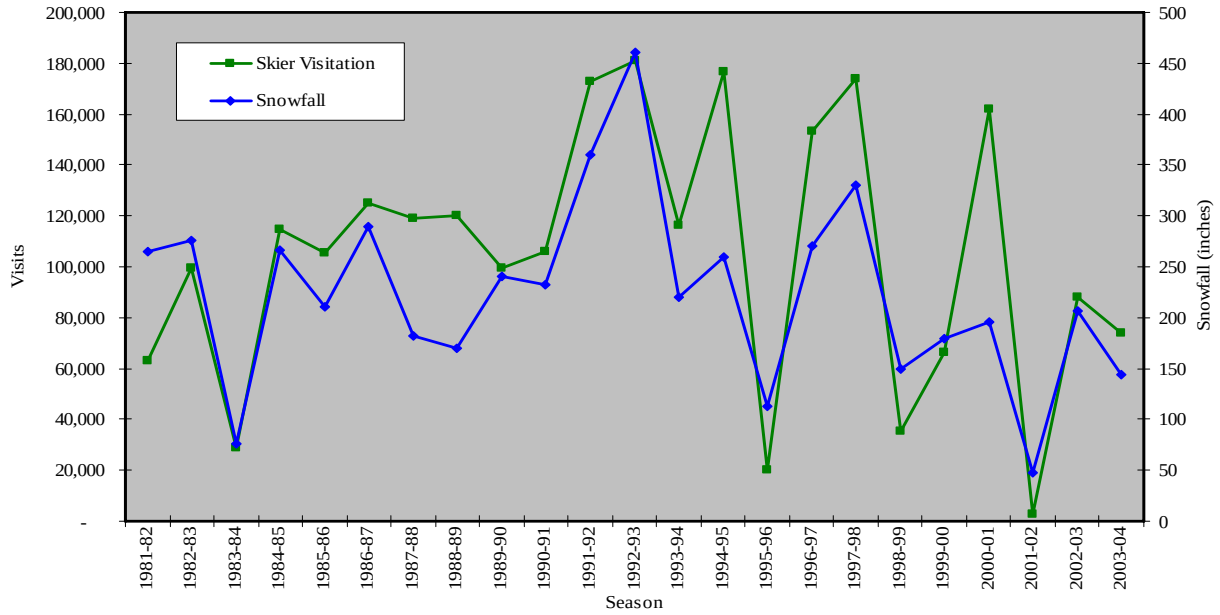
Figure 3E-1
Natural Snowfall at Arizona Snowbowl (1981/82 – 2002/03)



During the 22 seasons shown in the Figure 3E-1, the Snowbowl's median snowfall was 236 inches. However, snowfall in individual seasons ranged from 68 percent below the median (76 inches) to 95 percent above the median (460 inches). Significantly, median snowfall during the most recent five seasons – at 180 inches – has fallen well below the longer term median.

The Snowbowl's dependency on natural snowfall to generate skier visits is clearly shown in the following graphic, which compares variation in natural snowfall with variation in skier visits.

Figure 3E-2
Comparison of Natural Snowfall and Skier Visits
(1981/82 through 2003/04)



By analyzing Figure 3E-2, it is apparent that up and down variation in snowfall results in similar variation in skier visits. The effect has been even more significant in the past 11 seasons, with above average snowfall resulting in well above average visits and below average snowfall resulting in well below average visits. In conclusion, the Snowbowl is highly dependent on natural snowfall to deliver skier visits and associated revenues. During the past decade, natural snowfall has fallen below the longer term median 60 percent of the time.

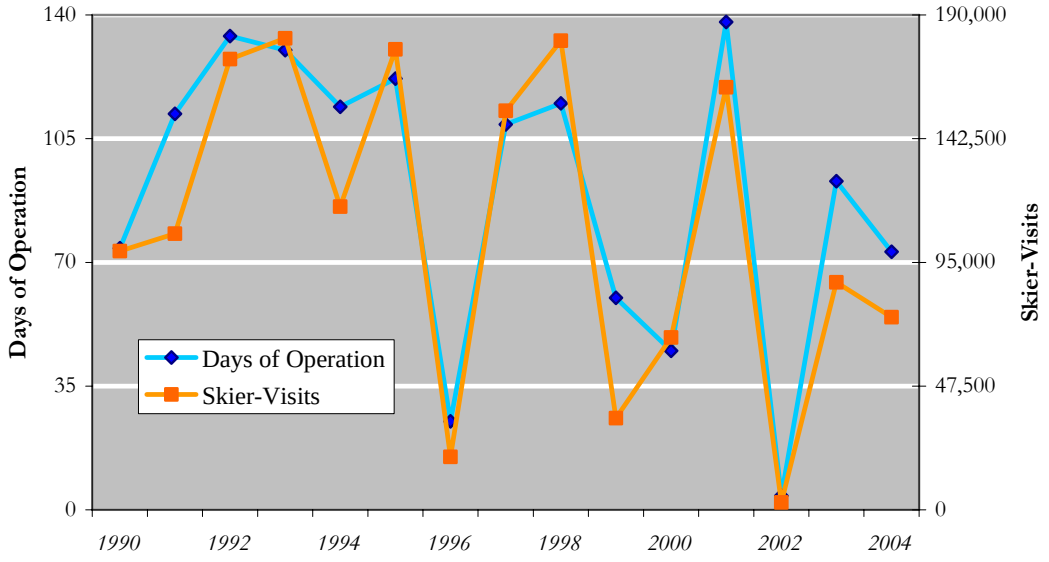
The impact of this skier visit variation on the Arizona Snowbowl as a for-profit business is shown in the graphic below. The graphic shows the Snowbowl's fiscal year net income over the past 11 seasons, as it has varied above and below the 'break-even' point.[148]

The relationship between skier visits and operating days is further illustrated in the figure below which depicts the historical relationship between operating days and skier visits at the Snowbowl.

The demand for skiing at the Snowbowl is clearly elastic – when more supply (operating days) are available, more skier visits result. Statistical correlation analysis indicates that the relationship is very strong, with variation in operating days being a useful statistic in predicting skier visits 87 percent of the time. The relationship is clear; there is substantial demand for skiing when the product is available. Further, increases in supply (operating days) result in increased use/skier visits.

[148] Source: Arizona Snowbowl Controller's Office. Net Income defined as total revenue from skiing operation less Cost of Sales, Expenses-Selling, G&A and Interest. Break-even point is the point where revenues equal costs.

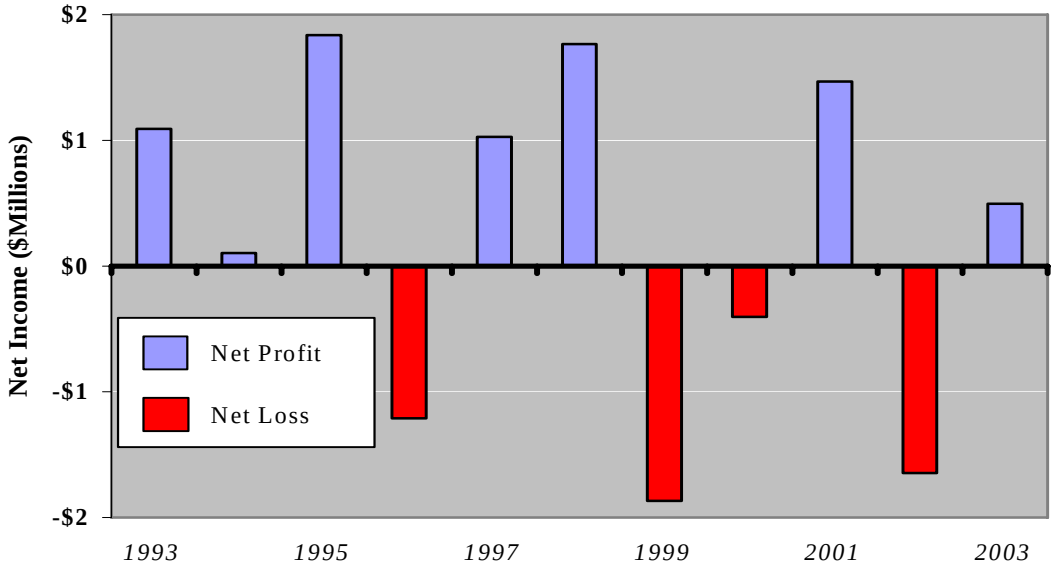
Figure 3E-3
Comparison of Days of Operation and Skier Visits
(1990/91 – 2003/04)



Strong demand for skiing in the Flagstaff market can be assessed from another perspective. Ski areas commonly assess utilization rate as an indicator of performance. The utilization rate is expressed as the annual skier visitation divided by capacity. Capacity is defined as the ski area's daily comfortable carrying capacity. The annual capacity is daily CCC times the number of operating days. The Snowbowl's current CCC is 1,880 skiers. Thus, in a year such as 2002/03, when the facility operated 93 days, the total capacity was 174,840. The utilization rate is determined by dividing the number of skier visits in that year (87,354) by total capacity, resulting in a utilization rate of 50 percent for the 2002/03 season. Over the period 1990 through 2004, the Snowbowl's average utilization rate was 64 percent. Moreover, the ski facility achieved an 83 percent utilization rate in 1998, a year when operating days were above average. These figures are an indication that demand exceeds supply for Alpine skiing in the Flagstaff market.

U.S. ski areas typically view demand to be strong when they achieve utilization rates in excess of 40 percent. Only those ski areas that experience unusually strong demand achieve utilization rates of 50 percent or more.

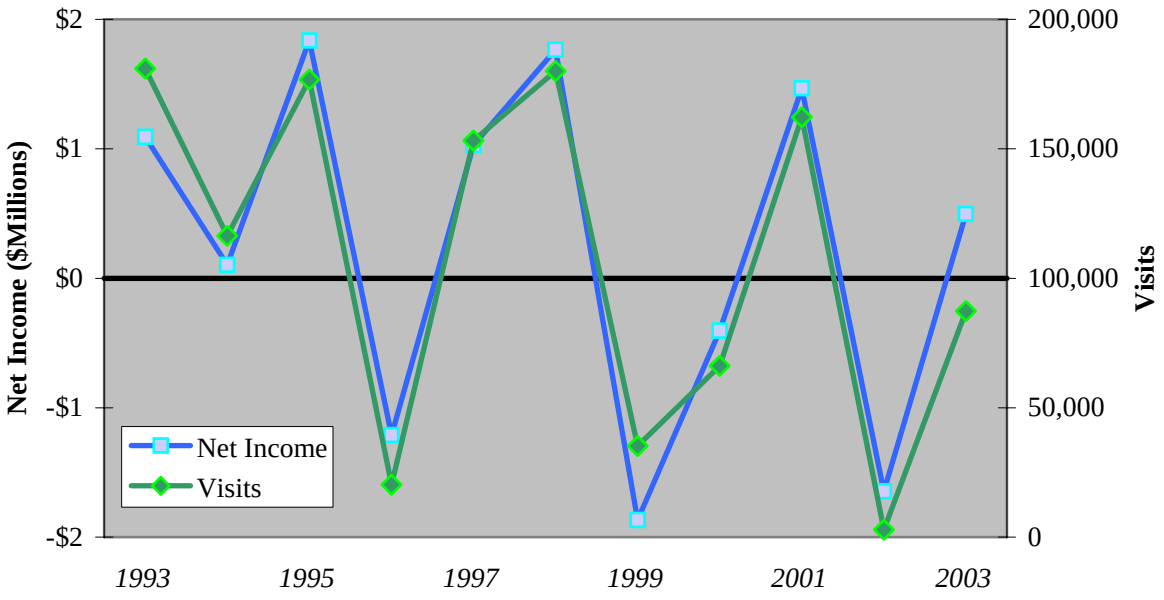
Figure 3E-4
Net Profit Season to Season
(1992/93 – 2002/03)



As indicated in Figure 3E-4, during the past 11 seasons, the Snowbowl experienced a net profit in seven years and a net loss in four years. Over the 11 year period, the cumulative net income of the ski area was $2.66 million. However, as noted above, during the same period the Snowbowl has made a total capital investment of $4.42 million, simply to maintain existing facilities and retain a consistent level of facility quality. Ski areas routinely need to invest six percent or more of gross revenues back into their facility simply for maintenance purposes. While the Snowbowl owners have been willing to infuse additional capital over the past 11 years for maintenance and quality purposes, it is apparent that the differential between net income and minimum required capital investment has been a losing proposition, resulting in a net loss of $1.77 million over the period. It is unlikely that the owner of any business would continue to operate on this basis over an extended period of time.

The extremely close relationship between skier visits and net income is shown in the graphic below.

Figure 3E-5
Comparison of Skier Visits and Net Profit
(1992/93 – 2002/03)



As indicated in Figure 3E-5, given the variability of snowfall at the ski area, the pattern of net profit/loss can be expected to continue for the foreseeable future, unless steps are taken to mitigate the impact of natural snowfall variability. Further, the pattern of profit and loss makes it difficult for owners to continue to provide the required capital (six percent of gross revenues) to maintain the facility. During the past 11 operating seasons, invested capital has exceeded the ski area's net profits.

Business owners may apply a variety of criteria in making decisions regarding the viability of an existing or potential business; Profit/Loss, Return on Investment, Internal Rate of Return, Tax Implications may all come into play. However, at the most basic level, the viability of any for-profit business rests on its ability to make a profit from year-to-year. The Arizona Snowbowl's record over the past 11 operating seasons shows a loss in four years, or 36 percent of the time. Further, it is clear that these losses are closely associated with significant variation in skier visits, a factor of inconsistent snowfall and skiing conditions. For most potential business owners, the prospect of owning a business that is likely to operate at a loss in four of 11 years would not be attractive. Just as significantly, current business owners are unlikely to continue to operate a business that often shows a loss, particularly when maintenance of the physical plant has required them to infuse 'out-of-pocket' capital.

The analysis clearly indicates that the full implementation of Alternative 3 is not viable from a purely financial perspective and that the prudent owner/investor would be highly unlikely to undertake completion of the alternative. While the alternative includes ski area improvements, the lack of reliable snowfall would continue to subject the ski area to inconsistent operations and

skier visit totals that would vary dramatically from year-to-year. Significantly, the ski area's break-even point (the point at which revenues from skier visits equal operational and debt costs) would increase due to the investment in the Alternative 3 improvements. Because average annual skier visits would not increase by a substantial amount, the ski area would experience a financial loss in a higher percentage of its operating seasons.

In summary:

- The Arizona Snowbowl is in a tenuous business position and would continue to be so under Alternative 1. With net income in the negative range for a significant percentage of its operating seasons, and minimal required capital investment exceeding cash flow, it is not reasonable to expect that the business will continue to operate unless improvements are made to generate more consistent skier visits or by substantially reducing the current level of maintenance and operational expenditures. The Snowbowl's record indicates that it is capable of operating profitably when there are sufficient skier visits. However, one major factor beyond the Snowbowl's control – inconsistent natural snowfall – results in unprofitable operations in an unacceptably high percentage of its operating seasons.

- Alternative 2 would improve the ski area's financial viability, make it a more attractive investment and help to ensure that the facility's positive economic contribution is enhanced and maintained.

- The prudent investor would likely not undertake all of the improvements included within Alternative 3.

Alternative 1 – No Action

Alternative 1 would result in no significant change in the Snowbowl's viability as a for-profit business. While average annual skier visits are projected to increase by 12.7 percent over the current level, season-to-season totals would continue to fluctuate dramatically. As such, it is reasonable to project that under Alternative 1, the ski area would continue to experience negative net income in 30 to 40 percent of its operating seasons. Thus, the viability of the ski area would remain tenuous.

In the event that the ski area continued to operate, it is unlikely that owners would continue to provide capital investment at the minimum required six percent of gross revenues, as this has required investment in excess of net profit in the past. Rather, it is likely that owners would revert to a lower investment level and that the ski area would offer a decreased level of services and/or a lower quality experience.

Alternative 2 – The Proposed Action

Alternative 2-The Proposed Action would result in a significantly altered business environment for the Arizona Snowbowl as a result of several major factors:

1. The alternative would result in a dramatic increase in average annual skier visits over the current level. Skier visits[149] are projected to increase by 119 percent under this alternative.

2. The skier visit total would be consistent under this alternative in contrast with current operating conditions. The addition of a snowmaking system would allow the ski area to consistently operate for 125 days per season. It is projected that season-to-season total skier visits would only vary by plus or minus 15 percent from the average.

3. Significant improvements to the skiing facility and the addition of a snowplay/snowtubing facility along with more consistent operations would result in greater season pass sales and attract a higher percentage of destination visitors. Destination skiers typically spend more per capita than do day visitors. Further, the Snowbowl would become more competitive in the Arizona market.

4. A higher and more consistent level of ski area revenues would make it possible for owners to continue to invest at least the minimum six percent of gross revenues to maintain the physical facilities and maintain quality levels.

For the business owner, the prospect of consistent business operations would be the most attractive outcome of Alternative 2. Under this alternative, annual skier visit totals are only expected to vary from the average by plus or minus 15 percent. While the investment required to achieve Alternative 2 is substantial and would result in a higher break-even point (more skier visits required to achieve profitable operations), year-to-year variations in business levels would be minimalized and would result in positive net income in a higher percentage of seasons than under current operating conditions. The ski area would be in a significantly better financial position from which to maintain the physical facilities and maintain quality levels.

The viability of the Arizona Snowbowl as a for-profit business would be enhanced under this alternative. Further, Alternative 2 would result in the ski area becoming a more attractive investment, both for current or prospective owners. Again, this would improve the facility's longer term viability as a generator of winter-based economic activity in the Flagstaff area.

Alternative 3

Because of the lack of a consistent and reliable operating season due no snowmaking capabilities under this alternative, the ski area's continuing financial viability would effectively be similar to that for Alternative 1 - no significant change in the Snowbowl's viability as a for-profit business. The viability of the ski area would remain tenuous.

[149] This does not account for snowplay visits.

In the unlikely event that Alternative 3 was to be fully accomplished, the viability of the Arizona Snowbowl as a for-profit business would decrease. Two major factors would result in decreased viability:

1. While average annual level skier visits would be projected to increase by 19.9 percent over the current level, season-to-season totals would continue to fluctuate dramatically. It is reasonable to project that visitor totals in a significant percentage of seasons would continue to fall below the current break-even point.

2. The substantial investment called for under Alternative 3 would result in a higher break-even point for year-to-year operations. Thus, the percentage of seasons in which operations would fall under the break-even point could increase.

A prudent business operator would not make the majority of the investments in Alternative 3, as the break-even point for profitable operations would increase while skier visit totals would continue to fluctuate dramatically. The viability of the ski area would decline significantly.

In the event that the ski area continued to operate, it is unlikely that owners would continue to provide capital investment at the minimum required six percent of gross revenues, as this has required investment in excess of net profit in the past. Rather, it is likely that owners would revert to a lower investment level and that the ski area would offer a decreased level of services and/or a lower quality experience.

Indicator:

Narrative Description of the Recreational/Social Function Which Snowbowl Serves

The Arizona Snowbowl serves a variety of recreational and social functions in the Flagstaff area. A summary of these functions follows:

- The Snowbowl is the primary facility for winter sports recreation in the greater Flagstaff area. With a location that is easy to access from the center of Flagstaff, the Snowbowl provides an outlet for winter recreation to the population of the entire region. It is significant to note that the Snowbowl is the only ski area in the Flagstaff area – the next closest ski area (Sunrise Park Resort) is more than 125 miles from Flagstaff. The Snowbowl is also the most accessible ski area for residents of the Phoenix metro area.

- The Snowbowl provides the regional population with its only facility[150] for quality Alpine skiing and snowboarding.

- The Snowbowl hosts and supports the Flagstaff Ski Club that provides a facility and training for Alpine and snowboard training and competition.

- The Snowbowl also provides a recreational outlet for those who are not involved in Alpine or Nordic skiing. Hiking trails and the Sky Ride provide a way for non-skiers to get into the

[150] The Williams Ski Area, located approximately 30 miles west of Flagstaff in Williams, is primarily a family day ski area with two lifts and seven trails. The Williams Ski Area is currently up for sale.

mountains and enjoy the mountain environment. The Sky Ride is significant, as many persons are not physically capable of hiking into the mountains. The Sky Ride provides a means to get direct access to this environment for those who cannot hike or ski.

- The Snowbowl provides one of the few true winter recreation attractions in the greater Flagstaff area. In addition to boosting winter visitation in the area, the facility provides Flagstaff with a recreational offering that is unusual in Arizona.

- The Snowbowl also is significant to the Flagstaff community from a social perspective:

  - The Snowbowl assists over 200 area organizations with fundraising efforts – primarily with lift ticket donations.
  - The Snowbowl hosts several large fundraisers and other major events, including: the Climb a Mountain to Conquer Cancer; the Huega Ski Express; Grand Canyon State Winter Games; the Special Olympics; Wine Fests; 5th Grade Learn to Ski; and others.
  - Local contributions: the Snowbowl recently donated ski tickets with a value of $30,000 to local public schools because of budget shortfalls.

- The Snowbowl holds memberships in a number of civic organizations and contributes to their causes. These include: Flagstaff Chamber of Commerce, Flagstaff Convention and Visitor Bureau.

- The Snowbowl supports over 25 programs at Northern Arizona University and assists with its educational goals by participating in a number of surveys and business studies.

- The Snowbowl makes a measurable contribution to the area economy by virtue of the expenditures made by ski area visitors. These contributions are summarized under 'Economic Indicators' above.

In summary, the Snowbowl is a unique facility – a winter recreation center in a state that is far better known for warm weather offerings – providing the only quality outlet for Alpine and Nordic activity in the region. The Snowbowl is also important to NAU in that it historically has been known as a University proximate to skiing opportunities. The ski area's existence benefits enrollment by attracting students who desire to include winter recreation as part of their university experience.

Alternative 1 – No Action

Alternative 1 would not result in a significant change to the Snowbowl's recreational and social functions as summarized above. However, as detailed under 'Financial Viability of the Ski Area,' the continuation of the current operation as a for-profit business may not be sustainable; the ski area would likely decrease expenditures on maintenance and non-essential services leading to an overall reduction in the quality of the services offered under Alternative 1. In this event, much of the social and economic functions summarized above may be reduced or lost. Perhaps most importantly, the quality of the most significant Alpine recreation venue within the Flagstaff area would be greatly diminished as compared to Alternative 2.

Alternative 2 – The Proposed Action

The recreational and social functions of the Snowbowl would be enhanced under Alternative 2. These enhancements are summarized below:

- The addition of a snowtubing/snowplay area would make the Snowbowl an accessible winter recreation venue for non-skiers. Snowtubing and snowplay require no experience or expertise and would allow persons who would otherwise not be involved in winter recreation to become involved.

- Annual visitation and thus visitor expenditures would be substantially increased under this alternative. As such, the Snowbowl's contribution to the area economy would increase.

- Because the Snowbowl's business volume would become more consistent under this option, the Snowbowl would have the capability to make more consistent contributions to area organizations, to more consistently host special events at the ski area and to commit to long-term social involvement in the community.

- The combination of an expanded Alpine skiing facility (lifts and trails) and greatly enhanced and consistent skiing conditions would make the Snowbowl more attractive to destination skiers. This would enhance the Snowbowl as the Flagstaff area's primary winter attraction and increase dollars spent by non-locals in the community.

Alternative 3

The prudent owner/investor would likely not undertake the full range of ski area projects envisioned under Alternative 3 quickly. As such, the impact of Alternative 3 could be similar to those for Alternative 1.

In the event that Alternative 3 was to be fully accomplished, the recreational and social functions now associated with the Snowbowl would be placed in jeopardy if current weather trends continued. Expenditure of the capital necessary to complete Alternative 3 could place the ski area in a perilous financial situation and business operations could potentially cease within several years due to lack of reliable operating seasons. If this occurred, the Snowbowl's recreational and social functions would be lost. The Flagstaff area would lose its most significant Alpine recreation venue and the area population would lose a highly accessible portal to the mountains.

Indicator:

A Discussion of Snowbowl Business Activity and Its Relationship With Flagstaff Area Tourism, Winter Tourism and Trends in Local Taxes.

A number of the identified indicators address a series of interrelated issues. Specifically, this indicator addresses: 1) the role that winter tourism plays in the Flagstaff area economy; 2) how snowfall and Snowbowl visitation relate to broader winter tourism activity in the Flagstaff area; 3) the possibility of a correlation between Snowbowl visitation and the BBB tax; and 4) how weather conditions affects tourism and the BBB tax.

The common thread running through this indicator is the role that the Snowbowl's activity plays in influencing the Flagstaff area tourism economy. More specifically, the indicator focuses on the question of whether Snowbowl activity is a major factor in year-to-year trends in tourism activity. The preceding economic analyses make it clear that the Snowbowl is a positive economic force in the region, in a number of ways: 1) the Snowbowl creates employment and generates significant economic output; 2) the Snowbowl draws visitors to the Flagstaff area who spend dollars at the ski area and at other area businesses; and 3) the Snowbowl offers a unique winter attraction in the Flagstaff area and plays a number of recreational and social roles in the community.

While the Snowbowl is clearly a positive economic contributor, even a cursory examination of the scope of the ski area operation in comparison with the full scope of the Flagstaff area economy makes it clear that the ski area is of insufficient size to be a dominant driver of trends in tourism or the broader economy. Thus, the issues posed by several of these indicators are essentially moot. A review of the issues and findings follows:

Several analytical exercises were completed to assess 'the percentage of Flagstaff's total economy represented by winter tourism in comparison with other major economic components of the community.' The table below shows the overall distribution of employment in Coconino County for 2002.[151]

[151] Arizona Dept. of Employment Security as made available on FlagData web site. Figures are averaged for 2002. Employment breakdown for City of Flagstaff alone were not available. However, total employment in the City of Flagstaff is approximately 35,500 persons, or 60.2 percent of the Coconino County total. The City is clearly the primary economic center in the county.

Table 3E-27
Distribution of Non-Farm Employment
Coconino County (2002)

	Annual Averages - 2002	
	Employment	**% of Total**
Goods Producing	**5,625**	**9.5%**
Natural Resources and Mining	125	0.2%
Construction	2,550	4.3%
Manufacturing	2,950	5.0%
Service-Providing	**53,325**	**90.4%**
Trade, Transportation, and Utilities	9,575	16.2%
Information	475	0.8%
Financial Activities	1,475	2.5%
Professional and Business Services	2,675	4.5%
Educational and Health Services	6,425	10.9%
Leisure and Hospitality	10,950	18.6%
Other Services	1,725	2.9%
Government	20,050	34.0%
Federal Government	3,500	5.9%
State and Local Government	16,550	28.1%
Total Private	***38,925***	***66.0%***
Total Non-farm	***58,975***	***100.0%***

The three major sources of employment in the county are Government, Leisure & Hospitality and Trade/Transportation & Utilities. This is a service-based economy with Goods Producing sectors only accounting for 9.5 percent of total nonfarm employment. Manufacturing only accounts for one in 20 jobs (five percent.)

While the Leisure & Hospitality figure provides some indication of the significance of tourism to the area economy, this category alone does not account for tourism's full economic impact. Recent research on the Flagstaff area economy has attempted to quantify tourism as an economic sector:

- A recent research study assessed 'industry clusters' to assess how significant these clusters are to the area economy.[152] The term 'cluster' refers to a geographic concentration of interdependent companies, suppliers, products, labor pool and institutions that together constitute an important competitive advantage for a region. The study found that the 'Tourism Cluster' is the "leading economic activity in Coconino County." Further, the study found that the 'Tourism Cluster' accounted for the employment of 13,345 persons in 1996. Based on a 1996 average employment level of 54,500, the 'Tourism Cluster' accounted for 24.5 percent of the county's employment in that year.[153]

[152] Morrison Institute for Public Policy, January 2000
[153] County employment figure source: U.S. Bureau of Labor Statistics.

- A 2001 article sponsored by Northern Arizona University indicated that, "Directly and indirectly, tourism in Flagstaff accounts for more than 20 percent of all business in town."[154]

In summary, the research indicates that tourism (in total) accounts for 24.5 percent of Flagstaff's economy. During the most recent five years for which data is available, an average of 35.3 percent of Flagstaff tourism occurred during the winter months.[155] Since tourism in total is estimated to account for approximately 24.5 percent of the Flagstaff area economy, winter tourism can be estimated to account for approximately 8.6 percent of the Flagstaff area economy.[156] In comparison, recent research indicated that the Northern Arizona University "helps keep more than 8,000 people employed."[157] With total county employment of approximately 59,000, it can be estimated that the University accounts for approximately 13.6 percent of the Flagstaff area economy.

The 'historic relationship between winter tourism level in Flagstaff, annual snowfall and annual skier visitation at the Arizona Snowbowl' was analyzed from a statistical perspective with analyses of the three data sets. While snowfall and skier visit data are readily available from the Snowbowl, there is no absolute count of winter tourism visitors in Flagstaff. As such, a proxy for annual tourism was developed using available tax data. Specifically 'Hotel BBB Sales' and actual BBB tax revenue data were used to develop a proxy for tourism activity on monthly and annual bases.[158]

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[154] Morlock, 2001.

[155] Tourism volume based on monthly BBB tax receipts. Winter defined as December through April – consistent with the typical Arizona Snowbowl operating season.

[156] 24.5% X 35.3% = 8.64%.

[157] Source: *Arizona's Universities: An Economic Engine for the State,* Arizona Board of Regents Web Site. This figure includes jobs generated on indirect bases. Direct employment is approximately 2,300 persons.

[158] 'Hotel BBB Sales' represent gross revenues at Flagstaff hotels that are subject to the BBB tax. BBB tax collections are actual BBB tax revenues. The BBB tax is a two percent tax on all lodging and restaurant/lounge sales in the City of Flagstaff. While 'Hotel BBB Sales' is a pure representation of lodging activity (including business travel) BBB tax revenues reflects a mix of restaurant/lounge and lodging sales. Source: Flagstaff Sales Tax Administrator.

Table 3E-28
Snowfall, Snowbowl Skier Visits and Winter Tourism Proxy
Historic Data Sets

	Snowfall (Inches)	Skier visits	Winter Tourism Proxy
1990/91	233	106,000	1.945
1992	360	173,000	2.275
1993	460	181,000	2.315
1994	220	116,388	2.456
1995	259	176,778	2.592
1996	113	20,312	2.569
1997	270	153,176	2.580
1998	330	180,062	2.667
1999	150	35,205	2.548
2000	180	66,152	2.670
2001	272	162,175	2.656
2002	87	2,872	2.636
2003	206	87,354	NA

The variables were tested separately to determine if statistical relationships exist.[159]

- *Relationship of Skier visits to Snowfall* - there is a strong relationship with a coefficient of determination of 0.803, indicating that snowfall is a useful statistic in predicting skier visits 80 percent of the time.[160] This relationship is shown graphically below.

- *Relationship of Winter Tourism to Snowfall* - there is a minimal relationship with a coefficient of determination of 0.105, indicating that snowfall is a useful statistic in predicting winter tourism only ten percent of the time.[161]

- *Relationship of Winter Tourism to Skier visits* - there is a minimal relationship with a coefficient of determination of 0.029, indicating that skier visits are a useful statistic in predicting winter tourism only three percent of the time.[162]

[159] The analyses were completed using the 'linest' function in Microsoft Excel. Linest is a regression function that uses the 'least square' method to calculate a straight line that best fits the data. The primary linear relationship between the variables was assessed with the 'coefficient of determination' variable that results from the analysis. A coefficient of 1.0 would indicate a perfect correlation in the sample, while a value of 0.0 would indicate that the variables are not related. A value of 0.80 would indicate that the equation can predict the dependent variable 80 percent of the time and would be regarded as a positive indicator of a statistical relationship.
[160] Analysis completed on data for period 1990/91 to 2002/03.
[161] Id.
[162] Id.

- *Relationship of Winter Tourism to Combined Snowfall/Skier visits* - there is a small relationship with a coefficient of determination of 0.179, indicating that the combination of snowfall/skier visits is a useful statistic in predicting winter tourism 18 percent of the time.[163]

In summary, it is apparent that snowfall is a strong predictor of skier visits at the Snowbowl. However, neither snowfall nor skier visits are useful for projecting total winter tourism in Flagstaff. Without question, snowfall and skier visits do have impacts on winter tourism in Flagstaff. Snowfall brings skiers who make expenditures at the Snowbowl and in Flagstaff. However, skier visits are only one component of all of the tourism activity that occurs during the winter and because the impact of these skier visits is relatively small in absolute terms, it is not a useful predictor of total activity levels.

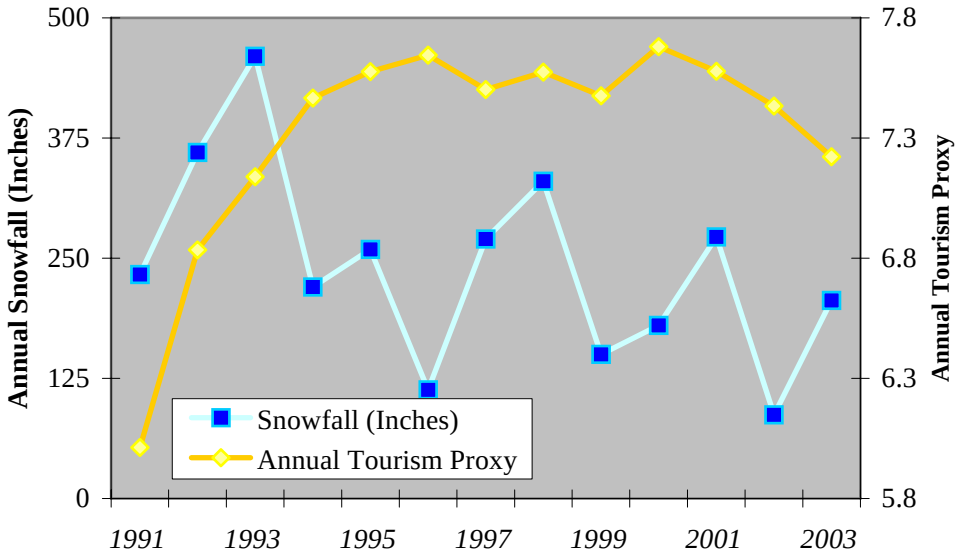
The issue of 'the effects of dry roads/fair weather on tourism in Flagstaff and the BBB' tax was assessed from several perspectives. The relationship between annual Flagstaff tourism (and the BBB tax) and dry roads was analyzed using several historic data sets. The presence or absence of dry roads was assessed using snowfall and precipitation data for the area. There is no absolute count of tourism visitors in Flagstaff. As such, a proxy for annual tourism was developed using available tax data, as described above. The data sets were combined to assess how tourism has varied from month-to-month and year-to-year over recent years. The variables were tested separately to determine if statistical relationships exist.[164] Results are summarized below.

- *Relationship of Flagstaff Annual Tourism to Snowfall* – if dry roads were assumed to have a positive impact on Flagstaff tourism, then a high snowfall year would be expected to have a negative impact on tourism volume. The relationship between annual snowfall and Flagstaff's annual tourism volume is shown in the following graphic.

[163] Id.

[164] The analyses were completed using the 'linest' function in Microsoft Excel.

Figure 3E-6
Relationship of Flagstaff Annual Tourism and Annual Snowfall

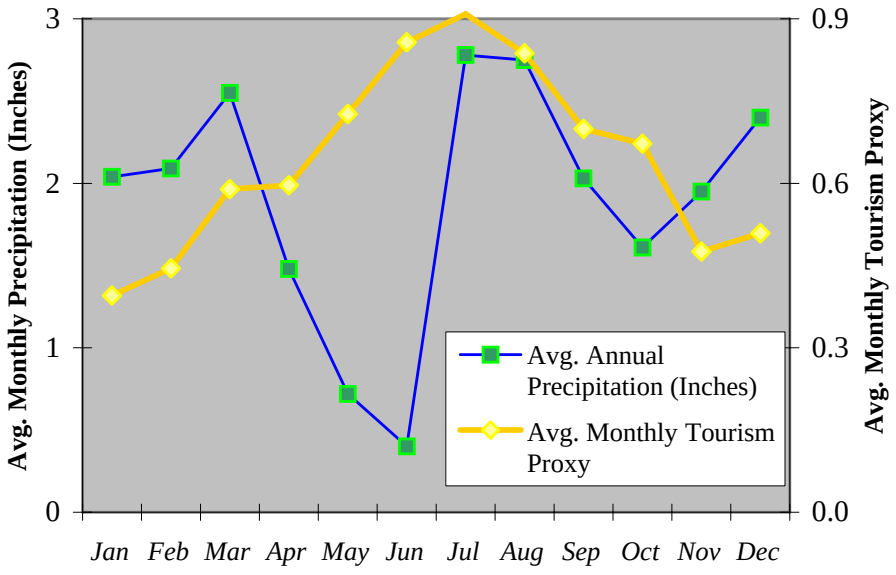


As shown in Figure 3E-6, there is no obvious relationship between snowfall and Flagstaff tourism. The two lines do not move in concert or in opposition to one another. The statistical analysis indicates there is minimal relationship between the two factors with a coefficient of determination of 0.063, indicating that snowfall is a useful statistic in predicting annual Flagstaff tourism only six percent of the time.[165]

- *Relationship of Flagstaff Tourism to Precipitation* – if dry roads were assumed to have a positive impact on Flagstaff tourism, then tourism volume would be higher in months with minimal precipitation and lower in months with higher precipitation. The relationship between average monthly precipitation and average variation in Flagstaff's monthly tourism volume is shown in the following graphic.

[165] Analysis completed on data for period 1990/91 to 2002/03.

Figure 3E-7
Relationship of Flagstaff Monthly Tourism and Monthly Precipitation



There is no obvious relationship between tourism and precipitation, as seen in Figure 3E-7. While declining precipitation appears to relate to increasing tourism in May and June, tourism is at its highest level in the month with the highest average precipitation (July). The statistical analysis shows a minimal relationship between the two factors with a coefficient of determination of 0.018, indicating that monthly precipitation is a useful statistic in predicting monthly Flagstaff tourism only two percent of the time.[166]

The data analysis suggests that, over the years, dry roads/wet weather bears little relationship to Flagstaff tourism volume and thus the BBB tax. While short-term events, such as a major snowfall, can clearly affect tourism volume over a period of several days, the reality is that with only 22.8 inches of precipitation annually, the impact of bad weather is limited to a small segment of the year.

Total tourism volume is more closely linked to the economy than to isolated weather events. The following chart shows annual Flagstaff tourism volume compared with the U.S. unemployment rate.

[166] Analysis completed on precipitation data averaged over 30 years. Monthly tourism data averaged for most recent four years.

Figure 3E-8
Relationship of Annual Flagstaff Tourism to U.S. Unemployment Rate

As seen in Figure 3E-8, Flagstaff tourism volume generally tended upward during a period of a decreasing U.S. unemployment rate (1997 to 2000), while tourism volume declined during a period of an increasing U.S. unemployment rate (2000 to 2003).[167] In conclusion, the macro economy has far more impact on Flagstaff tourism than do weather events.

Finally, the potential correlation between Snowbowl skier visitation and the Bed, Board and Booze tax was assessed. The BBB tax is a two percent tax collected on all purchases at local restaurants, lounges, hotels and campgrounds in Flagstaff. The Snowbowl does not collect the BBB tax, as it is not located in Flagstaff. However, Snowbowl's visitors have a direct impact on the tax by purchasing lodging and food & drink in Flagstaff as part of their trip to the Snowbowl. Day Visitors make stops at Flagstaff restaurants and lounges on their way to and from the Snowbowl, while Destination Visitors eat meals at Flagstaff restaurants, drink at lounges and use lodging facilities.

Given these expenditure patterns, Snowbowl visitors directly generate BBB tax revenues within Flagstaff. The current level of BBB annual tax generation by Snowbowl visitors has been estimated as follows:[168]

1. Estimate total expenditures made by Snowbowl visitors outside the resort as described above. These expenditures are in four categories – Eating-Drinking-Entertainment, Retail, Hotel-Lodging and Services. This total is currently estimated to be $5.63 million.

[167] The coefficient of determination for the two variables is 0.700 – showing a positive relationship.
[168] Estimates are for winter visitors to the Snowbowl only.

2. Adjust for spending categories relevant to the BBB tax. Two categories are relevant to the tax - Eating-Drinking-Entertainment and Hotel-Lodging. Current expenditures in these categories are estimated at $2.63 million annually.

3. Adjust for the percentage of these expenditures that are made in Flagstaff. Flagstaff is the urban center in the region and contains the great majority of the region's commercial establishments. Further, major travel routes to and from Snowbowl go through Flagstaff. It has been conservatively estimated that 75 percent of the relevant expenditures are completed in Flagstaff. These expenditures currently total $1.97 million.

4. Calculate the tax generated by Snowbowl visitors by multiplying relevant Flagstaff expenditures by the two percent tax rate. On this basis, it is estimated that Snowbowl visitors currently generate $39,460 in BBB tax on an annual basis.[169]

The calculations indicate that Snowbowl visitors make a positive contribution to BBB tax collections. Because this is an economy of significant size, BBB tax generated by Snowbowl visitors constitutes a small portion of total tax collections. This is shown in the table below.

Table 3E-29
BBB Tax Collections Generated by Snowbowl Visitors as a Percentage of Total BBB Tax Collections

	Annual	Winter (Dec - April)
Total BBB Tax	$3,771,646	$1,347,104
BBB Tax Generated by Snowbowl Visitors	$39,460	$39,460
Percentage of Total Tax Generated by Snowbowl Visitors	1.05%	2.93%

These findings are consistent with previous statements that the Snowbowl is a positive generator of economic activity, providing jobs and wages, but is not a major driver of the Flagstaff area economy.

Given the small segment of the BBB tax generated by Snowbowl visitors, it is unlikely that overall BBB tax collections would have a significant correlation with business activity at the Snowbowl; Snowbowl related collections constitute too small a percentage of total collections. Statistical tests assessing the relationship of Snowbowl visitation

[169] This is an average figure and varies substantially from year-to-year in direct proportion to skier visits at the Snowbowl.

with BBB tax collections showed no significant relationship between the two variables.[170] While the tests show no significant relationship, it remains significant that Snowbowl visitors generate BBB tax. Increases in ski area visitation would result in additional visitor expenditures in Flagstaff and increase BBB tax collections.

Based on the economic data, and meaningful economic indicators available for comparison, the analysis presented here discloses the anticipated impacts of the project proposal to the greater Coconino County/Flagstaff area at a macro scale. This has the effect of understating the value and contributions of the Snowbowl to specific segments of the Flagstaff economy. Clearly if the analysis were able to isolate the value of the ski area as an attractant to economic activity for individual market segments such as hotels, restaurants, and winter sports related retail stores, the contribution of the ski area would be far more pronounced.

Alternative 1 – No Action

Under Alternative 1-No Action the Snowbowl would continue to have a role as a positive contributor to the Flagstaff area economy by virtue of job maintenance, expenditures by visitors at area businesses, the ski area's recreational/social functions and tax payments made at Federal, state and local levels. However, the Snowbowl's current business situation is tenuous, as financial losses have been experienced in a number of recent years. Continuation of the current operation as a for-profit business may not be sustainable; the ski area would likely decrease expenditures on maintenance and non-essential services leading to an overall reduction in the quality of the services offered. In either event, the Snowbowl's contribution to the area economy would be reduced.

Under this alternative, winter tourism as a segment of the Flagstaff area economy would not change and the relationship between snowfall, skier visits and total winter tourism would remain at a minimal level. Total tourism volume in the area would continue to respond primarily to macro economic events. The alternative could result in additional BBB tax generation of approximately $4,500 annually, but would not significantly alter the current relationship between the BBB tax and Snowbowl visitation.

Alternative 2 – The Proposed Action

Under Alternative 2-The Proposed Action, the Snowbowl's role as a positive contributor to the Flagstaff area economy would be enhanced. The alternative would result in new jobs being created both directly and indirectly, would generate additional visitor dollars at area businesses, would enhance and solidify the ski area's recreational/social functions and would increase tax payments at Federal, state and local levels. These additional tax payments would provide additional support for programs and services.

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[170] Linear correlation analysis was used to assess three potential relationships using data from 1990 forward to the most recent year: 1) Annual skier visit totals with annual BBB collections; 2) Annual skier visit totals with ski season (December through April) BBB collections and; 3) Monthly skier visits with corresponding month BBB collections. The coefficient of determination statistic in each instance showed minimal relationships between the two variables. In addition, a test was completed to see if variations from skier visit monthly medians have a relationship with variations from the median for BBB collections. Again, no significant relationship was shown.

Under this alternative, winter tourism as a segment of the Flagstaff area economy would increase, as the additional activity at the Snowbowl would generate additional winter tourism dollars. The current strong relationship of snowfall to Snowbowl visitation would decrease in significance, as the Snowbowl would be able to offer quality skiing and snowtubing with or without snowfall – as a result of the inclusion of a snowmaking system. Total winter tourism would increase in response to more visits at the Snowbowl. However, total tourism volume in the area would continue to respond primarily to macro economic events. The alternative would result in additional BBB tax generation of approximately $59,000 annually, thus strengthening the relationship between Snowbowl visitation and the BBB. However, the BBB would continue to respond primarily to broader tourism and economic events.

Alternative 3

As noted, the prudent owner/investor would likely not undertake all of the ski area improvements included in Alternative 3 in an expedited manner. As such, the effects of this alternative would similar to those summarized above for Alternative 1-No Action. Any improvements completed under this alternative would be minor and would not significantly affect existing weather, visitation, and tourism and BBB tax relationships.

In the unlikely event that the alternative's improvements were to be fully completed, it is likely that the Snowbowl's current positive economic contribution would be lost, as it is likely that the ski area would cease business activity within several years.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

For the purpose of this cumulative assessment, it is assumed that Social and Economic Resource effects within the greater Flagstaff and Coconino County areas began with the original development of ski area facilities in the late 1930s, increased with approval an implementation of projects analyzed in the 1979 EIS, continue to the present day, and will extend into the foreseeable future.

Spatial Bounds

The affected environment relevant to a discussion of cumulative affects for Social and Economic Resources includes the greater Flagstaff and Coconino County area.

Past, Present, and Reasonably Foreseeable Future Actions

Past, present, and reasonably foreseeable projects with potential to cumulatively affect Social and Economic Resource include:

1. Residential and Summer Home Development in Hart Prairie
2. Snowbowl Wireless Telephone Communications Site
3. San Francisco Mountain Mineral Withdrawal

4. Transwestern Lateral Pipeline Project
5. Miscellaneous/ongoing Recreational Uses

All of these projects are within the spatial extent of the cumulative impact area, but are not of an extent or development scale sufficient to have significant cumulative effects. Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 - No Action

Past and present development of home sites has occurred independently of specific ski area development. While an intuitive correlation between specific ski area development activities and ongoing development in Hart Prairie may exist, there is no meaningful method of identifying a direct relationship between the two.

The extent to which the San Francisco Mountain Mineral Withdrawal will affect Social and Economic Resources in the area is speculative, in that entities which would have potentially been interested in pursuing mining activities are unknown. There are no known or suspected deposits of precious ore within the withdrawn area. However, a pumice mining operation recently ceased in the vicinity.

From a cumulative effects perspective, the construction and operation of the pipeline is considered negligible.

The general pursuit of recreation activities contributes to the overall Flagstaff economy. However, as detailed within this Social and Economic Resources analysis, the Flagstaff and Coconino County area is generally large enough that recreation actives are only a minor contributor to the overall economy. Cumulatively, the addition of past, present and foreseeable non-skiing recreation activities is anticipated to have an immeasurably minor effect on the area economy.

None of the identified past, present or reasonably foreseeable activities would combine with the effects anticipated under the No Action Alternative to create any significant cumulative social or economic resource impacts.

Alternative 2 – The Proposed Action

None of the identified past, present or reasonably foreseeable activities would combine with the effects anticipated under the Proposed Action to create any significant cumulative social or economic resource impacts.

Alternative 3

None of the identified past, present or reasonably foreseeable activities would combine with the effects anticipated under Alternative 3 to create any significant cumulative social or economic resource impacts.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Because all projects analyzed in the analysis of socioeconomic resources are proponent-driven and financed, no irreversible or irretrievable commitments of economic resources were identified.

3F. RECREATION

SCOPE OF THE ANALYSIS

The scope of this recreation analysis is limited to the San Francisco Peaks and, in particular, to the Arizona Snowbowl SUP area.

EXISTING CONDITIONS

COMFORTABLE CARRYING CAPACITY

The 1979 Environmental Statement approved a CCC[171] of 2,825 skiers. While Snowbowl regularly exceeds this figure on good snow days, weekends, and holidays, CCC at Snowbowl is currently limited by an uphill (i.e., lift) capacity of 1,880 guests and is ultimately limited by overall parking capacity. Snowbowl frequently experiences peak demand days, which exceed the CCC of the existing facilities and infrastructure. Over the past 10 seasons, average peak day (i.e., holidays and good snow days) attendance has been approximately 3,434 guests.

WINTER RECREATION

Annual Visitation

With a current population of approximately 5.5 million, Arizona was the second fastest growing state in the nation throughout the 1990s. The greater Phoenix area[172] accounts for nearly two-thirds of Arizona's population.[173] Located approximately 150 miles due north of metropolitan Phoenix, Flagstaff is just over two hours driving time from a population base of roughly 3.3 million people. The greater Phoenix area is projected to grow at more than twice the national rate for the next several decades. By 2009, the greater Phoenix area population is projected to grow to 3.6 million (a 2.1 percent change); by 2025, it is projected to grow to approximately five million.[174]

In 2001/02, Snowbowl sold approximately 1,250 season passes. Eighty-four percent (1,050) of these passes were sold to Flagstaff area residents. The 2002/03 season saw roughly the same percentage of season passes sold, with 1,662 sold to Flagstaff residents and 214 sold to out-of-town residents (89 and 11 percent, respectively).

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[171] As indicated in Chapter 1, CCC is defined as the number of guests that can be comfortably accommodated by a ski area at any point in time. It provides for a pleasant recreational experience by not overburdening a ski area's facilities (including, but not limited to, parking, restaurant seating, restrooms, and uphill/downhill capacity). CCC is used by ski area planners and the Forest Service as a planning tool and *does not constitute a cap on visitation.* Facilities are typically designed to accommodate 125 percent of a ski area's CCC in order to preserve the guest experience on peak visitation days, which are anticipated periodically throughout the season.

[172] The greater Phoenix area is defined primarily as Maricopa County, which includes (but is not limited to) the following cities: Phoenix, Scottsdale, Tempe, Mesa, Peoria, Surprise, El Mirage, Glendale, Goodyear, Buckeye, Tolleson, Avondale, Gilbert and Chandler.

[173] Greater Phoenix Economic Council, 2003

[174] Id.

Because Snowbowl has no snowmaking capabilities, the ski area's operations, and therefore financial viability, are 100 percent dependent on natural snowfall, and seasonal visitation fluctuates considerably from year-to-year. Table 3F-1 compares annual snowfall with days of operation and skier visitation for the past 22 seasons at Snowbowl.

Table 3F-1
Comparison of Annual Snowfall, Days Open and Visitation at Snowbowl

Season	Snowfall (Inches)	# of Days Open	# of Visits
1981/82	265	123	63,000
1982/83	276	135	99,626
1983/84	76	64	28,913
1984/85	266	118	114,707
1985/86	210	124	105,252
1986/87	290	112	125,026
1987/88	182	92	119,259
1988/89	170	79	120,132
1989/90	240	74	99,280
1990/91	233	112	106,000
1991/92	360	134	173,000
1992/93	460	130	181,000
1993/94	220	114	116,388
1994/95	259	122	176,778
1995/96	113	25	20,312
1996/97	270	109	153,176
1997/98	330	115	173,962
1998/99	150	60	35,205
1999/00	180	45	66,152
2000/01	272	138	162,175
2001/02	87	4	2,857
2002/03	206	96	88,000

Figure 1-2, displayed in Chapter 1, provides a graphical representation of annual skier visitation and total annual snowfall from 1981 through 2003. A statistical analysis of the 22 seasons of data clearly indicates there is strong relationship between the two variables with a correlation of 0.796, indicating that annual snowfall is a useful statistic in predicting skier visitation 79.6 percent of the time.

Terrain Overview

Approximately 2,300 feet of elevation difference exists between the top terminal of the Agassiz Chairlift and Hart Prairie. Snowbowl's existing terrain network is comprised of 32 developed trails on approximately 139 acres. However, additional skiable terrain in the form of natural, non-maintained glades (i.e., tree skiing) and chutes are available within the SUP area outside of

the formal trail network. A terrain park (open to snowboarders and skiers) is located on *Sunset Boulevard* (trail #10).

The Hart Prairie area is dominated by gentle terrain that is suitable for beginner level guests. The lower mountain in the vicinity of the Sunset Chairlift and *Fort Valley Glade* is predominantly intermediate level terrain with small pockets of steeper, expert terrain and gentler beginner terrain. The upper portions of the mountain are dominated by expert terrain with areas of intermediate terrain scattered throughout. The higher elevation terrain on the northern aspect of the SUP area is steep, but becomes more gradual in the lower elevations.

Skier ability levels at Snowbowl, and the percentages of overall terrain comprising each ability level, are provided in Table 3F-2.

Table 3F-2
Existing Terrain Breakdown by Ability Level

Ability Level	Existing Acreage	Percent of Snowbowl's Total Skiable Terrain
Beginner	0.5	0.4
Novice	43.9	31.7
Low-Intermediate	31.3	22.6
Intermediate	38.1	27.5
Advanced-Intermediate	15.4	11.1
Expert	9.4	6.8
Total	***138.6***	***100***

Given that Snowbowl caters heavily to the lower ability level skiers from the Phoenix market, the ski area is lacking beginner and intermediate (including low-intermediate and advanced-intermediate) terrain. It is also short on expert terrain.

Lift Network

Snowbowl's lift-accessed terrain is served by four aerial chairlifts and one beginner surface lift. Existing lift specifications are provided in Table 3F-3.

Table 3F-3
Existing Lift Network

Lift	Slope Length (feet)	Vertical Rise (feet)	Design Capacity (persons/hour)	Daily Lift Capacity (guests)
Agassiz Mid	4,794	1,296	810	480
Agassiz Top	6,475	1,973	270	200
Hart-Prairie	3,217	658	966	550
Sunset	2,677	637	1,350	460
Aspen	1,591	242	554	170
Little Spruce	302	35	200	20
Total			***4,150***	***1,880***

Terrain Density Analysis

In order to achieve a balanced recreational experience, the uphill (lift) capacity of a ski area should be balanced with its downhill (terrain) capacity. As the difficulty of the terrain increases, the acceptable skier density (skiers per acre) decreases.

Table 3F-4 presents a terrain density analysis displaying the existing terrain at Snowbowl using an industry accepted density in terms of guests per acre. The Density Index expresses the Actual Density over the Target Density as a percentage.

Table 3F-4
Terrain Density Analysis (Existing)

Lift	Daily Lift Capacity	Terrain Area (acres)	Actual Terrain Density (guest/acre)	Target Trail Density (guest/acre)[a]	Difference	Density Index
Agassiz Top	480	57.5	2	11	-9	18%
Agassiz Mid	200	14.8	4	7	-3	57%
Hart Prairie	550	26.4	6	18	-12	33%
Sunset	460	21.4	5	11	-6	45%
Aspen	170	18.1	4	18	-14	22%
Little Spruce	20	0.5	8	30	-22	27%
Total	***1,880***	***138.6***	***4****	***13****	***-9****	***32%****

[a] While no published industry standards exist, this is considered a norm throughout the industry as based on guest expectations.
* Weighted average.

Extremely high or low actual terrain densities (in comparison to the target) can be evidence of improperly balanced uphill and downhill capacities. The Actual Terrain Density and Density Index columns in Table 3F-4 indicate that, *at a CCC of 1,880*, Snowbowl has very low terrain densities, and that the current lift capacity is insufficient to accommodate the existing terrain, resulting in underused terrain.[175] Therefore, at Snowbowl's existing CCC of 1,880 guests, one would typically encounter relatively uncongested ski trails and at-capacity lifts.

[175] An inherent fault of the model used to calculate terrain densities is that it assumes a mathematical uniformity to the distribution of skiers across all available terrain which, in actuality, is not the case. This model cannot account

However, as previously mentioned, peak days frequently result in visitation well in excess of Snowbowl's existing CCC (approaching 3,400 skiers). Therefore, a terrain density analysis was conducted for peak capacity days in which crowds of 3,400 guests are experienced. This terrain density analysis indicates that increased attendance does not directly relate to increased terrain densities. While lift line waiting times currently become unacceptably long at 3,400 skiers (lines at more popular lifts such as Agassiz and Little Spruce can exceed 40 minutes) skier densities on Snowbowl's terrain increase only slightly.

Fall Line Analysis

A fall line represents the path an object would take as it descends a slope under the natural influence of gravity (e.g., a ball rolling downhill). A fall line analysis is useful in ski area planning, as it indicates the natural flow of skiers as they descend through terrain to lower elevations and eventually to lift terminals and/or the base area. Thus consistent fall lines throughout a ski area provide for the best recreational experience and result in lesser ground disturbance due to a reduced need for terrain modification associated with trail construction. An analysis conducted at Snowbowl indicates that both developed and undeveloped terrain throughout the SUP area exhibits consistent fall lines that are appropriate for skiing.

Slope Aspect Analysis

The results of the slope aspect analysis within the Snowbowl SUP area indicate that the majority of the developed terrain faces north/northwest, which provides for minimal sun exposure, optimal retention of snow, and therefore favorable skiing conditions. The exception is the Hart Prairie area, as it is oriented to the west, which detracts from snow conditions with late morning/early afternoon sun exposure.

Snowplay

While in the past, snow on the San Francisco Peaks brought large crowds to NFS lands to snowplay (defined as sledding, tubing, saucering, or building snowmen); this activity is not permitted within the Snowbowl SUP area, nor is it now allowed along the Snowbowl Road. Prior to the 2002/03 winter season, the general public was attracted to the areas along the Snowbowl Road for dispersed snowplay activities. These activities created ongoing public safety issues including: snow sliding on non-directional equipment (sleds, saucers and trash bags) in wooded or steep areas, sometimes across heavy traffic on Snowbowl Road, pedestrian/vehicular encounters, sanitation, and refuse concerns, conflicts with Native American traditional ceremonies and gathering, and difficulties for emergency vehicles passing through congested areas. During periods of abundant snow as many as 300 vehicles per day may have been parked along the Snowbowl Road belonging to visitors engaged in dispersed snowplay activities. Beginning with the 2002/03 winter season, the Forest Service has prohibited parking along the Snowbowl Road and initiated an active enforcement program. Although signs have been posted at the bottom of the Snowbowl Road informing visitors that snowplay is not

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for areas such as major collector trails which receive extremely high use and frequently experience unacceptably high skier densities.

allowed, scores of cars continue to drive up the road in search of snowplay opportunities. The majority of these visitors reach the Snowbowl base area only to be turned back by the ski area parking staff. On a peak day with good snow conditions, the Snowbowl parking staff may turn away as many as 500 cars full of visitors seeking an opportunity to play in the snow. Unable to consistently discern skiing guests from snowplay visitors, the Snowbowl staff frequently is required to ask visitors found snowplaying in and adjacent to the parking areas and on the ski trails to leave. This creates an unfortunate and contentious situation for all involved.

The Wing Mountain Cinder Pit (approximately three miles north of Snowbowl Road on Highway 180) and the Crowley area (approximately one mile past the Flagstaff Nordic Center on Highway 180) also offer dispersed snowplay activities. However, given the relatively low elevation of these sites, they rarely offer the necessary snow conditions to provide an adequate snowplay experience, particularly early in the season when snow is only present at higher elevations.

Summer Recreation

Summer Events

Events such as concerts, weddings, and festivals are held throughout the summer season. These events are reviewed and approved on a case-by-case basis via Snowbowl's annual summer operating plan.

Hiking within the SUP Area

Currently, demand for developed hiking trails within the SUP area far exceeds opportunity. While visitors may choose to hike both on and off roads/trails in the lower portions of the SUP area, due to the steep, loose nature of Snowbowl's terrain, no hiking trails or roads currently exist to accommodate hiking above the Agassiz Lift's mid-station. One exception is a short walking path leading from the Agassiz Lift's top terminal to an observation deck. Hiking is not allowed above the observation area to protect critical habitat for the San Francisco Peaks groundsel, fragile tundra, and important Native American religious sites. While hikers who start out at the base area may explore the entire SUP area as they choose, summer visitors riding the Agassiz Chairlift (described below) are required to ride it back down.

Summer Sky Ride

The Summer Scenic Sky Ride at the Snowbowl transports guests to the top of the ski area via the Agassiz Chairlift (11,500 feet in elevation). Approximately 30,000 visitors use the summer Scenic Sky Ride annually between Memorial Day and Labor Day. From this elevation, over 70 miles of the northern Arizona landscape can be viewed, including the Grand Canyon and downtown Flagstaff. Minimal hiking opportunities are available at the top of the Agassiz Chairlift in order to protect the fragile alpine tundra and endangered plants. A short path leads to an observation deck. Guests are prohibited from hiking down to the base area due to the absence of formal hiking trails within the upper limits of the SUP area. A Forest Service interpretive specialist is typically available to answer any questions regarding the biology, tundra, Native American cultural values and uses, threatened and endangered species, and geology of the region.

Kachina Peaks Wilderness

The Snowbowl SUP boundary is bordered on the north, south, and east by the Kachina Peaks Wilderness, which was designated by Congress in 1984. This 18,960-acre Wilderness encompasses most of the upper reaches of the San Francisco Peaks, including Humphreys Peak, Arizona's highest point at 12,633 feet elevation. The area is named for the Hopi spiritual beings who are said to inhabit the mountain.

Two hiking trails offer access to the Wilderness from the SUP area. The Humphreys Peaks Trail (No. 151) leads to the top of the Peaks, which form the rim of the Peaks' inner basin – a caldera which was formed during the Peaks' most recent volcanic eruption. That crater now supports a stand of white barked aspens and mixed conifers. The Kachina Trail (No. 150) offers access to the forest and meadows on the mountain's lower slopes south of the SUP area. Considering the relatively small size of this Wilderness area, its proximity to Flagstaff and large metropolitan areas, the high use of the designated wilderness for most types of non-motorized recreation activities, and the fact that the ski area is surrounded on three sides by Wilderness, the Forest Service faces considerable management challenges for both the Wilderness and the ski area for their intended values and objectives. Additionally, the Humphreys Peak Trail, originating from the SUP area, but located almost entirely within the Wilderness, is the highest use Forest Service system trail in the Flagstaff area, often receiving up to 400 hikers per day on holidays such as July 4th, and up to one hundred hikers per day on a typical summer mid-week day. Because Snowbowl's SUP area pre-dates the establishment of the Wilderness, the Forest Service manages the ski area in a way that allows activities typically permitted at other ski areas, but with as much consideration for impacts upon wilderness as is reasonable. Examples include events that may create noise levels that could affect wilderness users or wildlife habitat depending on the season and specific circumstances.

Camping is not allowed above timberline at 11,000 feet in elevation or within the Inner Basin. Hikers are also urged to stay in designated trails at this elevation. These restrictions are in place to help protect the fragile tundra, the threatened San Francisco Peaks groundsel (*Senecio Franciscanus*), Native American religious sites and concerns, and the City of Flagstaff's municipal water supply within the Inner Basin.[176]

Wilderness Trailhead Access

Trailhead parking and access to the Kachina Peaks Wilderness is available in the ski area's lower parking lots; day and over night parking is available for the Humphreys Trail in lots 8 and 9, and for the Kachina Trail in lot 6. Parking for Wilderness users in the Snowbowl's parking lots is available all summer and on weekdays during the winter. Backcountry and/or dispersed recreationists can use these parking lots during the summer and ski season weekdays for free or ski season weekends for a fee. Parking on the Snowbowl Road is prohibited.

[176] The Peaks' caldera, known as the Inner Basin, contains an aquifer that supplies part of the municipal water for the City of Flagstaff, the largest city on the Colorado Plateau. Water is piped southward to the city from a series of wells tapping the basin's aquifer, which is recharged by seasonal snowmelt.

Winter Wilderness Permits and Use

In 1998, the Forest Service instituted a winter permit system for access to the Wilderness from the SUP area. Individual permits are free, and are required to be carried when a person enters the Wilderness from the SUP area; permit holders are required to register each time the Wilderness is accessed through the ski area. The purpose of the permit system is to promote safety, education, and awareness of the hazards and responsibilities necessary for backcountry travel, not to restrict access. This is a result of numerous search and rescue efforts in recent years for poorly prepared people leaving the SUP area, and the resultant searches, injuries and fatalities from avalanches and cold weather. All backcountry travelers are held accountable for search and rescue efforts should they become necessary. Violators of this permit system are cited and fined.

Registration boxes are located within the SUP area at the Hart Prairie Lodge ticket windows and at the top of the Agassiz Chairlift.[177] Persons accessing the Wilderness overnight or for a period of time exceeding Snowbowl's operating hours are required to leave a copy of their permit in the windshield of their vehicle. Approximately 80 percent of visitors are assumed to register at the Wilderness registration boxes.

Forest Service-issued annual permits for winter-time access to the Kachina Peaks Wilderness during the last five seasons are provided in Table 3F-5.

Table 3F-5
Kachina Peaks Wilderness Permits

Year	Number of Permits Issued
1998/99	119
1999/00	138
2000/01	219
2001/02	44[a]
2002/03	384

[a] The CNF was closed to entry due to extreme fire hazard during a portion of this period.
Source: USDA Forest Service, 2002a.

Trail visitor numbers are calculated from trail registration boxes at each trail. Winter Wilderness use (between January and March) is approximately 10 percent of summer visitation. The information contained in Table 3F-6 was gathered from May 1998 to December 2000.

[177] Wilderness users are allowed to exit the ski area boundary atop the Agassiz Chairlift during winter months only.

Table 3F-6
Kachina Peaks Wilderness Use

Humphreys Trail	
2003	13,242 visitors
2002	8,686 visitors (0 recorded June)
2001	11,560 visitors (0 recorded January, February, or March)
2000	8,172 visitors (0 recorded in November or December)
1999	13,495 visitors (0 recorded January or February)
1998	13,735 visitors (0 recorded in January, February, March, April, May, or November)
Kachina Trail	
2003	5,512 visitors
2002	3,902 visitors (0 recorded in January, February, March, April, or June)
2001	5,090 visitors (0 recorded in November or December)
2000	4,813 visitors (0 recorded in March)
1999	5,062 visitors (0 recorded in January, February, March, or April)
1998	4,474 visitors (0 recorded in January, February, March, April, November, December)
Weatherford Trail	
2003	1,732 visitors
2002	687 visitors (0 recorded between January and April, or June)
2001	1,842 visitors (0 recorded February, March, November, or December)
2000	1,272 visitors
1999	1,198 visitors (0 recorded between January and April)
1998	1,129 visitors (0 recorded between January and April, November, and December)
Bear Jaw/Abineau Trail	
2003	1,837 visitors
2002	805 visitors (0 recorded February, March, or September)
2001	2,022 visitors (0 recorded in February, November, or December)
2000	2,296 visitors (0 recorded in November or December)
1999	1,325 visitors (0 recorded between January and April)
1998	1,126 visitors (0 recorded between January and May, November, or December)
Total Annual Use of Kachina Peaks Wilderness Trails	
2003	22,323
2002	14,080[a]
2001	20,514
2000	16,553[a]
1999	21,080
1998	20,464

[a] The CNF was closed to entry due to extreme fire hazard during a portion of this year.
Source: USDA Forest Service, 2003a.

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

Recreational Opportunities

The effects of the Proposed Action on the quality, distribution, and opportunity for winter and summer recreational experiences within the SUP area.

Indicator:

Comparison of Historic Annual Winter and Summer Recreation Visitation Versus Those Anticipated Under Various Alternatives.

Alternative 1 – No Action

Under Alternative 1, Snowbowl's CCC would remain at 1,880 guests. No improvements to ski area infrastructure or terrain would be approved under this alternative, and therefore the summer and winter recreational experience would be expected to remain unchanged under this alternative.

As Snowbowl's recent climatic history exhibits (reference Table 3F-1 – Visitation and Snowfall), visitation trends at the ski area would continue to be defined by natural snowfall under the No Action Alternative. Average *peak day* attendance would be anticipated to resemble historic trends - approximately 3,400 guests on a handful holidays and good snow days each year. Generally speaking, future annual visitation levels under the No Action Alternative would be expected to resemble historic visitation, with slight increases attributable to regional population growth.

In making visitation projections under the No Action Alternative, it is essential to note that major fluctuations would be expected from year-to-year. The historic record of the past 24 seasons shows that year-to-year totals vary as much as –97 percent to +71 percent from the median. Annual visitation could be expected to fluctuate from roughly 98,000 to 110,000 between year 0 (the first year following implementation of the No Action Alternative if it were selected) and year 11.[178] The summer Ski Ride program would be expected to continue to draw approximately 30,000 visitors each year under the No Action Alternative.

Alternative 2 – The Proposed Action

By increasing guest capacities at the day lodges, chairlifts, terrain, and other ski area infrastructure, the CCC of the Snowbowl would increase to 2,825 guests-at-one-time, without substantially increasing the current capacity of skier parking. While this increase would not constitute a change in peak day attendance, it would allow the ski area to better accommodate current use levels. With the increased CCC, busy holiday and snow day crowds that currently overburden the ski area's infrastructure would be more comfortably accommodated resulting in an improved visitor experience.

While average peak day attendance levels are not anticipated to increase under the Proposed Action, the frequency of these peak days is anticipated to increase across the course of the winter

[178] Barring any unforeseen climatic or economic conditions that would inordinately effect visitation.

season. Therefore, total annual visitation associated with skiing would be projected to increase considerably under the Proposed Action, as attributable to a more consistent snow pack due to the installation of snowmaking, increased lift capacity, increased skiable terrain, and a small increase in parking. Year-to-year variability in visitation under the Proposed Action would be expected to be much less under the Proposed Action, approximately +/- 15 percent. If the Proposed Action were implemented, annual visitation levels could be expected to increase from roughly 98,000 in year 0 to around 215,000 by year 11.

The snowtubing facility would be expected to attract a new market for wintertime recreation, helping meet existing demand, as well as provide an additional amenity for Snowbowl's existing clientele. The snowtubing facility has been designed with a CCC of 600 tubers-at-one-time; this figure, along with an accompanying parking area, is independent of Snowbowl's proposed on-mountain CCC of 2,825. However, it is assumed that the snowtubing facility would only approach full capacity on weekends and during holiday periods. The snowtubing facility's annual contribution to additional wintertime attendance at Snowbowl has been projected to fluctuate from roughly 34,000 and 42,000 between year 0 and year 12. Peak day tubing usage could approach as many as 1,680 guests.[179]

The installation of a hiking trail linking Agassiz Lodge with the top of the Agassiz Chairlift, thereby enabling guests to hike between the top of the Agassiz Chairlift and the base area, is not anticipated to substantially increase summertime guest attendance. This hiking trail is intended to accommodate existing demand for hiking opportunities within the SUP area, and is not anticipated to substantially increase summer visitation. This trail may serve the purpose of providing an alternate hiking experience for people who would have hiked the crowded Humphreys Peak Trail, thereby removing some of the heavy pressure on that trail. Additionally, a slight increase in non-Sky Ride related hiking use of the new FS system trail may result. Summertime attendance on the Sky Ride could reasonably be expected to increase slightly as a result of this new hiking opportunity as people take advantage of riding uphill and associated hiking downhill. Overall use, however, would not be expected to increase substantially, and would likely hover in the neighborhood of 30,000 visitors annually.

Alternative 3

As detailed within the Social and Economic Resources section (Section E), the certainty of the development of the facilities included within Alternative 3 is financially unclear. Given the wide variability in visitation as a function of natural snowfall, the owners of the Snowbowl may not be able or willing to invest the funds necessary to capitalize the Alternative 3 improvements. Likely, a portion of the Alternative 3 improvements - those requiring smaller investments – would be developed. For the purposes of comparison, this section provides estimated changes in annual visitation assuming *all* of the Alternative 3 improvements would be implemented.

Under Alternative 3, wintertime attendance is anticipated to increase slightly above the No Action Alternative, but below that of the Proposed Action. Alternative 3 does not include snowmaking or installation of the snowtubing facility – the two components of the Proposed Action that would be expected to generate the bulk of additional wintertime visitation. Therefore, projected annual visitation would be constrained by continued unreliability of snow

[179] Assuming four, two-hour sessions per day at a 70 percent use rate.

cover and expectations regarding days open per season. However, the small increases in projected annual visitation in Alternative 3 are attributable to regional population growth (as in the No Action Alternative), construction of the Humphreys Pod (additional lift capacity and terrain), small additions to parking, as well as trail grading projects that exceed those prescribed in the Proposed Action. More intense trail grading in strategic areas are designed to allow Snowbowl to open trails under reduced natural snow conditions, and thereby would be expected to contribute to incremental increases in annual visitation (assuming adequate natural snowfall) as compared to the No Action Alternative.

Essentially the same year-to-year fluctuations in visitation as presented in the No Action Alternative remain for Alternative 3. Alternative 3 could be expected to produce annual skier visitation levels between 98,000 and 118,000 between year 0 and year 11.

Indicator:

Narrative Description of the Quality of Winter and Summer Recreational Opportunities Under All Alternatives.

Alternative 1 – No Action

Under the No Action Alternative, no operational or infrastructural changes/additions would occur within Snowbowl's SUP that would improve the recreational experience. Generally speaking, the quality of wintertime recreation opportunities under the No Action Alternative would continue to be dictated by the amount of natural snowfall throughout each season. As indicated in Table 3F-1, natural snowfall is widely variable, meaning that Snowbowl would continue to offer an undependable winter recreational experience.

In lieu of updating guest service facilities at Snowbowl, selection of the No Action Alternative would translate to a continuation of crowded, and sometimes undesirable guest experiences in many areas, such as in the lodges and on the chairlifts. As mentioned previously, Snowbowl would be expected to continue to experience peak demand days under the No Action Alternative, which considerably exceed the current CCC of the existing facilities, lifts, and terrain. The public's demand for beginner and intermediate terrain would continue to exceed supply on peak days, resulting in high terrain densities and higher potential for safety concens. Table 3F-7 compares total terrain and allocation according to ability level across all three alternatives.

Table 3F-7
Total Skiable Acreage Under Alternatives 1, 2 and 3

Ability Level	Alternative 1 (acres)	Percentage of Skiable Terrain	Alternative 2 (acres)	Percentage of Skiable Terrain	Alternative 3 (acres)	Percentage of Skiable Terrain
Beginner	0.5	0.4	2.0	1.0	2.0	1.0
Novice	43.9	31.7	44.0	21.5	42.5	21.0
Low Intermediate	31.3	22.6	34.5	16.9	34.5	17.0
Intermediate	38.1	27.5	51.0	25.0	51.0	25.2
Advanced Intermediate	15.4	11.1	40.9	20.0	40.9	20.2
Expert	9.4	6.8	31.8	15.6	31.8	15.7
Total	***138.6***	***100***	***204.2***	***100***	***202.7***	***100***

As described within the Existing Conditions section, a demonstrated demand exists for dispersed snowplay activities. Under the No Action Alternative, the Snowbowl Road would remain closed to parking – and therefore snowplay activities along the road. Despite efforts to inform the public of the parking and snowplay prohibitions, it is anticipated that numerous visitors would continue to drive up the Snowbowl Road only to be turned away by the parking staff.

As detailed within the Social and Economic Resources section (Section E), the Snowbowl operates in a capital-intensive business, where capital expenditures are required on a regular basis to maintain the quality of the recreational product, offer an adequate level of guest service, and to maintain a reasonable level of competitiveness with other ski areas. Over the past eleven operating years, the Snowbowl has invested a cumulative total of $4.42 million in capital expenditures, all of which has been oriented toward ski area maintenance.[180] Within the ski industry, it is generally assumed that at least six percent of gross revenues should be allocated for maintenance capital – capital expenditures sufficient to maintain a ski area at an acceptable level of quality, but not to make major improvements to the facility. The Snowbowl's capital investment over the past eleven years has equaled 8.87 percent of gross revenues.[181] However, this level of expenditure has required the ski area owners to infuse additional capital as these expenditures have exceeded net revenues. Under the No Action Alternative, it is probable that the owners of the Snowbowl would be unable or unwilling to continue to infuse the recurring capital necessary to maintain the quality and service level currently offered.

While no changes would occur to the recreational experience under the No Action Alternative, it is probable that Snowbowl's existing and potential clientele would be effected in terms of the forgone recreational opportunities derived from improved (or at least minimally maintained) facilities, and increased snowpack consistency that are associated with the Proposed Action.

[180] The Snowbowl's capital expenditures have been oriented toward maintenance of the current level of quality, including items such as restrooms, snow grooming equipment, reconstructed or new ski runs, water trucks, and background infrastructure. Capital investment has not been sufficient to add improvements that would be evident to the skier, such as new lifts, lodge space, and terrain.

[181] 11 year Gross Revenues = $49.78 million. 11 Year Capital Expenditures = $4.42 million (8.8 percent of Gross Revenues).

Alternative 2 – The Proposed Action

Under the Proposed Action, all effects to the quality of the recreational opportunities within the SUP (summer and winter) would be positive in nature.

Winter Recreation

Lifts and Terrain

Under the Proposed Action, the only aerial lift at Snowbowl that would remain unchanged is Agassiz. The remaining three lifts in the existing lift network would be realigned and/or upgraded. Two of the upgraded lifts (Sunset and Hart Prairie) would use high-speed, detachable-chair technology. The upgraded lift network would also be complimented by the installation of the Humphreys Chairlift (likely using the Sunset Chairlift after its replacement). Three beginner surface lifts would be added to improve Snowbowl's teaching opportunities in the Hart Prairie area. In addition, the proposed terrain park would specifically be serviced by a surface lift. Combined, the upgrades and additions to Snowbowl's surface and aerial lift network would improve the recreational experience for guests of all levels by improving the balance between uphill and downhill capacities.

As indicated, Snowbowl lacks beginner and intermediate terrain. With selection of the Proposed Action, Snowbowl's developed terrain network would increase from approximately 139 acres to 204.2 acres (a 47 percent increase). The nature of the developed terrain additions would primarily benefit Snowbowl's intermediate guests, with approximately 41 acres of additional intermediate (including low intermediate, intermediate, and advanced intermediate) terrain proposed. Due to the nature of the natural terrain in the SUP area, beginner and novice guests would gain a modest amount of new terrain (1.6 acres), and advanced skiers would gain roughly 22 acres of developed terrain. The additional 47 acres of improved glades would enhance the skiing experience for Snowbowl's advanced and expert clientele. In total, the quality of the recreational experience at Snowbowl would improve as lifts are improved and skiers are better distributed across more terrain. The reader is referred to Table 3F-7 for specific terrain allocations. (Note: the 47 acres of improved glades are not reflected in Table 3F-7.)

Consistent Snowpack

The public scoping period (which included mailings, public meetings, and media coverage) produced approximately 1,020 responses, of which approximately 65 percent were in favor of the Proposed Action as presented. While the Forest Service NEPA process is clearly not intended to be a "voting" process, this indicates considerable support for the primary component of the Proposed Action – snowmaking. It is apparent that Snowbowl's clientele considers snowmaking to be integral to the betterment of the ski area's recreational experience.

While the proposed snowmaking system would not rule out all natural variables (i.e., snowmaking technology is highly dependent on ambient air temperatures to be successful), it is designed to provide a consistent snowpack each season from roughly mid/late November through late March/early April. A consistent snowpack from season-to-season would help redefine the Snowbowl as a permanent and reliable winter sports facility in Northern Arizona's recreational setting. It is probable that this redefinition would reduce Arizonans traveling beyond the state (into the Four Corners area) in search of better, more consistent snow conditions.

Terrain Density Analysis

As a component of this analysis, a terrain density analysis was performed for the proposed additions and increased CCC of 2,825.

Table 3F-8
Terrain Density Analysis (Proposed Action)

Lift	Daily Lift Capacity	Terrain Area (acres)	Actual Terrain Density (guest/acre)	Target Trail Density (guest/acre)	Difference	Density Index
Agassiz/C-3	650	43.5	5	8	-3	63%
Hart-Prairie/DC-4 (New)	660	31.0	10	17	-7	59%
Sunset/DC-4 (New)	690	82.7	3	10	-7	30%
Aspen/C-2	160	16.2	3	18	-15	17%
Humphreys/C-3 (New)	470	27.2	5	6	-1	83%
Carpet 1	80	1.0	19	18	1	106%
Carpet 2	80	1.0	19	18	1	106%
Half Pipe	35	1.5	7	12	-5	59%
Totals	***2,825***	***204.2***	***6****	***11****	***-5****	***56%****

* Weighted Average.

As compared to Table 3F-4, Table 3F-8 indicates that the uphill (i.e., lift) and downhill (i.e., trail) capacities are better balanced under the Proposed Action than under the existing condition. Even with a higher CCC, the additional terrain made available under the Proposed Action better disperses guests across the SUP area. Therefore the terrain/infrastructural upgrades and increased CCC under the Proposed Action would improve the Snowbowl's ability to accommodate the existing levels of visitation. Skier densities would remain within the industry norm while lift line waiting periods would decrease. Decreased skiers densities would result in improved skiers circulation and safety.

Slope Aspect Analysis

The results of the slope aspect analysis conducted for existing terrain within the SUP area are provided in the Existing Conditions section. The majority of the proposed terrain additions are aligned in north/northwest aspects (which provide for optimal retention of snow). However, the terrain additions related to the development of the Humphreys Chairlift are not. A detailed slope aspect analysis was completed specific to the approximately 31 acres of skiing trails proposed within the Humphreys pod. The aspect of these trails averages 238.9 degrees azimuth, which would be characterized as a southwest-west slope aspect. The majority of the terrain (93.4 percent) lies southwest (180 to 270 degrees azimuth) with the remainder (6.6 percent) facing west to northwest (270 to 337 degrees azimuth).

While the Humphreys pod does not offer an optimal slope aspect, operations at other western ski areas – at similar elevations – has demonstrated that this can be effectively overcome through the installation of snowmaking infrastructure and through a concerted effort in maintaining adequate coverage in this pod. Additionally, the ski trails have been specifically designed in a mosaic of open spaces with the intent of maximizing the shading potential of the existing tree canopy.

Through a combination of snowmaking, natural shading, and effective snow management, it is anticipated that the skiing terrain within the Humphreys area would provide an acceptable skiing product throughout the majority of Snowbowl's operating season.

Snowplay

The proposed lift-served, developed snowplay area in Hart Prairie would help fulfill the ongoing demand for alternative winter recreation activities on the CNF. As detailed within the Existing Conditions section, the areas along the Snowbowl Road were recently closed to parking in an effort to manage ongoing issues stemming from dispersed snowplay activities. The proposed snowplay facility would offer an additional attraction for non-skiers who normally would not use or visit the ski area or perhaps lack the physical abilities to ski. In addition, the snowplay facility would benefit Snowbowl's existing clientele, as another option for recreation while using the ski area's facilities. The professionally designed/maintained snowtubing area would provide a safe and organized alternative to dispersed snowplay activities that currently occur on NFS lands along the Snowbowl Road and elsewhere on the CNF.

Half Pipe

The half pipe, proposed for construction near the Sunset Lift, would add a currently unavailable but needed element to Snowbowl's alternative terrain features. The half pipe would benefit snowboarders and skiers alike, and would be specifically served by a surface lift. With much of Snowbowl's use coming from snowboarders, and considering the popularity of such terrain features, this would be an attractive addition to the ski area.

Upgraded Guest Services

Upgrading the ski area's uphill capacity (and therefore CCC) would necessitate making commensurate improvements to ski area-wide infrastructure and guest service facilities.[182] By increasing and updating Snowbowl's guest service facilities at Agassiz Lodge and Hart Prairie Lodge, a Native American cultural and education center, and new ski team buildings, the overall recreational experience would be improved (e.g., food service seating would be increased eliminating the need for guests to sit on the floor).

In addition to the capital investments necessary to develop the proposed facilities, the Proposed Action would allow the business to continue to invest the recurring maintenance capital necessary to maintain the quality and level of service offered to the guest.

Summertime Recreation

Hiking

The proposed hiking trail from Agassiz Lodge to the top of the Agassiz Chairlift would add a new element to Snowbowl's summertime recreational offerings. The trail would enable guests to hike down to the base area after using the Sky Ride program. Approximately 30 percent of guests participating in the summer Sky Ride express an interest in being allowed to hike off the

[182] Infrastructure, utilities and guest services are further detailed in Section G.

mountain rather than ride the lift down. Additionally, the opportunity to hike from the bottom of the ski area to the top of Agassiz Chairlift is expected to be highly valued.

Alternative 3

From a recreational perspective, Alternative 3 does not include the primary elements associated with the Proposed Action which would most affect the overall recreational experience. Without snowmaking and snowtubing, the overall recreation experience at Snowbowl would be less desirable than the Proposed Action, particularly on busy days, and would continue to deteriorate as skiers and snowboarders seek more favorable, out-of-state opportunities. The ski area's reputation in Northern Arizona's recreational environment would continue to be defined by climatic conditions with a continued dependency on natural precipitation. While difficult to measure, skier export to neighboring states would be expected to continue, as warranted by snowfall and climatic trends.

As additionally detailed within the Social and Economic Resources section, operations under Alternative 3 would continue to be heavily dependant upon natural snowfall. Correspondingly, skier visitation levels, and therefore revenues, are not anticipated to stabilize. As such, it is probable that the owners of the Snowbowl would be unable or unwilling to continue to infuse the recurring capital necessary to maintain the quality and service level currently offered. Likely, a portion of the Alternative 3 improvements - those requiring smaller investments – would be developed. Dependant upon which facilities are ultimately implemented, the actual effects to the quality of winter recreation would realistically be a blending of those effects described under the No Action Alternative and those detailed under Alternative 3.

For the purposes of comparison, this section assesses the quality of winter and summer recreation opportunities assuming that *all* of the Alternative 3 improvements would be implemented.

Winter Recreation

Lifts and Terrain

Under Alternative 3, the aerial lift system and terrain development would be identical to that described under the Proposed Action.

Consistent Snowpack

The Snowbowl's reliance upon natural snowfall and variability in skier visitation would continue under Alternative 3. While it is probable that a series of infrastructural improvements may be made to the facility under Alternative 3, consistency of skiing conditions and predictability of operations would remain unchanged. It is probable that Arizonans would continue traveling beyond the state (into the Four Corners area) in search of better, more consistent snow conditions.

Terrain Density Analysis

Under Alternative 3, the terrain density anticipated under Alternative 3 would be essentially identical to that evaluated under the Proposed Action.[183]

Slope Aspect Analysis

The results of the slope aspect analysis conducted for existing terrain within the SUP area are provided in the Existing Conditions section. The majority of the proposed terrain additions are aligned in north/northwest aspects (which provide for optimal retention of snow); however, the terrain additions related to the development of the Humphreys Chairlift are not. A detailed slope aspect analysis was completed specific to the approximately 31 acres of skiing trails proposed within the Humphreys pod. The aspect of these trails averages 238.9 degrees azimuth, which would be characterized as southwest-west. The majority of the terrain (93.4 percent) lies southwest (180 to 270 degrees azimuth) with the remainder (6.6 percent) facing west to northwest (270 to 337 degrees azimuth).

The Humphreys pod does not offer an optimal slope aspect in terms of season-long snow retention. Although the ski trails have been specifically designed in a mosaic of open spaces with the intent of maximizing the shading potential of the existing tree canopy, it is anticipated that the aspect of these trails would cause them to melt-off periodically between storm cycles. Through a combination of natural shading and effective snow management, it is anticipated that under Alternative 3, the skiing terrain within the Humphreys area would provide an acceptable skiing product for roughly half of the Snowbowl's operating season.

Snowplay

Because construction and maintenance of the proposed snowplay facility would be dependent on a reliable source of snow (i.e., snowmaking), this facility would not be developed under Alternative 3. Thus, no additional recreational opportunities would be available to non-skiers within the SUP area during the winter. As described within the Existing Conditions section, a demonstrated demand exists for developed and dispersed snowplay activities. Under Alternative 3, the Snowbowl Road would remain closed to parking – and therefore snowplay activities would not be allowed along the Snowbowl Road. Despite efforts to inform the public of the parking and snowplay prohibitions, it is anticipated that numerous visitors would continue to drive up the Snowbowl Road only to be turned away by the parking staff.

Half Pipe

The half pipe, proposed to be constructed near the Sunset Lift, would add a currently unavailable element to Snowbowl's alternative terrain features. Similar to the Proposed Action, the proposed half pipe would be partially constructed of dirt, which would allow it to be operational without snowmaking coverage. However, the overall size and quality of the half pipe would be reduced as compared to the Proposed Action due to the inability to augment its construction with machine-produced snow.

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[183] Negligible differences in terrain density are attributable to the Proposed Action's realignment of the Aspen Chairlift and use of some of the Hart Prairie terrain for the snowtubing areas.

Upgraded Guest Services

Upgrading the ski area's uphill capacity (and therefore CCC) would necessitate making commensurate improvements to ski area-wide infrastructure[184] and guest service facilities. By increasing and updating Snowbowl's guest service facilities, the overall recreational experience would be improved (e.g., food service seating would be increased eliminating the need for guests to sit on the floor).

Summertime Recreation

Hiking

Under Alternative 3, the proposed hiking trail from Agassiz Lodge to the top of the Agassiz Chairlift would be developed as described under the Proposed Action.

Wilderness Values

Implementation of the Proposed Action may affect the experience of wilderness users within the surrounding Kachina Peaks Wilderness.

Indicators:

Quantitative Description of Seasonal Wilderness Use and Visitation.

Narrative Discussion of the Anticipated Effects of the Proposed Action to Wilderness Users

The discussion within this section combines a description of the two identified indicators.

Alternative 1 – No Action

Selection of the No Action Alternative is not expected to directly or indirectly impact the Kachina Peaks Wilderness. Under this alternative summer and winter access, use and enjoyment of the Wilderness would not change. Annual Wilderness use would be expected to follow historic trends, as provided in Table 3F-6.

Alternative 2 and 3

Similar to the No Action Alternative, neither of the action alternatives would directly or indirectly impact summer or winter access, use or enjoyment of the adjacent Kachina Peaks Wilderness. All projects likely to occur under either of the action alternatives would be confined to the established Snowbowl SUP area, and no additional access to, or use of, the Wilderness is anticipated. Therefore, it is not anticipated that any of the changes occurring within the ski area would affect any Wilderness values or users. Annual Wilderness use would be expected to follow historic trends, as provided in Table 3F-6.

[184] Power, water, and sewer upgrades are detailed in the Infrastructure and Utilities section of this chapter.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of the cumulative effects analysis for recreation resources extends from the conception of Snowbowl as a developed winter recreational venue into the foreseeable future for which these opportunities can be expected to continue at the Snowbowl.

Spatial Bounds

The physical extent of this cumulative effects analysis comprises the Snowbowl SUP area and approximately 5,000 acres of the surrounding Kachina Peaks Wilderness (approximately one quarter of the total Wilderness acreage).

Past, Present, and Reasonably Foreseeable Future Actions

1. Wilderness designation
2. Miscellaneous facilities and trail construction within Snowbowl's SUP area
3. Summer events held at Snowbowl
4. San Francisco Mountain Mineral Withdrawal
5. Peaks segment of the Arizona Trail
6. Private land development
7. Miscellaneous/ongoing recreational uses
8. Snowbowl Road Parking Restrictions Snowbowl Road Paving

Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 – No Action

The Snowbowl has existed on the San Francisco Peaks since 1938, and its developed character has necessarily grown over the decades in proportion to greater demand and use. The Kachina Peaks Wilderness was not designated by Congress until 1984 – well after the establishment of the majority of Snowbowl's existing facilities and trail systems. While it is acknowledged that the ski area and Wilderness represent different, and in some cases, conflicting, management emphases,[185] Snowbowl's operations and development have been, and continue to be, entirely confined to the SUP area and have been conducted in accordance with the terms of its SUP and Forest Plan management direction.

Many of the past, present, or reasonably foreseeable future actions identified above are positive in nature when considered in a recreational context. For example, withdrawal of the Peaks and surrounding area from mineral entry (completed in 2000) has maintained the visual and recreational character and opportunities of the analysis area. The Peaks segment of the Arizona

[185] For example, portions of the lift and trail network can be seen from within the Wilderness. Noise is not considered an issue, as the Wilderness receives the majority of its use during the non-winter months when Snowbowl operations area minimal.

trail (a decision which is currently under litigation) will provide additional hiking and interpretive opportunities in the cumulative effects analysis area.

Recent parking restrictions on the Snowbowl Road have had the effect of shifting dispersed winter snowplay to other areas of the Forest as well as private land. This has improved access to the Snowbowl by reducing congestion on the road. In addition, paving of the Snowbowl Road has improved use and access to the Snowbowl.

It is difficult to assess the effects of past, present, and future private land development in Hart Prairie on recreational resources. Cumulatively, with development of the Snowbowl, this has brought more people, facilities, traffic, and activity within close proximity to the Wilderness and will continue with future development. This may lead to increased use of the Wilderness in the future. Miscellaneous/ongoing recreational uses of the area – both on and off-Forest, have increased over the years and will likely increase with or without selection of the No Action Alternative.

Summer events will continue to occur within the SUP area, as reviewed and approved on a case-by-case basis.

Alternative 2 – The Proposed Action

While the Proposed Action represents the greatest potential for effects to recreational opportunities in the cumulative effects analysis area, cumulative effects of implementation of the Proposed Action are anticipated to be largely the same as those described under Alternative 1, with the following exceptions:

Installation of snowmaking capabilities within the SUP area would provide an improved, more reliable snowpack within the SUP area, thereby, in all likelihood, deterring some dispersed winter use beyond the SUP area under less-than-favorable snow conditions.

By providing a developed snowplay facility within the SUP area, dispersed snowplay elsewhere on NFS and private lands would be reduced. This would alleviate some of the safety, sanitation, and vehicular/pedestrian congestion in the vicinity.

The establishment of the proposed hiking trail from the Agassiz Lodge to the top of the Agassiz Chairlift could offset some use of the Wilderness by reducing pressure on the Humphreys Peak Trail, and thus lessen impacts on Wilderness during the summer.

Alternative 3

Cumulative impacts associated with selection of Alternative 3 would be largely the same as those disclosed under Alternative 1.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

All projects elements have been designed to enhance the summer and winter recreational experience within Snowbowl's SUP area. No irreversible or irretrievable commitments of recreational resources were identified.

3G. INFRASTRUCTURE AND UTILITIES

INTRODUCTION

Neither public nor agency scoping identified potential effects to infrastructure and utilities as a major issue for this proposal; however, changes would occur to both infrastructure and utilities under the two action alternatives. As a result, domestic water, wastewater, power, and fuel storage at Snowbowl are described and analyzed herein.

SCOPE OF THE ANALYSIS

The scope of analysis for the infrastructure and utilities section of this EIS focuses on the Snowbowl SUP area (NFS lands) and the length of the corridor from the City of Flagstaff to the ski area in which the reclaimed water would be piped from the Rio de Flag wastewater treatment facility to Snowbowl for use in the proposed snowmaking system and as a source of reclaimed water for the ski area.

EXISTING CONDITIONS

WATER AND WASTEWATER

Because Snowbowl is located on a volcanic mountain in an arid landscape, a potable water source does not exist at the ski area. Therefore, all potable water is trucked to the ski area from the Bonito fill station in Flagstaff via a 3,200 gallon capacity tender truck. In a typical year, Snowbowl hauls approximately 1.5 million gallons of potable water. This equates to approximately 470 trips each year. During the ski season, Snowbowl hauls approximately 10,000 gallons of water per night on the weekends and 5,000-7,000 gallons of water per night mid- week. During the summer, the ski area uses approximately 10,000 gallons of water per week.

Potable water is held in aboveground storage tanks adjacent to each base area facility. The Agassiz Lodge, Hart Prairie Lodge, and maintenance facility have tanks of 10,000, 20,000, and 2,500 gallons, respectively. In addition to potable water for drinking, Snowbowl also has one 10,000 gallon water storage tank located across the road from the Hart Prairie Lodge for fire suppression as required by state and local laws.

Of the approximately 1.5 million gallons of water hauled to the ski area annually, approximately 60 percent (900,000 gallons) is consumed in restroom facilities. Each of the three main base area facilities at Snowbowl has an on-site, self-contained septic system and leachfield. The Agassiz Lodge, Hart Prairie Lodge, and maintenance shop have systems capable of treating 10,000, 10,000, and 1,200 gallons of wastewater per day, respectively. The septic systems are pumped annually, or as needed, to avoid overflow. Snowbowl's septic systems are adequately sized to meet current needs.

POWER

Electric power is provided to Snowbowl by Arizona Public Service (APS). A main line runs from Flagstaff to the ski area via an existing, overhead utility corridor, located south of the maintenance facility (refer to either figure 2-6 or 2-9). From here, an electric power line runs through the access road to the maintenance facility and to the Hart Prairie Lodge. Spurs from the Hart Prairie Lodge connect to the bottom of the Aspen Chairlift, the Hart Prairie Chairlift bottom and top terminals, the Agassiz Lodge, and the Agassiz Chairlift bottom terminal. The lifts at Snowbowl are individually powered by electric motors; the electrical requirements for each lift are detailed in the Table 3G-1. In the event of an electrical power outage, however, each lift has an auxiliary power unit (APU) powered by either gasoline or diesel fuel. This enables operation of the lifts in the event of a power outage. On average, APUs at each lift run fewer than 25 hours per year.

Table 3G-1
Electrical Requirements for Existing Lifts

Lift	Electrical Requirement (hp)
Agassiz	400
Hart Prairie	150
Sunset	150
Aspen	110

All facilities use electricity for lighting. Propane is the source of energy for heat and cooking. The main propane storage tanks are located in the base area, with one 1,000-gallon tank at the Agassiz Lodge, one at Hart Prairie (6,000 gallons), and one 1,000-gallon tank at the maintenance facility. Each lift shack has its own portable propane tank, which is transported to the bottle dock at the maintenance shop to be refilled as necessary. The large base area tanks are serviced and filled as needed.

FUEL STORAGE

Fuel is stored in an above ground tank at the maintenance facility, located approximately on-half of a mile south of the Hart Prairie Lodge. The tank holds 2,000 gallons of gasoline and 6,000 of diesel fuel. Additionally, each lift has a small fuel tank associated with its APU. These tanks contain enough fuel for approximately eight hours of operation.

COMMUNICATIONS

Communication services are provided to Snowbowl by Qwest. All communication lines at Snowbowl connect to the main line in the existing utility corridor (shared with power), south of the maintenance facility. From this connection with the main line, a phone line runs through the access road to the maintenance facility and to the Hart Prairie Lodge. Spurs from the Hart Prairie Lodge connect to the bottom of the Aspen Chairlift, the Hart Prairie Chairlift bottom and top terminals, the Agassiz Lodge, and the Agassiz Chairlift bottom terminal. While the existing network of communication lines throughout the SUP area are adequate to meet Snowbowl's existing operational needs, the system is currently maxed out and cannot be augmented without

upgrading the main line. Refer to either Figure 2-6 or 2-9 for locations of exiting communication lines.

A two-way radio repeater is situated at 11,500 feet adjacent to the top patrol area. Mountain personnel, such as ski patrol, use line of sight radios for instantaneous communication while outdoors.

GUEST SERVICES

Existing on-mountain visitor services are provided in two buildings: the 18,425 square foot Hart Prairie Lodge (at the base of the Hart Prairie and Sunset chairlifts) and the 5,080 square foot Agassiz Lodge at the base of the Agassiz Chairlift. In total, these two buildings comprise approximately 23,505 square feet of guest service and administrative space.

There are presently a total of 614 indoor, cafeteria style seats and 648 outdoor seats available between the two buildings, for a total of 1,262 seats. Based on an average daily seating turnover rate of 4.0,[186] Snowbowl has indoor seating for approximately 2,450 guests. For Snowbowl's CCC of 1,880, this number of indoor seats is ample. However, because peak daily visitation has averaged 3,400 skiers in the past, it is apparent that current guest seating falls considerably short of what is actually needed to provide an adequate experience.

The kitchen/scramble[187] area in the Hart Prairie Lodge falls short of meeting Snowbowl's needs, or guests expectations, for quality services and facilities. On any day in which Snowbowl's attendance reaches 2,000 guests, the Hart Prairie Lodge experiences long food and cashier lines (sometimes extending out the door onto the deck), inadequate seating (resulting in guests sitting on the floor or standing while they eat) and general congestion throughout the building.[188] Restrooms are, however, considered adequate at the Hart Prairie Lodge.

Similar to the Hart Prairie Lodge, the Agassiz Lodge lacks adequate seating on even moderately busy days, which means that guests are forced to sit on the floor or stand while they eat or warm up. Due to outdated (1961) and undersized kitchen/scramble facilities, menu options are extremely limited and lines are unacceptably long. Restroom capacities are insufficient resulting in long waits.

[186] A turnover rate of three to five times is the standard range used in determining restaurant capacity. Sit-down dining at ski areas typcially results in a turnover rate of three, while cafeteria style dining is characterized by a higher turnover rate. Furthermore, weather has an influence on turnover rates at ski areas, as on snowy days skiers will spend more time indoors than on sunny days.

[187] The "scramble" area refers to the self-service and cashier line portions of cafeteria-style food service areas.

[188] This is especially true on days in which outdoor seating is undesireable due to weather conditions.

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

Effects on ski area infrastructure and supporting utilities within and beyond the SUP area.

Indicator:

Disclosure of Current Versus Anticipated Requirements for Guest Seating; Power, Domestic Water Supply and Wastewater Treatment.

Effects to infrastructure and utilities are primarily related to public safety, demand/consumption, efficiency, and reliability. Domestic water includes availability and quality of potable water for on-mountain consumption at restaurants and the proposed snowplay facility, as well as non-potable uses such as capacity, availability, and code compliance for fire suppression facilities (sprinkler systems), and restroom facilities. Sewer facilities include capacity, availability, and code compliance of restroom and restaurant wastewater facilities. Power (electrical distribution) facilities on the mountain are related to availability, reliability, and contingency planning. Fuel storage issues at Snowbowl are typically confined to public safety issues.

In addition to the narrative discussion of existing and proposed utilities provided here, refer to Table 2-5, Summary of Environmental Consequences, which quantifies both permanent and temporary ground disturbances associated with the installation of the described infrastructure under each alternative.

Alternative 1 – No Action

With selection Alternative 1, Snowbowl's CCC would remain at 1,880, and daily visitation (including peak visitation) would remain similar to that of the recent past – subject to weather conditions.

Water and Wastewater

Under Alternative 1, Snowbowl would continue to haul all of its domestic water from the City of Flagstaff. There would be no additional storage capacity and demand would be anticipated to remain the same.

Wastewater facilities currently meet the demands of the ski area, even on peak days. Snowbowl would continue to use approximately 60 percent of the water it hauls from Flagstaff to accommodate non-potable (i.e., toilet) services.

Power

Because the existing electrical service is adequate to meet Snowbowl's needs current needs, upgrades to power supply and distribution are not necessary under Alternative 1. However, the existing overhead power line experiences occasional outages when trees fall across it. The line may be placed underground in the future within the right-of-way for the Snowbowl road.

Fuel Storage

There is an adequate supply of gasoline, diesel, and propane storage at the ski area to meet existing demands.

Communications

Under the No Action Alternative service would continue to be provided by Qwest. No new or additional lines would be installed. However, if the power line is buried in the right-of-way, the communication line would be buried with it.

Guest Services

No changes would occur to guest service facilities under the No Action Alternative. Guest seating and restrooms would continue to be inadequate on even moderately busy days. Existing buildings would not be brought into compliance with the Americans with Disabilities Act (ADA) under the No Action Alternative.

Alternative 2 – the Proposed Action

The utilities and infrastructure discussed below are depicted on Figure 2-6.

In order to better accommodate existing demand, the Proposed Action would increase Snowbowl's CCC from 1,880 to 2,825. As stated, it is typical for ski areas to size infrastructure and guest services to accommodate as much as 125 percent of CCC. Under the Proposed Action guest service facilities and related infrastructure have been sized to accommodate approximately 3,000 guests. However, as was also stated, parking is, and will continue to be, a constraint to daily attendance, even with minor increases in parking areas.[189]

Water and Wastewater

Under Alternative 2, Snowbowl would continue to transport 100 percent of its potable water via truck from Flagstaff. While daily skier visitation is not anticipated to increase substantially, the occurrence of peak days is expected to increase in frequency and implementation of the proposed snowplay facility would increase demand for potable water at the Snowbowl. However, with construction of the reclaimed water pipeline from Flagstaff, it would no longer be necessary for the Snowbowl to use valuable potable water for non-potable services. Therefore, under the Proposed Action, 100 percent of trucked in potable water would be available for culinary uses; subsequently the frequency in which potable water is delivered to the ski area would decrease.

Snowbowl proposes to construct (and bury) one additional 10,000-gallon potable water storage tank at the snowplay area to accommodate guests' needs there. In addition, water stored in the main snowmaking impoundment would be routed to the maintenance shop, the Agassiz Lodge, the Hart Prairie Lodge, and the snowplay facility for non-potable needs and for emergency fire suppression. Three additional buried 10,000-gallon (non-potable) water storage tanks would be constructed - one each at the Agassiz and Hart Prairie lodges, and one at the snowplay facility.

[189] Estimated at 2.5 guests per vehicle, Snowbowl's 10.6 acres of parking would continue to have a capacity of approximately 3,000 guests.

In order to accommodate the additional guest service facilities (specifically restrooms and food service operations), the on-site septic system for the Agassiz Lodge would be upgraded with an additional drainfield proposed to be located under the parking lot south of the Lodge (refer to Figure 2-6).

The septic system for the snowtubing area would be sized to accommodate peak day use of the facility. This would equate to approximately 1,680 snowtubers using five gallons of water per day (capacity of 8,500 gpd). Ground disturbance for this system has been accounted for in the proposed grading for construction of the snowtubing area.

While the existing septic system at the Hart Prairie Lodge would not need to be enlarged, under the Proposed Action, the drainfield may be disturbed during conduction activities in the Hart Prairie area and therefore may warrant repair.

The reader is referred to figures 2-5 and 2-6 for locations of exiting/proposed leachfields in relation to proposed grading activities.

Snowmaking

Installation of a snowmaking system would require trenching for air, power, and water lines, as well as construction of a 10 million gallon on-mountain water impoundment. In the winter this storage pond would be used as a source of water for the proposed snowmaking system (and, to a lesser degree, for non-potable water needs at the ski area). In the summer, the water in the impoundment would be available for wildland firefighting operations as a high elevation water source. The storage pond would be easily accessible by helicopters, making it a valuable time conserving resource.

The Proposed Action includes installing fire hydrants along the pipeline corridor from Flagstaff. Strategically located, these hydrants, located on Observatory Mesa and in the Fort Valley residential community, would help protect these areas by providing expedited access to a readily available source of water for fire suppression in case of an emergency.

With very few exceptions, snowmaking is proposed on all existing and new trails under Alternative 2. A network of snowmaking water, power, and air lines would be buried on the south side of each trail to accommodate the proposed snowmaking under Alternative 2. Refer to Figure 2-3 for the proposed snowmaking air/water line configuration.

Power

Under the Proposed Action, the Hart Prairie, Sunset, and Aspen chairlifts would be upgraded and/or realigned; each would have a top drive terminal and would have various electrical power requirements as described in Table 3G-2. Each chairlift would also be outfitted with a diesel APU with fuel storage sufficient for one day of operation.

The new Humphreys Chairlift would have a bottom drive terminal requiring a 200 horsepower motor. Power to this lift would be supplied via a short spur off the proposed snowmaking water, power, and air line corridor that would run along the western edge of the proposed Humphreys

Pod. The proposed lift would also have a diesel APU with aboveground fuel storage for one operating day.

Table 3G-2
Electrical Requirements for Proposed Lifts

Lift	Electrical Requirement (hp)
Agassiz	435
Humphreys	200
Hart Prairie	250
Sunset	600
Aspen	75

With the addition of snowmaking infrastructure, new/upgraded lifts and other projects, Snowbowl's existing power supply is inadequate and would need to be upgraded. The increased demand for electricity associated with the upgraded Agassiz and Hart Prairie lodges, snowmaking system and upgraded lift network would be met by additional supply and infrastructure through APS. This could be achieved under two scenarios:[190] 1) by replacing and upgrading overhead power lines that currently enter the SUP area in its southwestern corner; or 2) by dismantling the exiting overhead power lines/infrastructure and installing a new, upgraded power line in the same trench as the reclaimed water line along the Snowbowl Road corridor. The proposed snowplay facility would be accommodated by a spur off of the upgraded infrastructure, under either scenario. The two existing lodges have an adequate supply of propane to meet the increased demand for heat in the upgraded facilities. The snowplay facility would require an additional propane tank for heating purposes.

Fuel Storage

Under the Proposed Action, an additional propane tank would be installed at the snowplay facility. No other changes/additions to fuels storage would be warranted.

Communications

Under the Proposed Action, the main telephone line servicing Snowbowl would need to be upgraded. Since this line currently shares the overhead corridor with power, the ultimate location of an upgraded line would depend on future discussion with APS and Qwest, because this line could easily be buried along with power and reclaimed water in the Snowbowl Road corridor. An additional line would be a buried from the maintenance facility to the proposed snowmaking primary pumphouse located adjacent to the water impoundment.

[190] Additional discussions with APS are pending final project engineering which is contengient upon project approval.

Guest Services

Proposed improvements to the Hart Prairie and Agassiz day lodges would help achieve a better balance between guest services and attendance levels. The Proposed Action would increase guest service square footage from approximately 23,500 square feet to approximately 47,000 square feet (including the enlarged Hart Prairie and Agassiz lodges, the snowplay facility, and the Native American Cultural and Education Center). Creating more guest service space (seating, restrooms, food service, and kitchen/scramble) would allow Snowbowl to better meet guests' needs on average and peak visitation days, when attendance could be expected to meet or exceed 3,400 guests. This would allow Snowbowl to respond to existing issues with inadequate guest service by providing facilities to accommodate 125 percent of the increased CCC. Under the Proposed Action, existing buildings would be brought into compliance with the ADA.

Alternative 3

The utilities and infrastructure discussed below are depicted on Figure 2-9.

As with the Proposed Action, Alternative 3 would size guest service facilities and related infrastructure to accommodate approximately 3,000 guests – approaching 125 percent of CCC. However, parking capacity would continue to be a constraint to daily attendance, even with minor increases in parking areas. As with the Proposed Action, in order to better accommodate existing demand, Alternative 3 would have a CCC of 2,825.

Water

Without the snowmaking impoundment for non-potable water storage, Snowbowl would continue to use approximately 60 percent of the potable water it trucks to the ski area to accommodate its non-potable water needs. However, under Alternative 3 Snowbowl would construct an additional buried 10,000-gallon water storage tank at the Agassiz Lodge to help accommodate existing demands for potable water. As a result, the amount of water hauled and the cost associated with transportation would be slightly reduced, but would not drastically differ from the existing conditions.

As with the Proposed Action, in order to accommodate additional guest service facilities (specifically, increased toilets), the on-site septic systems for the three existing buildings may need to be upgraded in size under Alternative 3. Additional septic capacity for the Hart Prairie and Agassiz lodges would be the same as described under the Proposed Action. Final size and design (and need) for these systems would be directly related to the size of the proposed buildings, number of additional toilets and the number of people to be accommodated by each facility.

Power

Because Alternative 3 excludes snowmaking, Snowbowl's existing power supply is adequate to accommodate the anticipated demand under Alternative 3. However, several short spurs would be required to provide electric power to the new Humphreys Chairlift, the new surface lifts, and the proposed realigned Sunset and Hart Prairie chairlifts. Each of these lifts would have a top drive terminal and would have various electrical power requirements as described in Table 3G-2.

One additional line would be buried within a mix of existing and proposed trails to the top of the Agassiz Chairlift.

As with the Proposed Action, the new Humphreys Chairlift would have a bottom drive terminal requiring an approximate 200 horsepower motor. Power to this lift would be supplied via a spur from the Agassiz Chairlift. The proposed lift would also have a diesel APU with aboveground fuel storage for one operating day.

As with Alternative 1, the power line will eventually be placed underground within the Snowbowl Road right-of-way.

Fuel Storage

There is an adequate supply of gasoline, diesel, and propane storage at the ski area to meet demands under Alternative 3.

Communications

Alternative 3 would not necessitate any changes to the existing communications network at Snowbowl. If and when the power is buried then the communications would likely also be buried.

Guest Services

Aside from the omission of the Native American Cultural and Education Center, Alternative 3 improvements to guest services would be identical to the Proposed Action.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of this cumulative effects analysis extend from when Snowbowl was established in 1938 through the foreseeable future in which Snowbowl can be expected to operate.

Spatial Bounds

The spatial bounds of this cumulative effects analysis are limited to the Snowbowl SUP area and the proposed pipeline corridor between the permit area and the Rio De Flag Water Reclamation Plant.

Past, Present, and Reasonably Foreseeable Future Projects

The only reasonably foreseeable future action that has been identified in relation to utilities and infrastructure is the Snowbowl wireless telephone communications site. No other specific past, present, or reasonably foreseeable future projects with potential to cumulatively affect infrastructure and utilities were identified as having occurred or likely to occur within the spatial and temporal bounds of this analysis.

Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternatives 1, 2, and 3

While approved for construction at Snowbowl's maintenance area, the wireless telephone communications site would not cumulatively affect infrastructure or utilities, other than potentially eliminating the need for the continuation of phone land lines at Snowbowl.

APS has indicated that sufficient power is available in the grid to meet Snowbowl's power needs under the Proposed Action. This could be achieved without affecting other APS customers.

The reader is referred to the cumulative effects analysis contained in Section H – Watershed Resources for information on cumulative impacts associated with private septic systems in Hart Prairie.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There would be no irreversible or irretrievable commitments of resources as a result of either action alternative. As has been stated before, all infrastructure and facilities that are installed could be removed at a later date.

3H. WATERSHED RESOURCES

SCOPE OF THE ANALYSIS

The focus of this analysis is the potential impacts to watershed resources from implementation of the Proposed Action; specifically, proposed snowmaking operations which would utilize reclaimed water as the source for snowmaking.

The study area for this watershed analysis is depicted in Figure 3H-1. As opposed to the eight subwatersheds that compose the study area in the Soils and Geology analysis, the study area for the Watershed Analysis is comprised of two primary areas: the Hart Prairie Watershed and Agassiz Subwatershed. These areas were differentiated by the drainage divide along the ridge that runs west from Agassiz Peak. Within the Hart Prairie watershed the "Snowbowl Sub-area" further delineates the area of direct impact from the proposed snowmaking activities. The Snowbowl sub-area includes slightly over 1,000 acres of land encompassing the majority of the Snowbowl SUP area. The Snowbowl Sub-area consists of four subwatersheds, as defined in the Soils and Geology analysis - Snowbowl, Sunset, Hart Prairie, and Humphreys; each includes snowmaking coverage. The larger Hart Prairie Watershed (which would include inputs from the Snowbowl Sub-area) is used for indirect impacts to down-gradient shallow groundwater discharges/users.

A portion of the snowmaking is proposed to occur in terrain within the upper portion of the Agassiz Sub-watershed. The Agassiz Sub-watershed includes a small part of Snowbowl's southernmost terrain and proposed improvements that occur south from the drainage divide between the Snowbowl sub-area and the Agassiz sub-watershed. Four of the subwatersheds identified in the Soils and Geology analysis (Meadows and Lower, Middle, and Upper Agassiz Ridge) were lumped into the Agassiz Sub-watershed analyze the direct impact of snowmaking. Indirect impacts were evaluated for the potential groundwater underflow from the Agassiz Subwatershed to shallow groundwater discharging in downgradient springs on the southwest flank of Agassiz Peak.

Cumulative groundwater quantity and quality effects of the proposed snowmaking were considered in relation to: 1) bacterial contamination from past, present, and future land use activities in Hart Prairie, 2) potential long-term effects on the regional aquifer from diversions of reclaimed water for snowmaking, and 3) other past, present, and reasonably foreseeable future projects identified by the Forest Service ID Team.

A portion of the indicators that were decided upon for conducting this analysis (see Chapter 1) are most appropriately discussed in the Existing Conditions section, and are labeled as such.

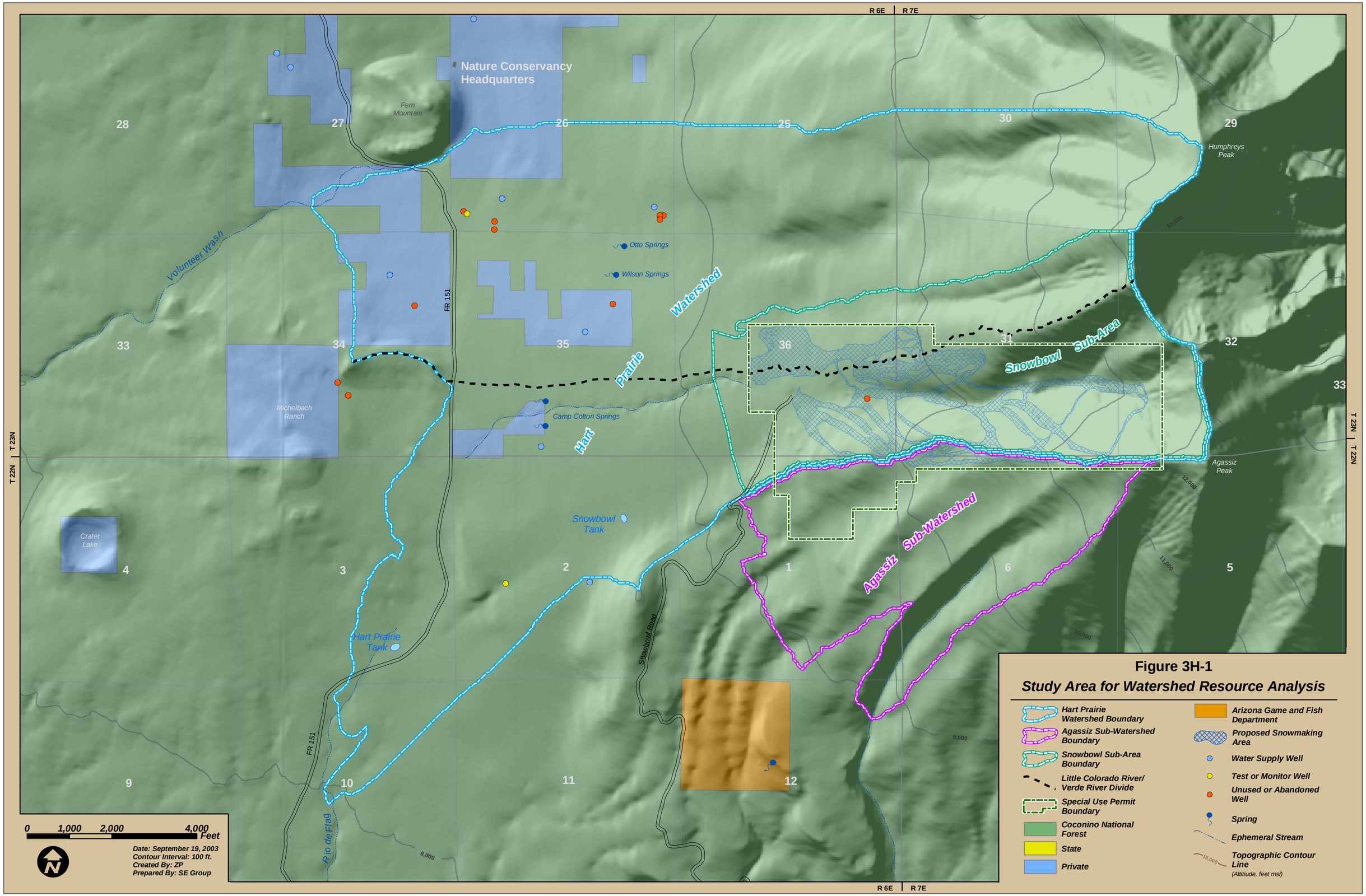

Figure 3H-1

Study Area for Watershed Resource Analysis

STUDY METHODOLOGY

This analysis of potential impacts to watershed resources is excerpted from a technical report prepared in conjunction with this EIS entitled *Analysis of Watershed Resource Issues for the Arizona Snowbowl Facilities Improvement Environmental Impact Statement*.[191] The technical report, in its entirety, is part of the official project record and is available for review at the Peaks Ranger District office.

This analysis was conducted by reviewing pertinent records, permits, and required permit reporting provided by the City of Flagstaff and the Arizona Department of Environmental Quality (ADEQ) for the treatment and monitoring of the Rio de Flag water reclamation facility (WRF) influent and effluent. In addition, Federal and State requirements and standard industry practices, in Arizona and other states for the reuse and recharge of reclaimed wastewater, were reviewed.

Interviews were conducted with personnel responsible for the management, operation, and maintenance of the WRF and the reuse distribution system. Finally, water rights and the ability to reuse the effluent for the proposed snowmaking were evaluated by reviewing pertinent water case law and precedents set by Arizona municipalities.

Anticipated volumes of reclaimed water required for proposed snowmaking operations during dry, average, and wet climatic conditions were generated by Sno.Matic Controls and Engineering, Inc.[192] As detailed in the Soils and Geology section of this chapter, Resource Engineering, Inc.,[193] provided analyses for the following parameters for dry, average, and wet climatic conditions in the study area: precipitation; water loss to evaporation, transpiration, and sublimation; and the resulting water available for groundwater recharge or surface water runoff.[194]

Potential direct and indirect effects of proposed snowmaking were analyzed by the following means:

1. compiling and reviewing previous investigations that characterized the regional and local hydrogeologic and climatic conditions and watersheds in the San Francisco Mountain region

2. defining the sub-watersheds that comprise the study area, based on hydrogeologic conditions and modeling

3. compiling and analyzing data and reports for wells and springs in the study area

4. identifying downgradient users of groundwater or spring water

5. conducting a field reconnaissance of the study area

[191] Errol L. Montgomery & Associates, Inc., 2003
[192] Sno.Matic Controls and Engineering, Inc., 2003
[193] REI conducted the Soils and Geology analysis contained in Section I.
[194] Resource Engineering, Inc., 2003

6. evaluating the volumes of groundwater recharge available in the watersheds from natural precipitation and proposed snowmaking operations

7. calculating relative dilution of the applied effluent in groundwater recharge for varying climatic conditions

EXISTING CONDITIONS

HYDROGEOLOGIC SETTING

The Snowbowl is located on San Francisco Mountain in the Plateau Uplands Hydrogeologic Province of Arizona, a high desert plateau region where landforms are dominated by deeply incised canyons, high isolated mesas and buttes, and volcanic peaks.[195] The regional aquifers are relatively deep (generally more than 1,000 feet) and occur in sandstone and limestone units that are generally flat-lying. Groundwater movement in these aquifers occurs chiefly via fracture zones. The land surface over much of the San Francisco Mountain region consists of permeable volcanic deposits and fractured limestone, which provide for rapid infiltration of precipitation and results in meager surface water runoff.[196]

Although this region is often described as a "water-short area", groundwater is, in fact, truly abundant. However, depth to the most favorable aquifers is great, resulting in high costs for groundwater exploration and development programs. These high costs and lack of understanding of the groundwater systems, particularly for geologic conditions that control locations of prolific groundwater-yielding zones in the aquifers, have prevented more extensive development.[197]

Most of the annual precipitation in Arizona occurs in late summer and mid-winter. Although the late summer monsoons provide intense rainstorms, these storms are of relatively short duration and are believed to provide limited groundwater recharge due to high rates of evapotranspiration during the summer. It is the longer duration winter rains, snowfall, and subsequent snowmelt, which provide most of the groundwater recharge to the aquifers in the Flagstaff region. On a long-term average basis, approximately 70 percent of the precipitation on San Francisco Mountain is winter snowfall from Pacific Ocean storm systems, and 30 percent is from annual monsoon storm systems originating in the southern Pacific Ocean and the Gulf of Mexico.[198] Groundwater level measurements reported for wells in the interior valley of San Francisco Mountain suggest that recharge occurs chiefly from winter precipitation.[199] Extensive research conducted in both the Fern Mountain Botanical Area of the Coconino National Forest and the Homestead at Hart Prairie of The Nature Conservancy by NAU students and faculty, including Dr. Abe Springer[200] confirm that most groundwater recharge occurs during the spring snowmelt and that both discharge from springs and shallow groundwater levels in Hart Prairie progressively decline each summer as the effects of the snowmelt diminish. The NAU data, which are for the part of the Hart Prairie watershed that drains surface water to the Verde River

[195] Cooley, 1963; Montgomery & Harshbarger, 1989
[196] Montgomery & Harshbarger, 1989
[197] Montgomery et al., 2000
[198] Jones, 1993
[199] Higgins, 1998
[200] Gavin, 1988; Amentt, 2002; and DeWald et al., 2004

basin, demonstrate the effects of the prolonged ongoing drought on the decline of these shallow water resources.

Losses of rainfall and snow to evapotranspiration and sublimation are high in the region. Work conducted by Northern Arizona University[201] has provided new insight to the magnitude of evapo-sublimation losses on the San Francisco Plateau. The results of this work are incorporated into the estimates for groundwater recharge used in this report. The climate for the Hart Prairie watershed and San Francisco Mountain region, together with citations of sublimation studies, is detailed in the Soils and Geology analysis of this chapter prepared by Resource Engineering Inc.,[202] which conducted watershed modeling for the EIS to provide projections of volumes of water available for groundwater recharge from precipitation and proposed snowmaking at the Arizona Snowbowl Ski Area. Model projections generated by Resource Engineering, Inc. are an important basis for analyses given herein of potential impacts from the EIS Alternatives..

San Francisco Mountain is a predominantly andesitic composite volcano; the existing individual peaks are erosional remnants of the composite volcano.[203] The eruptions of the central volcano and peripheral vents resulted in complex interfingering and interlayering of various types of volcanic deposits. As a consequence, these deposits are highly heterogeneous both vertically and laterally, and comprise a complex system exhibiting a wide range of fracture development and permeability. The Snowbowl is located in a prominent valley on the western slopes of San Francisco Mountain. The hydrogeologic features of the Snowbowl watershed and downgradient Hart Prairie watershed control, to a large extent, the movement and fate of snowmelt, stormwater runoff, groundwater recharge, and groundwater in the underlying perched aquifers and the regional aquifer system. Figure 3H-2 is a conceptual diagram showing hydrogeologic features in the Hart Prairie watershed.

The uppermost hydrogeologic unit underlying Hart Prairie consists chiefly of unconsolidated, coarse-grained, unsorted debris-avalanche deposits, lahars, and colluvium, which form a broad debris fan down slope from Snowbowl Canyon.[204] These surficial deposits include rocks of the Sinagua Formation as named by Updike and Péwé.[205] The extent and compositional variations of the Sinagua Formation indicate that it was deposited primarily by viscous volcanic mud flows, autoclastic breccia flows, alpine debris flows, and alluvial fans.[206]

[201] Avery et. al, 1993
[202] Resource Engineering, 2003 (as amended)
[203] Holm, 1986
[204] Holm, 1988
[205] Updike and Péwé, 1970
[206] Updike and Péwé, 1974

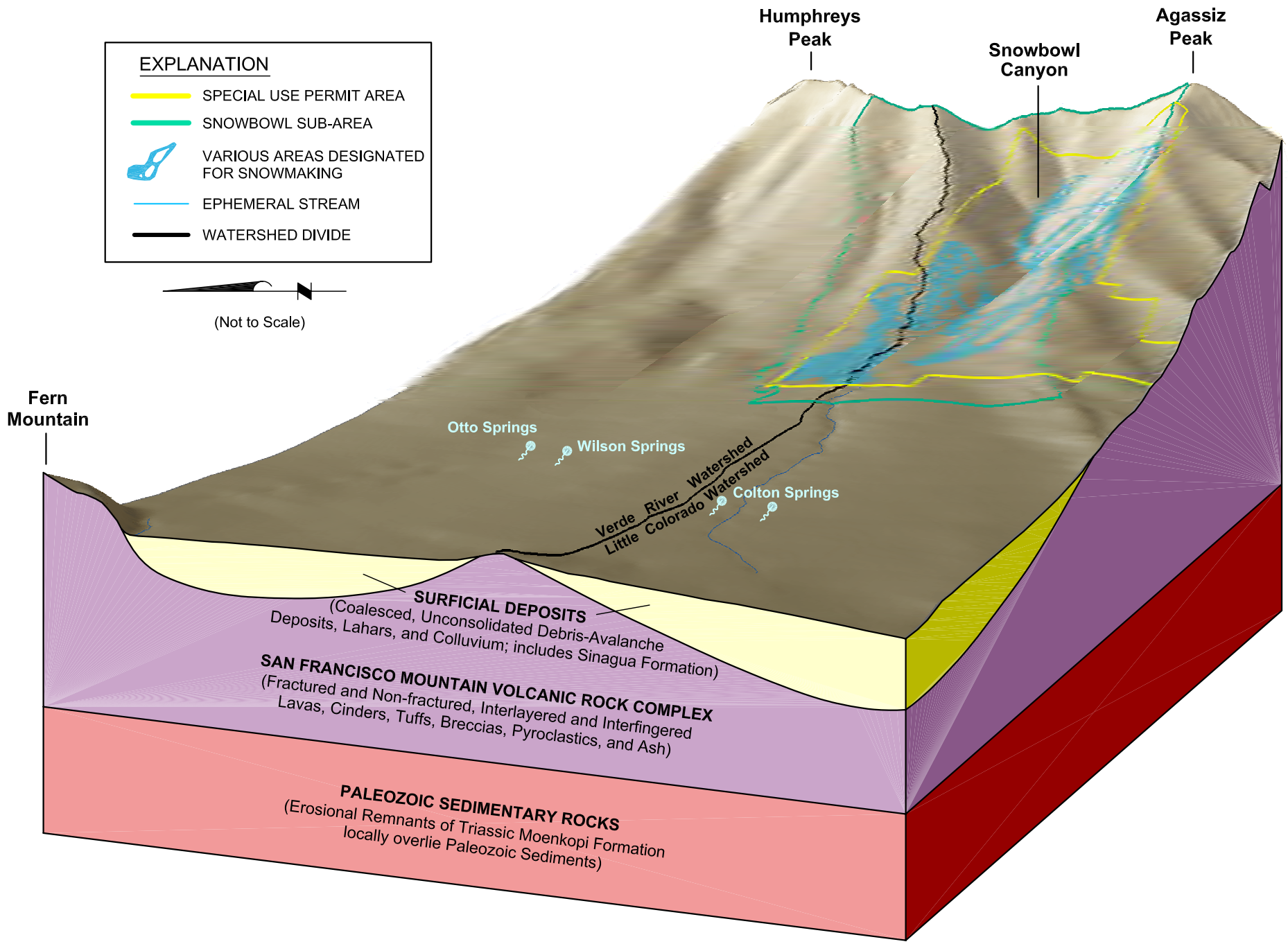

FIGURE 3H-2. CONCEPTUAL BLOCK DIAGRAM FOR HART PRAIRIE WATERSHED

1148.01\3-d block diagram\18Oct2004

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The volcanic cinders and debris, fractured lavas and breccias, pyroclastic rocks, and colluvial materials at land surface in the Hart Prairie watershed enhance rapid infiltration and downward percolation of snowmelt and surface water runoff. The permeability and storage capacity of the underlying sediments are sufficiently high to absorb available snowmelt.[207] Groundwater moves vertically downward into laterally discontinuous perched groundwater zones in the surficial deposits and underlying volcanic rocks (refer to Figure 3H-2). Due to the complex interfingering and interlayering of the debris flows of the surficial deposits and the various types of volcanic deposits, the pattern of groundwater movement in the perched aquifers is complex.

The most important hydrogeologic units in the Hart Prairie watershed are the surficial deposits, which include the Sinagua Formation, and the adjacent and underlying volcanic rocks. Thickness of the surficial deposits is about 200 to 250 feet, where penetrated by wells in Hart Prairie.[208] The surficial deposits contain zones of silt and clay that retard, but do not stop, downward movement of groundwater and support transitory perched groundwater zones during rainy seasons and spring snowmelt. The perched zones occur at different depths in the surficial deposits, and are thin and laterally discontinuous. Springs and seeps occur where groundwater perched on these silt and clay zones intersects the land surface, and flow rate is strongly dependent on seasonal precipitation.[209] After snowmelt, perched groundwater in the base of the surficial deposits slowly percolates to deeper perched zones in the volcanics or to the regional aquifer, and the perched water table declines steadily until the surficial deposits are drained or until another recharge event occurs.[210]

Due to the complex coalescing of the surficial deposits and the interfingering and interlayering of various types of underlying volcanic deposits, it is believed that:

- the patterns of groundwater movement in the perched aquifers are complex;
- the divides for groundwater movement in these perched systems do not necessarily coincide with the topographic divides for surface water flow; and
- the divides for groundwater movement are complex and likely change in response to annual variations in the amount and distribution of snowmelt in the Hart Prairie watershed.

Due to the complex movement of groundwater through the surficial deposits and underlying volcanic deposits in this area, it is not presently possible to precisely project where snowmelt infiltrated from upslope areas flows in the downgradient Hart Prairie watershed. The analyses of hydrogeologic units and groundwater levels suggest that much of the upslope snowmelt infiltrates downward below the surficial level of the springs and seeps that are found more than 3,500 feet downgradient from the Hart Prairie base area (refer to Figure 3H-1). In addition, available data regarding the rates and variability of discharge to springs from shallow groundwater zones in the Hart Prairie area indicate that recharge within relatively small catchments proximal to the springs could be the primary sources for the springs.

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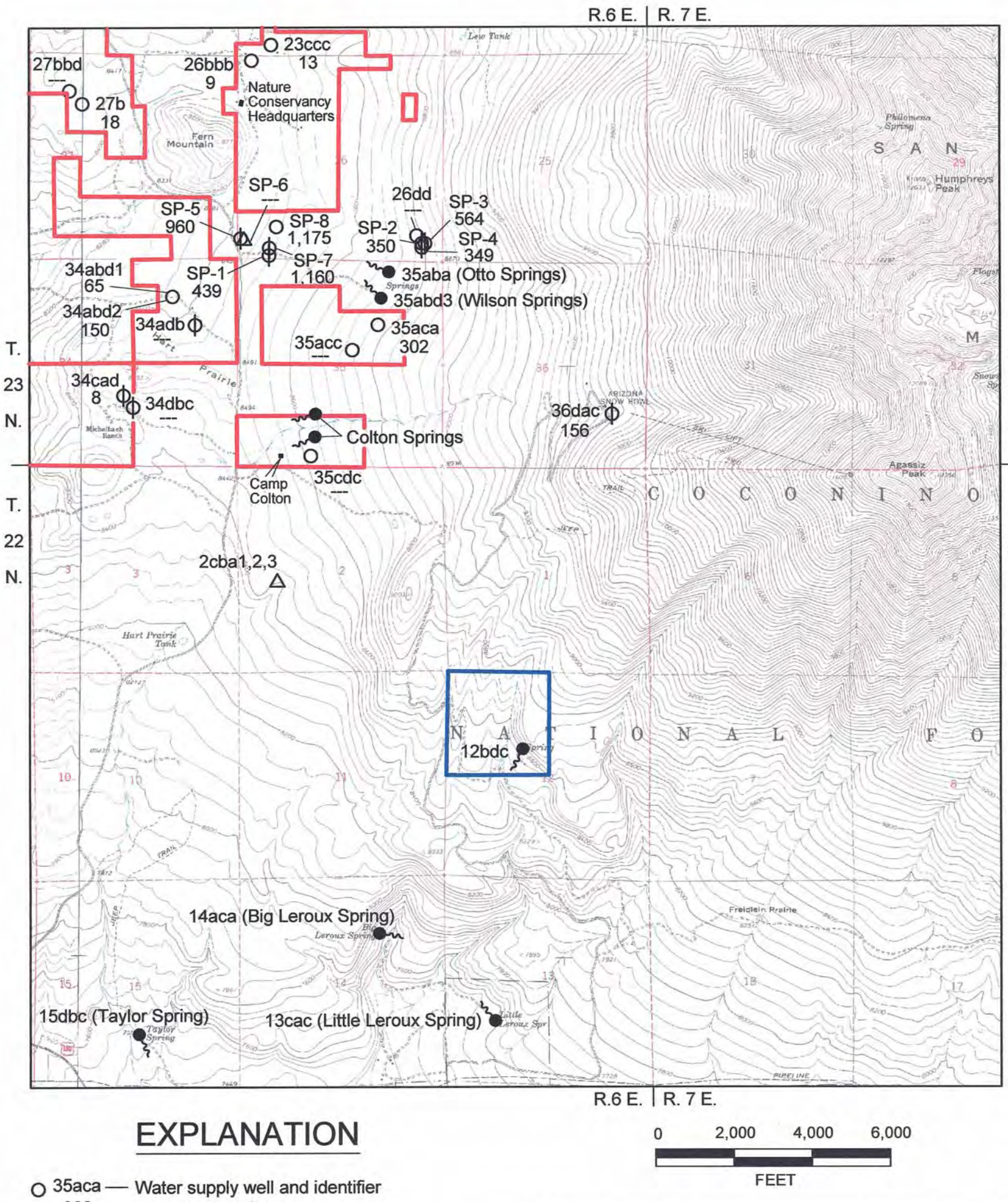
[207] Halfpenny, 1971; W.S. Gookin & Associates, 1974
[208] Halfpenny, 1972
[209] Harshbarger, 1972
[210] Halfpenny, 1971

An inventory of records available for wells and springs in the Hart Prairie watershed area is contained in the technical report from which this analysis is excerpted. Locations for these wells and springs are shown on figures 3H-1 and 3H-3. The location of private and state land is depicted on Figure 3H-3. Records are available for 43 wells and eight springs in the approximate 25-square-mile area. Seventeen of these wells are not shown because they are shallow monitoring or exploration wells installed to depths of four feet or less for purposes of research associated with the Fern Mountain Botanical Area of the Coconino National Forest and the Homestead at Hart Prairie of The Nature Conservancy.[211] Although important data have been obtained from these 17 shallow wells for purposes of the Bebb willow community, these wells do not provide information for the deeper perched groundwater systems in the Hart Prairie watershed and, therefore, are not discussed in detail here or shown on the figure. Of the 26 wells shown, nine wells are reported to be used for domestic purposes, one well is used for both domestic and livestock purposes, 11 wells are unused or abandoned, and three wells piezometer/monitor wells. The type of use is not reported for two of the wells shown. Detailed drilling data, such as depth drilled and a log of the sediments penetrated, is not available for many of the wells.

Eight spring areas are depicted on Figure 3H-3. All these springs are important for supporting local wildlife and plant communities; the following information concerns reported use by humans. Otto, Wilson, and Colton springs are located in the Hart Prairie watershed (figures 3H-1 and 3H-3). Wilson and Colton springs are used for domestic water supply. The unnamed spring on state land, Big Leroux, Little Leroux, and Taylor spring are located in the larger Rio de Flag watershed and are all owned by the Forest Service. Big and Little Leroux springs are reported to be used for domestic and fire control purposes. The unnamed spring and Taylor Spring are reported to be unused by humans.

[211] Gavin, 1988; Amentt, 2002; and DeWald et al., 2004



R.6 E. | R. 7 E.

0 2,000 4,000 6,000

FEET

EXPLANATION

○ 35aca — Water supply well and identifier
302 — Well depth, in feet
--- indicates well reported by ADWR, but no data exists for well

ϕ Unused or abandoned well

△ Test or monitor well

Spring

Private property

State property

UNITED STATES FOREST SERVICE
COCONINO NATIONAL FOREST
PEAKS RANGER DISTRICT

WELL AND SPRING LOCATION MAP

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CONSULTANTS IN HYDROGEOLOGY
TUCSON, ARIZONA

FIGURE 3H-3

1148.01\welloc-revised FIG no.\15Oct2003 Flagstaff West CD UTM-NAD27

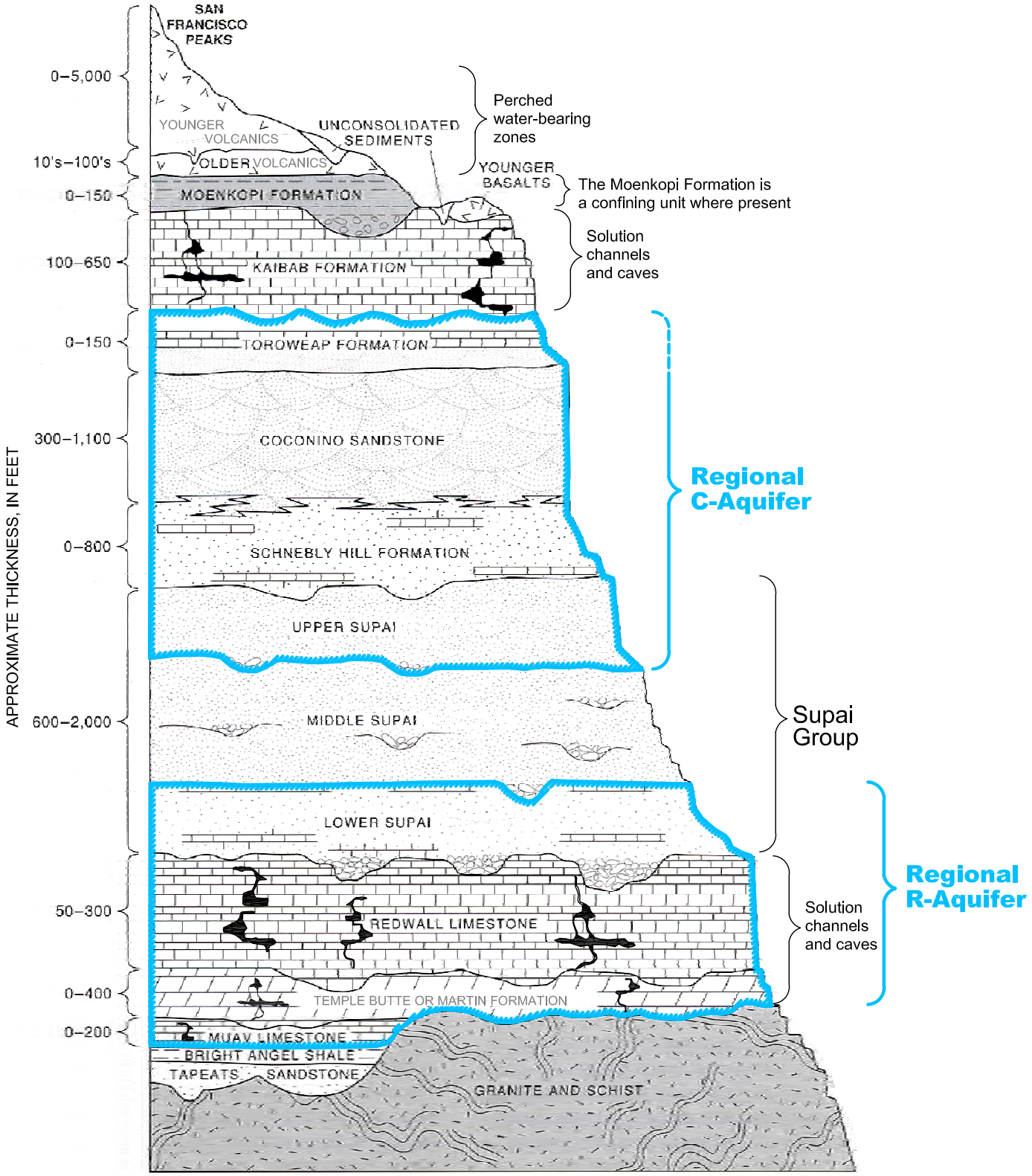
Chemical quality of groundwater in the study area has been characterized by analysis of water samples obtained from: Wilson Springs; the unnamed spring on state land; the Camp Colton water system; wells SP-1, SP-4, SP-7, and SP-8, which were drilled in the north half of Hart Prairie to depths ranging from 349 to 1,175 feet; and two shallow wells that were drilled to depths of nine and 13 feet north from the Homestead at Hart Prairie of The Nature Conservancy. Results of available laboratory chemical analyses for inorganic chemical constituents indicate that water quality is somewhat variable across the different sources, but is generally "very good" and meets all Federal primary and secondary drinking water standards. Concentrations of dissolved solids are generally somewhat larger for the deeper wells than for the springs and shallower wells, suggesting more significant geochemical interaction associated with deeper percolation and longer residence time of recharge water reaching the deeper wells. Water quality concerns are limited to potential impacts to perched aquifers from leaching of untreated wastewater from septic systems in the Hart Prairie area. Based on laboratory chemical analyses, water type for the shallow perched groundwater system in Hart Prairie is predominantly calcium bicarbonate.

Regional Hydrogeologic Units

Detailed descriptions of the individual rock formations and aquifers in the San Francisco and Coconino plateaus region are provided elsewhere,[212] and are therefore not repeated in this analysis, which focuses on local conditions in the Hart Prairie watershed. In the Flagstaff region, the most important geologic strata that control groundwater movement and storage, in descending order, are: unconsolidated sediments (alluvium, colluvium, and volcanic debris); volcanic rocks; Moenkopi Formation; Kaibab Formation; Toroweap Formation; Coconino Sandstone; Hermit Shale; Schnebly Hill Formation; Supai Group; Redwall Limestone and Muav Limestone; Bright Angel Shale; and Tapeats Sandstone.[213] A generalized stratigraphic column for geologic units in the Flagstaff region is shown on Figure 3H-4.

[212] Harshbarger & Associates and John Carollo Engineers, 1972-1974; Harshbarger & Associates, 1976; Montgomery & DeWitt, 1974-75 and 1982; Errol L. Montgomery & Associates, Inc., 1985, 1992-93, 1996, and 1998; Montgomery et al., 2000; and Bills et al., 2000

[213] Montgomery et al., 2000



Modified from Billingsley and others (1980) and Bills and others (2000)

FIGURE 3H-4. GENERALIZED STRATIGRAPHIC COLUMN, FLAGSTAFF REGION, ARIZONA

1148.01\general stratigraphic section\18Oct2004

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The most important aquifer systems for the Coconino and San Francisco plateaus are the C-aquifer system and the R-aquifer system. Both are described as regional aquifer systems; however, the R-aquifer system is by far the most important for groundwater transmission and storage, and is truly regional. Perched aquifers also occur at places above the C- and R-aquifers and contain and transmit small amounts of groundwater. These perched aquifers are thin and discontinuous[214] and commonly depend on annual recharge to sustain yield to wells and springs.

The C-aquifer includes the Coconino Sandstone and adjacent water-bearing strata including at some places in the sub-basins, the Toroweap Formation, Kaibab Formation, Schnebly Hill Formation, and the upper part of the Supai Group. The R-aquifer includes the carbonate rocks of the Redwall Limestone and adjacent water-bearing strata, such as the Muav Limestone and Martin or Temple Butte Formation, and in some cases the brittle rocks in the lower part of the Supai Group (refer to Figure 3H-4).

Regional Groundwater Circulation and Storage

Groundwater beneath the Coconino and San Francisco plateaus originates as recharge from infiltration of rainfall and snowmelt. Because the use of groundwater on these plateaus is as yet relatively small, long-term average annual recharge may be assumed to be approximately equal to the long-term average annual groundwater discharge of more than 260,000 acre-feet per year (AF/yr) from major regional aquifer springs along the margins of the plateaus.[215] This rate of recharge is in the magnitude of four percent of total average annual precipitation on the plateaus. A reasonable estimate for groundwater storage may be in the magnitude of five million AF, and is obtained as the product of approximately 10,000 square miles, average saturated thickness of 800 feet, and average specific yield or drainable porosity of 0.1 percent.[216]

The total discharge rate from major regional aquifer springs is relatively stable due to the attenuation of seasonal variations in recharge by the large storage capacity and areal extent of the regional aquifer. Therefore, the estimate of long-term average annual recharge is reasonable, even though short-term trends in recharge may vary substantially from this long-term average. Long-term climatic changes may eventually affect the amount of groundwater in storage and the base flow from the major springs; however, assessment of the potential for this effect is beyond the scope of this EIS. As for any estimates of regional aquifer recharge and groundwater storage, there is inherent uncertainty due to limitations in our ability to measure these parameters. However, the amount of groundwater discharge from the major regional aquifer springs is based on flow measurements and represents an unusual level of certainty for a parameter that is rarely known to such a degree on a regional scale.

In the Flagstaff area, downward-moving recharge water ultimately passes all upper perching horizons and reaches the C-aquifer, where large amounts of groundwater storage occur over limited areas. In the Flagstaff Woody Mountain and Lake Mary wellfield areas, located along the Oak Creek and Anderson Mesa Faults, respectively, all rock units from the C-aquifer downward are saturated.[217] Groundwater in the saturated zone of the C-aquifer moves laterally

[214] Montgomery et al., 2000
[215] Id.
[216] Id.
[217] Id.

and downward, very slowly in areas of non-fractured rock, and less slowly in areas where abundant fractures occur. Rapid water level rise has been measured in C-aquifer wells located near sinkholes and fracture systems during or soon after large surface water runoff events, such as Navajo Army Depot well NAD-1[218] and near the Bottomless Pits.[219] At distances of a few miles to a few tens of miles from the Lake Mary and Woody Mountain wellfield areas, saturated thickness in the C-aquifer diminishes to zero or near zero due to full drainage of the groundwater downward to the R-aquifer system. After groundwater passes downward to the R-aquifer, it provides groundwater storage in the regional system, and moves slowly toward the Colorado and Verde river drains, chiefly along arterial fractured rock aquifer zones related to regional geological structures.[220]

Discharge from the Regional Aquifers

The amount of groundwater that moves through the C- and R-aquifers can be estimated by summing the flow from large springs that occur on the margins of the plateaus, where groundwater discharges to tributaries of the Colorado and Verde rivers. A long-term average annual volume of more than 260,000 AF of groundwater discharges from the margins of the Coconino and San Francisco plateaus each year.[221] Of this amount, about two-thirds discharges to the Colorado River from the R-aquifer system at Blue Springs and Havasu Springs. About one-third of the natural groundwater discharge is to the Verde River, and occurs from both the C- and R-aquifers.[222] Other smaller springs, including Garden and Hermit Springs, and small perched aquifer springs and seeps, discharge groundwater to the Colorado River from the plateaus, but are not important for present purposes of summing total amount of groundwater discharge from the plateaus. Although the amount of groundwater that issues from these springs is small, the springs have environmental importance. Additional groundwater discharges from the plateaus to the Colorado River at locations where rocks of the R-aquifer crop out at river level. These outcrop areas are chiefly near the confluence of Havasu Creek with the Colorado River, but also occur in the lower reaches of Marble Canyon above the confluence of the Little Colorado River with the main stem of the Colorado River. These amounts of groundwater discharge are unknown.[223]

Total groundwater discharge to the Verde River from the Coconino and San Francisco plateaus is estimated at 95,000 AF/yr.[224] Of this amount, roughly 10,000 AF/yr issues from the C-aquifer and about 85,000 AF/yr issues from the R-aquifer. Groundwater discharge from the R-aquifer system to the upper reaches of the Verde River, in the vicinity of Summer's Spring, located in the Sycamore Canyon drainage, is about 45,000 AF/yr. This groundwater is derived from the southern part of the Coconino Plateau.[225] About 10,000 AF/yr of groundwater discharge from the C-aquifer occurs from Sterling Spring, in the upper reaches of Oak Creek, and from gains in base flow of the creek to roughly the location of Indian Garden. About 40,000 AF/yr issues from

[218] Wilkerson, 2000
[219] Bills, 2004
[220] Montgomery et al., 2000
[221] Id.
[222] Id.
[223] Id.
[224] Id.
[225] Id.

the R-aquifer system to the lower part of Oak Creek below Sedona; much of this discharge occurs at Page Spring. This groundwater originates on the southern part of the San Francisco Plateau.[226] Groundwater movement in the Oak Creek Canyon area is strongly influenced by fractured rock zones along the Oak Creek fault system and related faults in the Sedona area.

City of Flagstaff Groundwater Use

The Flagstaff municipal water supply system obtains groundwater from three principal wellfields and surface water from Upper Lake Mary – a man-made reservoir.[227] In drier periods when surface water is less abundant, Flagstaff relies heavily on groundwater from municipal wellfields. In 2002, only roughly 196 AF, or about two percent, of water used was obtained from Upper Lake Mary, and roughly 8,573 AF, or 98 percent, was groundwater pumped from municipal wellfields.[228] From 1993 to 2002), about 75 percent of the water used by Flagstaff has been groundwater. During years of drought, such as 1989, 1990, and 2002, Upper Lake Mary may be nearly dry, and a much larger fraction of water used is obtained from groundwater.

The earliest Flagstaff municipal water supply was from springs located in the Inner Basin of the San Francisco Peaks. The pipeline from the springs to Flagstaff was completed in 1899.[229] Beginning in 1966, the Inner Basin groundwater supply was further developed by construction of production water wells. Groundwater supply from the Inner Basin is vulnerable to drought; when drought conditions threaten the water supply from Upper Lake Mary, water yield from Inner Basin springs and wells is also diminished.[230] Groundwater in the Inner Basin is stored in a perched aquifer system that lies far above the regional C-aquifer, which is used for Flagstaff's other municipal wellfields. In 2002, about 25 AF of groundwater was obtained from the Inner Basin by the City.[231]

In 1956, Flagstaff began development of a wellfield in the regional C-aquifer near Woody Mountain, which now consists of 10 production water wells. In 2002, a total of about 4,780 AF of groundwater were yielded to the Flagstaff municipal system from these wells.[232] After the Woody Mountain wellfield was established, deep wells were also constructed in the C-aquifer in the Lower Lake Mary area, and these successful wells established the Flagstaff Lake Mary wellfield. In 2002, a total of about 3,335 AF of groundwater were yielded from seven wells in the Lake Mary wellfield.[233]

Recently, additional groundwater supply has been obtained from deep wells in the C-aquifer constructed along the Rio de Flag drainage on the east side of the city. These wells include the Continental-2 well, Fox Glen-1 well, Shop well, and Interchange well. In 2003, a total of about

[226] Id.
[227] Montgomery and DeWitt, 1982
[228] City of Flagstaff, 2003
[229] Montgomery et al., 2000
[230] Montgomery and DeWitt, 1982
[231] City of Flagstaff, 2003
[232] Id.
[233] Id.

544 AF of groundwater were yielded from these wells.[234] The most recent well constructed in this area, the Rio well, is expected to be brought into production in the near future.

Other Groundwater Use

Other wells are completed in the C-aquifer in the Flagstaff area and chiefly supply local water companies and individual developments. Total amount of groundwater use from these other wells is unknown, but is estimated to be small compared to City of Flagstaff use.[235] Although most of the water used on the Coconino and San Francisco plateaus occurs at Flagstaff, substantial amounts have been developed, and are used by Sedona, Williams, Tusayan, and Grand Canyon Village. One of the principals of groundwater hydrology is that, over the short-term, groundwater pumped from wells is obtained solely from groundwater storage in aquifers. Over the long-term, the source of groundwater begins to be accounted for as reduction of natural discharge. For the Coconino and San Francisco plateaus, reduction of natural discharge must be accounted for chiefly by reduction in groundwater discharge to springs along the Colorado and Verde river drains. Total groundwater used on the plateaus, including Sedona, was about 8,000 AF/yr in 2000.[236] This total use represents about three percent or less of discharge to springs along the Colorado and Verde rivers, and about 0.2 percent of estimated groundwater in storage.

An important, but small, supply of groundwater proximate to the study area is obtained from wells completed in thin, discontinuous perched groundwater zones in the alluvium, colluvium, and volcanic rocks above the Moenkopi Formation in Fort Valley. Records for more than 240 wells are reported for Fort Valley,[237] which is located along the Rio de Flag drainage, about three miles south of the study area. These perched groundwater zones occur in permeable sediments on top of silt and clay lenses in the alluvial and colluvial deposits, in permeable cinders and fractured volcanic deposits on top of interflow clay layers or non-fractured lavas in the volcanic rock sequence, and in fractures in the upper part of the Moenkopi Formation. Depth to water in wells has been reported to range from two to 250 feet.[238] Recently, a well was completed in the lower part of the C-aquifer in the Fort Valley area and is reported to yield several tens of gallons per minute for domestic supply.

[234] City of Flagstaff, 2004
[235] Bills et al., 2000
[236] Montgomery et al., 2000
[237] Allen, 1995
[238] Id.

WASTEWATER TREATMENT AND REUSE

Prior to treatment, municipal wastewater contains many chemicals and microorganisms that, if released to the environment untreated, could cause adverse ecological effects, or may present known or potential health risks to humans, if ingested.[239] Concentrations of constituents potentially harmful to public health or the environment are required to be reduced or eliminated prior to reuse. The amount of required reduction or removal depends on the planned reuse.

The U.S. Environmental Protection Agency (EPA) regulates most aspects of wastewater treatment and treatment plant discharges under the Clean Water Act (CWA). The CWA requires all discharges to waters of the United States to obtain a National Pollutant Discharge Elimination System (NPDES) Permit. Although the intent of the CWA and NPDES Permit program is to regulate discharges to surface water, the program provides a broad framework of command and control for municipal wastewater treatment so as to reduce or eliminate concentrations of constituents potentially harmful to public health or the environment. In particular, the NPDES Permit requires pretreatment to control the discharge of industrial pollutants to sewers and mandates that the discharge comply with specified technology-based effluent limitations and monitoring and reporting requirements. The CWA also compels federal and state governments to promulgate specific water quality standards to protect the physical, chemical, and biological integrity of the state's surface water for designated use categories that include: drinking water source (DWS); fish consumption (FC); full-body contact (FBC); partial-body contact (PBC); and aquatic and wildlife (A&W).

In practice, States have typically adopted wastewater discharge regulations similar to the Federal NPDES program. Although the EPA delegates authority to the States for the regulation of NPDES discharge permits, few States have developed enforceable programs and criteria to specifically regulate water reuse. Among the States that have developed programs, California, Florida, and Arizona are at the forefront.[240] Arizona wastewater reuse regulations are discussed in subsequent sections of this chapter.

Wastewater Treatment

Municipal wastewater treatment is a multi-stage process intended to remove or reduce organic matter, solids, nutrients, and disease-causing organisms that are present in raw wastewater generated from community residences, businesses, and industries. Typical untreated municipal wastewater is comprised of 99.94 percent water and 0.06 percent dissolved and suspended material.[241]

Conventional wastewater treatment begins with preliminary screening to remove debris and large solid material present in the waste stream that could damage or clog pumps, valves, piping, and other equipment. Mechanical bar screens, comminutors (grinding equipment analogous to large-scale kitchen sink garbage disposals), and grit chambers are used to separate solid debris from wastewater. The collected debris is commonly disposed of in a landfill. The screened wastewater is then put through primary treatment.

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[239] National Research Council, 1982
[240] National Research Council, 2003
[241] Water Pollution Control Federation, 1989

Primary treatment separates suspended solids in a clarification tank or sedimentation basin. Primary treatment removes slightly more than one-half of the suspended solids and one-third of the biochemical oxygen demand (BOD)[242] from decomposable organic matter. It also removes some nutrients, pathogens, trace elements, and potentially toxic compounds.[243] Solids are drawn off the bottom and skimmed off the top of the tank or basin, where they receive further treatment as sludge. The clarified wastewater flows to the next stage of treatment.

Secondary treatment is a biological process designed to remove dissolved organic matter from wastewater. Typically, microorganisms are cultivated and added in suspension (in the "activated sludge" process) or attached to media (in the "trickling filter" process) to remove biodegradable organic material. Secondary treatment processes can remove up to 95 percent of the remaining BOD and suspended solids, as well as significant amounts of heavy metals and dissolved organic compounds.[244]

Final treatment focuses on removal of disease-causing organisms in wastewater. Treated wastewater can be disinfected by adding oxidants, such as chlorine, by ultraviolet light radiation, or by ozonation.

Further treatment of wastewater by various advanced treatment processes is necessary in some systems to meet more stringent discharge or reuse requirements or to address particular water quality concerns associated with the source water. Advanced treatment may include biological methods, ion exchange, chemical precipitation, filtration, reverse osmosis, air stripping, carbon adsorption, electrodialysis, and other variations of these treatment processes for additional removal of suspended solids, nutrients, dissolved inorganic compounds, dissolved organic compounds, and microorganisms.[245] An overview of the Rio de Flag Water Reclamation Facility treatment process is given in a subsequent section of this chapter.

Wastewater Constituents

Chemical Constituents

Wastewater contains a combination of chemical constituents from a wide variety of natural or anthropogenic sources. The types and amounts of these constituents vary depending on: the source of the municipal water; the types of industrial, commercial, and household wastes discharged to the treatment plant; and the effectiveness of industrial pretreatment and source control programs. Municipal water use generally leads to an increase in mineral and organic content relative to the original water quality.[246] The increase in concentration of dissolved solids and organics by municipal use has an important influence on the degree to which the water can be reclaimed for reuse.

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[242] A measure of the pollution present in water, obtained by measuring the amount of oxygen absorbed from the water by the microorganisms present within it.
[243] National Research Council, 2003
[244] Water Pollution Control Federation, 1989
[245] Asano, 1998
[246] Snoeyink and Jenkins, 1980

Although many studies have investigated the toxicology of specific chemical constituents that may be present in wastewater, limited data is available to assess potential public health effects from concentrations and combinations of chemical constituents that occur in wastewater. Several detailed studies have examined potential human health hazards associated with drinking reclaimed water at Windhoek, South Africa, the only city in the world that has implemented direct potable reuse, and in Denver, Colorado, where direct reuse was rigorously assessed, but not adopted. Those studies suggested that no adverse health effects should be anticipated from the direct reuse of reclaimed water for drinking water purposes at these sites.[247] Two major studies have evaluated the health effects associated with ingestion of groundwater that has commingled with effluent in the subsurface as a result of wastewater recharge operations in California's Orange and Los Angeles counties. In these counties, recharge of secondary wastewater effluent had occurred for more than 30 years, resulting in populations being exposed to as much as 38 percent effluent in their drinking water supplies.[248] Results of the comprehensive epidemiologic evaluation concluded there were no adverse health effects in populations exposed to the effluent compared to unexposed populations in the area.[249]

The City of Flagstaff has conducted extensive monitoring of wastewater constituents in reclaimed water from the Rio de Flag WRF. Monitoring, as is discussed in subsequent sections of this chapter, is required to maintain compliance with three water permits. In addition, the City has undertaken further water quality analyses to compare the reclaimed water to Arizona surface water quality standards (SWQS) and national drinking water standards.[250]

A summary of all monitoring data compiled from approximately January 2000 to June 2002 for regulated parameters subject to SWQS is provided in Table 3H-1. The results in this table are color coded. Those data in blue have sufficiently low analytical detection levels to demonstrate that the effluent meets the standard. The data presented in green show that the contaminant was not detected, but the detection level was above at least one of the numerical standards for a designated use. It should be noted that ADEQ considers a result of non-detect as meeting the standard, when obtained using an appropriate licensed analytical procedure. Tables 3H-2a and 3H-2b present the results of monitoring data compiled from January 2000 to June 2002 for a variety of regulated parameters for which numeric criteria have been developed as drinking water standards. These tables list the concentrations of these substances in reclaimed water from the Rio de Flag WRF in comparison to primary and secondary drinking water standards.

[247] National Resource Council, 2003
[248] Karimi et al., 1998
[249] Nellor et al., 1984; Sloss et al., 1996 and 1999
[250] Aquatic Consulting and Testing, Inc., 2002

Table 3H-1
Rio de Flag State of Arizona Numeric Water Quality Criteria (µg/L)

	Rio de Flag WRP							A & Wc		A & Ww		A & Wedw		A & We	
Parameter	(µg/L)	DWS	FC	FBC	PBC	AgI	AgL	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
Acenapthene	<5	420	2,670	84,000	84,000	NNS	NNS	850	550	850	550	850	550	NNS	NNS
Acenaphthylene	<5	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Acrolein	<50	3.5	25	700	700	NNS	NNS	34	30	34	30	34	30	NNS	NNS
Acrylonitrile	<50	0.07	0.7	3	56,000	NNS	NNS	3,800	250	3,800	250	3,800	250	NNS	NNS
Alachlor	< 0.1	2	NNS	14,000	14,000	NNS	NNS	2,500	170	2,500	170	2,500	170	NNS	NNS
Aldrin	<0.02 to < 0.1	0.002	0.0001	0.08	42	c	c	2.0	NNS	2.0	NNS	2.0	NNS	4.5	NNS
Ammonia-N	<50	NNS	NNS	NNS	NNS	NNS	NNS	b	b	b	b	NNS	NNS	NNS	NNS
Anthracene	<5	2,100	1,000	420,000	420,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Antimony (as Sb)	<1 to < 2 T	6 T	4,300 T	560 T	560 T	NNS	NNS	88 D	30 D	88 D	30 D	1,000 D	600 D	NNS	NNS
Arsenic (as As)	4.5 to 6 T	50 T	1,450 T	50 T	50 T	2,000 T	200 T	360 D	190 D	360 D	190 D	360 D	190 D	440 D	230 D
Asbestos	< 0.2 MFL	7 MFL	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Atrazine	< 0.1	3	NNS	49,000	49,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Barium (as Ba)	240 to 300 T	2,000 T	NNS	98,000 T	98,000 T	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Benzene	< 0.5	5	140	93	93	NNS	NNS	2,700	180	2,700	180	8,800	560	NNS	NNS
Benzidine	<50	0.0002	0.001	0.01	4,200	0.01	0.01	1,300	89	1,300	89	1,300	89	10,000	640
Benzo (a) anthracene	<5	0.048	0.49	1.9	1.9	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Benzo (a) pyrene	< 0.02 to <5	0.2	0.05	0.2	0.2	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Benzo (ghi) perylene	<10	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Benzo (k) fluoranthene	<5	0.048	0.49	1.9	1.9	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
3,4-Benzofluoranthene	<5	0.048	0.49	1.9	1.9	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Beryllium (as Be)	< 1 to <2 T	4 T	1,130 T	2,800 T	2,800 T	NNS	NNS	65 D	5.3 D	65 D	5.3 D	65 D	5.3 D	NNS	NNS
Bis (2-chloroethoxy) methane	<10	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Bis (2-chloroethyl) ether	<10	0.03	1.4	1.3	1.3	NNS	NNS	120,000	6,700	120,000	6,700	120,000	6,700	NNS	NNS
Bis (2-chloroisopropyl) ether	<10	280	174,400	56,000	56,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Boron (as B)	250	630	NNS	126,000 T	126,000 T	1000 T	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Bromodichloromethane	<0.5	TTHM	46	TTHM	28,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
p-Bromodiphenyl ether	<5	NNS	NNS	NNS	NNS	NNS	NNS	180	14	180	14	180	14	NNS	NNS
Bromoform	< 0.5	TTHM	360	180	28,000	NNS	NNS	15,000	10,000	15,000	10,000	15,000	10,000	NNS	NNS
Bromomethane	< 0.5	9.8	4,020	2,000	2,000	NNS	NNS	5,500	360	5,500	360	5,500	360	NNS	NNS
Butyl benzyl phthalate	<5	1,400	5,200	280,000	280,000	NNS	NNS	1,700	130	1,700	130	1,700	130	NNS	NNS
Cadmium (as Cd) *	<0.5 to <2 T	5 T	84 T	700 T	700 T	50 T	50 T	6.8	3.1	6.8	3.1	6.8	3.1	103.1	NNS

Table 3H-1
Rio de Flag State of Arizona Numeric Water Quality Criteria (µg/L)

	Rio de Flag WRP							A & Wc		A & Ww		A & Wedw		A & We	
Parameter	(µg/L)	DWS	FC	FBC	PBC	AgI	AgL	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
Carbofuran	< 0.9	40	NNS	7,000	7,000	NNS	NNS	650	50	650	50	650	50	NNS	NNS
Carbon tetrachoride	< 0.5	5	4	11	980	NNS	NNS	18,000	1,100	18,000	1,100	18,000	1,100	NNS	NNS
Chlordane	< 0.1 to <0.2	2	0.002	4	700	NNS	NNS	2.4	0.004	2.4	0.21	2.4	0.21	3.2	0.45
Chlorine (total residual)	<50	700	NNS	140,000	140,000	NNS	NNS	11	5	11	5	11	5	NNS	NNS
Chlorobenzene	< 0.5	100	20,900	28,000	28,000	NNS	NNS	3,800	260	3,800	260	3,800	260	NNS	NNS
p-Chloro-m-cresol	<5	NNS	NNS	NNS	NNS	NNS	NNS	15	5	15	5	15	5	48,000	15,000
2-Chloroethyl vinyl ether	<1	NNS	NNS	NNS	NNS	NNS	NNS	180,000	9,800	180,000	9,800	180,000	9,800	NNS	NNS
Chloroform	<0.5 to 1.2	TTHM	470	230	14,000	NNS	NNS	14,000	900	14,000	900	14,000	900	NNS	NNS
Chloromethane	< 0.5	NNS	NNS	NNS	NNS	NNS	NNS	270,000	15,000	270,000	15,000	270,000	15,000	NNS	NNS
Chloronaphthalene beta	<5	560	4,300	112,000	112,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
2-Chlorophenol	<5	35	400	7,000	7,000	NNS	NNS	2,200	150	2,200	150	2,200	150	NNS	NNS
4-Chlorophenyl phenyl ether	<5	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Chromium (as Cr III) *	<1 to < 10 T	10,500 T	1,010,000 T	2,100,000 T	2,100,000 T	NNS	NNS	811	106	811	106	811	106	2,723	NNS
Chromium (as Cr IV)	<1 to <10 T	21 T	2000 T	4200 T	4200 T	NNS	NNS	16 D	11 D	16 D	11 D	16 D	11 D	34 D	23 D
Chromium (as Cr)	<1 to < 10 T	100 T	NNS	100 T	100 T	1,000 T	1,000 T	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Chrysene	<5	0.479	4.92	19.2	19	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Copper (as Cu) *	7.8 to 11 T	1300 T	NNS	1,300 T	1,300 T	5,000 T	500 T	20	13	20	13	20	13	24	NNS
Cyanide	< 10 T	200 T	215,000 T	28,000 T	28,000 T	NNS	200 T	22 T	5.2 T	41 T	9.7 T	41 T	9.7 T	84 T	19 T
Dibenz(ah)anthracene	<10	0.048	0.20	1.9	1.9	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Dibromochloromethane	<0.5	TTHM	34	TTHM	28,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
1,2-Dibromo-3-chloropropane (DBCP)	< 0.01	0.2	NNS	2,800	2,800	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
1,2-Dibromoethane (EDB)	< 0.01	0.05	NNS	0	0	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Dibutyl phthalate	<10	700	12,100	140,000	140,000	NNS	NNS	470	35	470	35	470	35	1,100	84
1,2-Dichlorobenzene	< 0.5 to <5	600	2,800	126,000	126,000	NNS	NNS	790	300	1,200	470	1,200	470	5,900	2,300
1,3-Dichlorobenzene	< 0.5 to <5	NNS	NNS	NNS	NNS	NNS	NNS	2,500	970	2,500	970	2,500	970	NNS	NNS
1,4-Dichlorobenzene	< 0.5 to <5	75	77,500	560,000	560,000	NNS	NNS	560	210	2,000	780	2,000	780	6,500	2,500
3,3'-Dichlorobenzidine	<50	0.08	0.08	3.1	3.1	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS

Table 3H-1
Rio de Flag State of Arizona Numeric Water Quality Criteria (µg/L)

	Rio de Flag WRP							A & Wc		A & Ww		A & Wedw		A & We	
Parameter	(µg/L)	DWS	FC	FBC	PBC	AgI	AgL	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
p,p'-Dichlorodiphenyldichloroethane (DDD)	<0.02	0.15	0.001	5.8	5.8	0.001	0.001	1.1	0.001	1.1	0.02	1.1	0.02	1.1	0.02
p,p'-Dichlorodiphenyldichloroethylene (DDE)	<0.02	0.1	0.001	4.1	4.1	0.001	0.001	1.1	0.001	1.1	0.02	1.1	0.02	1.1	0.03
p,p'-Dichlorodiphenyltrichloroethane (DDT)	<0.02	0.1	0.0006	4.1	700	0.001	0.001	1.1	0.001	1.1	0.001	1.1	0.001	1.1	0.006
1,1-Dichloroethane	< 0.5	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
1,2-Dichloroethane	< 0.5	5	100	15	280,000	NNS	NNS	59,000	41,000	59,000	41,000	59,000	41,000	NNS	NNS
1,1-Dichloroethylene	< 0.5	7	320	230	12,600	NNS	NNS	15,000	950	15,000	950	15,000	950	NNS	NNS
cis-1,2-Dichloroethylene	< 0.5	70	NNS	70	70	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
trans-1,2-Dichloroethylene	< 0.5	100	136,000	28,000	28,000	NNS	NNS	68,000	3,900	68,000	3,900	68,000	3,900	NNS	NNS
Dichloromethane	< 0.5 to <3	5	1,600	190	84,000	NNS	NNS	97,000	5,500	97,000	5,500	97,000	5,500	NNS	NNS
2,4-Dichlorophenol	<5	21	800	4,200	4,200	NNS	NNS	1,000	88	1,000	88	1,000	88	NNS	NNS
2,4-Dichlorophenoxyacetic acid (2,4-D)	< 0.1	70	NNS	14,000	14,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
1,2-Dichloropropane	< 0.5	5	236,000	126,000	126,000	NNS	NNS	26,000	9,200	26,000	9,200	26,000	9,200	NNS	NNS
1,3-Dichloropropene	<0.5	0.2	6.6	7.8	42	NNS	NNS	3,000	1,100	3,000	1,100	3,000	1,100	NNS	NNS
Dieldrin	<0.02 to < 0.1	0.002	0.0002	0.09	70	0.003	0.003	2.5	0.002	2.5	0.002	2.5	0.005	4	0.9
Diethyl phthalate	<5	5,600	0.0001	0.0001	0.0001	NNS	NNS	26,000	1,600	26,000	1,600	26,000	1,600	NNS	NNS
Di(2-ethylhexyl) phthalate	0.6 to <4	6	7.4	100	28,000	NNS	NNS	400	360	400	360	400	360	3,100	360
2,4-Dimethylphenol	<5	140	2,300	28,000	28,000	NNS	NNS	1,000	310	1,000	310	1,100	310	150,000	43,000
Dimethyl phthalate	<5	NNS	NNS	NNS	NNS	NNS	NNS	17,000	1,000	17,000	1,000	17,000	1,000	NNS	NNS
4,6-Dinitro-o-cresol	<50	28	7,800	5,600	5,600	NNS	NNS	310	24	310	24	310	24	NNS	NNS
2,4-Dinitrophenol	<50	14	14,400	2,800	2,800	NNS	NNS	110	9.2	110	9	110	9	NNS	NNS
2,4-Dinitrotoluene	<5	14	5,700	2,800	2,800	NNS	NNS	14,000	860	14,000	860	14,000	860	NNS	NNS
2,6-Dinitrotoluene	<5	0.05	NNS	2	5,600	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Di-n-octyl phthalate	<10	2,800	NNS	560,000	560,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
1,2-Diphenylhydrazine	<10	0.04	0.5	1.8	1.8	NNS	NNS	130	11	130	11	130	11	NNS	NNS
Endosulfan sulfate	<0.02	NNS	NNS	NNS	NNS	NNS	NNS	0.22	0.06	0.22	0.06	0.22	0.06	3.0	1.5
Endosulfan (Total)	<0.02	42	240	8,400	8,400	NNS	NNS	0.22	0.06	0.22	0.06	0.22	0.06	3.0	1.5
Endrin	< 0.01	2	0.8	420	420	0.004	0.004	0.18	0.002	0.2	0.08	0.2	0.08	0.7	0.3

Table 3H-1
Rio de Flag State of Arizona Numeric Water Quality Criteria (µg/L)

	Rio de Flag WRP							A & Wc		A & Ww		A & Wedw		A & We	
Parameter	(µg/L)	DWS	FC	FBC	PBC	AgI	AgL	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
Endrin aldehyde	<0.02	NNS	NNS	NNS	NNS	NNS	NNS	0.18	0.002	0.2	0.08	0.2	0.08	0.7	0.3
Ethylbenzene	< 0.5	700	28,700	140,000	140,000	NNS	NNS	23,000	1,400	23,000	1,400	23,000	1,400	NNS	NNS
Ethyl chloride	<0.5	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Fluoranthene	<5	280	380	56,000	56,000	NNS	NNS	2,000	1,600	2,000	1,600	2,000	1,600	NNS	NNS
Fluorene	<5	280	14,400	56,000	56,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Fluoride	130 to 430	4,000	NNS	84,000	84,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Heptachlor	<0.01 to < 0.04	0.4	0.0002	0.4	700	NNS	NNS	0.52	0.004	0.52	0.004	0.58	0.013	0.9	0.1
Heptachlor epoxide	<0.01 to < 0.02	0.2	0.0001	0.2	18	NNS	NNS	0.52	0.004	0.52	0.004	0.58	0.013	0.9	0.1
Hexachlorobenzene	< 0.1 to <5	1	0.001	1	1120	NNS	NNS	6.0	3.7	NNS	NNS	NNS	NNS	NNS	NNS
Hexachlorobutadiene	<10	0.45	0.50	18	280	NNS	NNS	45	8.2	45	8.2	45	8.2	NNS	NNS
Hexachlorocyclohexane alpha	<0.02	0.006	0.01	0.22	11,200	NNS	NNS	1,600	130	1,600	130	1,600	130	1,600	130
Hexachlorocyclohexane beta	<0.5	0.02	0.02	0.78	840	NNS	NNS	1,600	130	1,600	130	1,600	130	1,600	130
Hexachlorocyclohexane delta	<0.02	NNS	NNS	NNS	NNS	NNS	NNS	1,600	130	1,600	130	1,600	130	1,600	130
Hexachlorocyclohexane gamma (lindane)	<0.02	0.2	25	420	420	NNS	NNS	2.0	0.08	3.4	0.28	7.6	0.61	11	0.9
Hexachlorocyclopentadiene	< 0.1 to <10	50	580	9,800	9,800	NNS	NNS	3.5	0.3	3.5	0.3	3.5	0.3	NNS	NNS
Hexachloroethane	<5	2.5	9	100	1,400	NNS	NNS	490	350	490	350	490	350	850	610
Indeno (1,2,3-cd) pyrene	<10	0.048	0.49	1.9	1.9	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Isophorone	<5	37	2,600	1,500	280,000	NNS	NNS	59,000	43,000	59,000	43,000	59,000	43,000	NNS	NNS
Lead (as Pb) *	2 to 3.1 T	15 T	NNS	15 T	15 T	10,000 T	100 T	103	4	103	4	103	4	217	NNS
Manganese (as Mn)	5.1	980 T	NNS	196,000 T	196,000 T	10,000 T	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Mercury (as Hg)	<0.2 to <0.5 T	2 T	0.6 T	420 T	420 T	NNS	10 T	2.4 D	0.01 D	2.4 D	0.01 D	2.6 D	0.2 D	5.0 D	2.7 D
Methoxychlor	< 0.1 to <0.2	40	NNS	7,000	7,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Napthalene	<5	140	20,500	28,000	28,000	NNS	NNS	1,100	210	3,200	580	3,200	580	NNS	NNS
Nickel (as Ni) *	<5 to <10 T	140 T	4,600 T	28,000 T	28,000 T	NNS	NNS	675	75	675	75	675	75	5,992	NNS
Nitrate (as N)	3120 to 5000	10,000	NNS	2,240,000	2,240,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Nitrite (as N)	<10	1,000	NNS	140,000	140,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Nitrate/Nitrite (as N)	3620	10,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Nitrobenzene	<5	3.5	1,900	700	700	NNS	NNS	1,300	850	1,300	850	1,300	850	NNS	NNS

Table 3H-1
Rio de Flag State of Arizona Numeric Water Quality Criteria (µg/L)

	Rio de Flag WRP							A & Wc		A & Ww		A & Wedw		A & We	
Parameter	(µg/L)	DWS	FC	FBC	PBC	AgI	AgL	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
o-Nitrophenol	<5	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
p-Nitrophenol	<10	NNS	NNS	NNS	NNS	NNS	NNS	4,100	3,000	4,100	3,000	4,100	3,000	NNS	NNS
n-Nitrosodimethylamine	<5	0.001	8	0.03	0.03	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
n-Nitrosodiphenylamine	<5	7.1	16	290	290	NNS	NNS	2,900	200	2,900	200	2,900	200	NNS	NNS
n-Nitrosodi-n-propylamine	<5	0.005	0.005	1.4	0.2	133,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Pentachlorophenol *	< 0.04 to <20	1	1,000	12	42,000	NNS	NNS	13.6	8.6	13.6	8.6	13.6	8.6	54.9	NNS
Phenanthrene	<5	NNS	NNS	NNS	NNS	NNS	NNS	30	6.3	30	6.3	54	6.3	NNS	NNS
Phenol	<5	4,200	1,000	840,000	840,000	NNS	NNS	5,100	730	7,000	1,000	7,000	1,000	180,000	26,000
Polychlorinatedbiphenyls(PCBs)	<0.5 to <20	0.5	0.007	28	28	0.001	0.001	2.0	0.01	2.0	0.02	2.0	0.02	11	2.5
Pyrene	<5	210	10,800	42,000	42,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Selenium (as Se)	< 2 to <5 T	50 T	9,000 T	7,000 T	7,000 T	20 T	50 T	20 T	2.0 T	20 T	2.0 T	50 T	2.0 T	33 T	2.0 T
Silver (as Ag) *	0.7 to 1.1	35 T	107,700 T	7,000 T	7,000 T	NNS	NNS	7.3	NNS	7.3	NNS	7.3	NNS	7.3	NNS
Styrene	< 0.5	100	NNS	280,000	280,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Sulfides	<100	NNS	NNS	NNS	NNS	NNS	NNS	100	NNS	100	NNS	100	NNS	100	NNS
2,3,7,8-TCDD (Dioxin)	<1.7E-06	0.0000003	4.00E-09	0.00009	1.4	NNS	NNS	0.01	0.005	0.01	0.005	0.12	0.01	0.1	0.01
1,1,2,2-Tetrachloroethane	< 0.5	0.17	11	7	56,000	NNS	NNS	4,700	3,200	4,700	3,200	4,700	3,200	NNS	NNS
Tetrachloroethylene	< 0.5	5	3,500	14,000	14,000	NNS	NNS	2,600	280	6,500	680	6,500	680	15,000	1,600
Thallium (as Tl)	< 1 T	2 T	7.2 T	112 T	112 T	NNS	NNS	700 D	150 D	700 D	150 D	700 D	150 D	NNS	NNS
Toluene	< 0.5	1,000	201,000	280,000	280,000	NNS	NNS	8,700	180	8,700	180	8,700	180	NNS	NNS
Toxaphene	<0.5 to < 1	3	0.001	1.3	1400	0.005	0.005	0.73	0.0002	0.73	0.02	0.73	0.02	11	1.5
1,2,4-Trichlorobenzene	<5	70	950	14,000	14,000	NNS	NNS	750	130	1700	300	NNS	NNS	NNS	NNS
1,1,1-Trichloroethane	< 0.5	200	NNS	200	200	1000	NNS	2,600	1,600	2,600	1,600	2,600	1,600	NNS	NNS
1,1,2-Trichloroethane	< 0.5	5	42	25	5600	NNS	NNS	18,000	12,000	18,000	12,000	18,000	12,000	NNS	NNS
Trichloroethylene	< 0.5	5	203,200	280,000	280,000	NNS	NNS	20,000	1,300	20,000	1,300	20,000	1,300	NNS	NNS
2,4,6-Trichlorophenol	<5	3.2	6.5	130	130	NNS	NNS	160	25	160	25	160	25	3,000	460
2,4,5-TP	< 0.1	50	NNS	11,200	11,200	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Trihalomethanes, Total	<0.5	100	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Uranium (as U)	Ra 226 pass	35 D	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Vinyl chloride	< 0.5	2	13	2	4200	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS

Table 3H-1
Rio de Flag State of Arizona Numeric Water Quality Criteria (µg/L)

	Rio de Flag WRP							A & Wc		A & Ww		A & Wedw		A & We	
Parameter	**(µg/L)**	**DWS**	**FC**	**FBC**	**PBC**	**AgI**	**AgL**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**
Xylenes (Total)	**< 0.5**	10,000	NNS	2,800,000	2,800,000	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS	NNS
Zinc *	**50 to 67**	2100 T	69,000 T	420,000 T	420,000 T	10,000 T	25,000 T	169	169	169	169	169	169	1,603	NNS

Source: Aquatic Consulting and Testing, Inc. 2002.
Water quality criteria derived from Arizona Administrative Code, Title 18, Chapter 11, Appendix A (amended by final rule-making effective April 8, 2003)
[a] See Table for approximate ammonia values
[b] The standard to protect this use is 7 million fibers (longer than 10 micrometers) per liter.
[c] The standard to protect this use is 0.003 µg/L aldrin/dieldrin.
* Toxicity values are based on water hardness of 154 mg/L as calcium carbonate and a pH of 7.4.

T = Total Metal
TTHM = Total Trihalomethanes
µg/L = micrograms per liter
mg/L = milligrams per liter
MFL = million fibers per liter

D (or highlight) = Dissolved Metal
> = greater than
< = less than

Ra = Radium
pass = acceptable at screening level

FC = Fish Consumption
FBC = Full Body Contact
PBC = Partial Body Contact

DWS = Domestic Water Source
AgL = Agricultural Livestock Watering
WRF = water reclamation facility

A&Wc = Aquatic and Wildlife (cold water)
A&Ww = Aquatic and Wildlife (warm water)
A&Wedw = Aquatic and Wildlife (effluent dependent water)

A&We = Aquatic and Wildlife (ephemeral)
AgI = Agricultural Irrigation
NNS = No Numeric Standard

Reported Value Explanation:

Below all numeric standards

Not detected; analytical detection limit cannot measure to level of one or more numeric criteria

Detected above one or more numeric criteria

Table 3H-2a
National Primary Drinking Water Standards

Parameter - Inorganic Chemicals	Units	Rio de Flag WRP Effluent	MCL
Antimony (as Sb)	µg/L	**<1 to < 2**	6
Arsenic (as As)	µg/L	**4.5-6**	50
Asbestos (fiber >10 micrometers)	MFL	**< 0.2**	7
Barium (as Ba)	µg/L	**240-300**	2,000
Beryllium (as Be)	µg/L	**< 1 to <2**	4
Cadmium (as Cd) [1]	µg/L	**<0.5 to <2**	5
Chromium (Total)	µg/L	**<1 to < 10**	100
Copper (as Cu) [1]	µg/L	**7.8 to 11**	TT[2], Action Level=1,300
Cyanide (as free cyanide)	µg/L	**< 10**	200
Fluoride	µg/L	**130 to 430**	4000
Lead (as Pb) [1]	µg/L	**2 to 3.1**	TT[2], Action Level=15
Mercury (inorganic)	µg/L	**<0.2 to <0.5**	2
Nitrate (measured as Nitrogen)	mg/L	**3.1 to 5.0**	10
Nitrite (measured as Nitrogen)	mg/L	**<10**	1
Selenium (as Se)	µg/L	**< 2 to <5**	50
Thallium (as Tl)		**< 1**	2
Parameter - Organic Chemicals			
Acrylamide		**NA**	TT[3]
Alachlor	µg/L	**< 0.1**	2
Atrazine	µg/L	**< 0.1**	3
Benzene	µg/L	**< 0.5**	5
Benzo (a) pyrene (PAHs)	µg/L	**< 0.02 to <5**	0.2
Carbofuran	µg/L	**< 0.9**	40
Carbon tetrachoride	µg/L	**< 0.5**	5
Chlordane	µg/L	**< 0.1 to <0.2**	2
Chlorobenzene	µg/L	**< 0.5**	10
Dalapon	µg/L	**NA**	200
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	**< 0.01**	0.2
o-Dichlorobenzene	µg/L	**< 0.5 to <5**	600
p-Dichlorobenzene	µg/L	**< 0.5 to <5**	75
1,2-Dichloroethane	µg/L	**< 0.5**	5
1,1-Dichloroethylene	µg/L	**< 0.5**	7
cis-1,2-Dichloroethylene	µg/L	**< 0.5**	70
trans-1,2-Dichloroethylene	µg/L	**< 0.5**	100
Dichloromethane	µg/L	**< 0.5 to <3**	5
2,4-Dichlorophenoxyacetic acid (2,4-D)	µg/L	**< 0.1**	70
1,2-Dichloropropane	µg/L	**< 0.5**	5
Di(2-ethylhexyl) adipate	µg/L	**NA**	400
Di(2-ethylhexyl) phthalate	µg/L	**0.6 to <4**	6
Dinoseb	µg/L	**NA**	7
2,3,7,8-TCDD (Dioxin)	µg/L	**<1.7E-06**	0.00003
Diquat	µg/L	**NA**	20
Endothall	µg/L	**NA**	100
Endrin	µg/L	**< 0.01**	2
Epichlorohydrin	µg/L	**NA**	TT[3]

Table 3H-2a
National Primary Drinking Water Standards

Parameter - Inorganic Chemicals	Units	Rio de Flag WRP Effluent	MCL
Ethylbenzene	µg/L	**< 0.5**	700
Ethylene dibromide	µg/L	**NA**	0.05
Heptachlor	µg/L	**<0.01 to < 0.04**	0.4
Heptachlor epoxide	µg/L	**<0.01 to < 0.02**	0.2
Hexachlorobenzene	µg/L	**< 0.1 to <5**	1
Hexachlorocyclopentadiene	µg/L	**< 0.1 to <10**	50
Lindane	µg/L	**NA**	0.2
Methoxychlor	µg/L	**< 0.1 to <0.2**	40
Oxamyl (Vydate)	µg/L	**NA**	200
Pentachlorophenol [1]	µg/L	**< 0.04 to <20**	1
Polychlorinatedbiphenyls(PCBs)	µg/L	**<0.5 to <20**	0.5
Picloram	µg/L	**NA**	500
Simazine	µg/L	**NA**	4
Styrene	µg/L	**< 0.5**	100
Tetrachloroethylene	µg/L	**< 0.5**	5
Toluene	µg/L	**< 0.5**	1,000
2,4,5-TP (Silvex)	µg/L	**< 0.1**	50
1,2,4-Trichlorobenzene	µg/L	**<5**	70
1,1,1-Trichloroethane	µg/L	**< 0.5**	200
1,1,2-Trichloroethane	µg/L	**< 0.5**	5
Trichloroethylene	µg/L	**< 0.5**	5
Vinyl chloride	µg/L	**< 0.5**	2
Xylenes (Total)	µg/L	**< 0.5**	10,000
Zinc	µg/L	**<10 to 67**	5000

Source for MCLs: U.S. Environmental Protection Agency, July 2002

Notes:
[1] = Toxicity values based on water hardness of 154 mg/L as calcium carbonate and a pH of 7.4, all metal concentrations are dissolved unless otherwise indicated
[2] = Lead and Copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L
[3] = Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorhydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

Acrylamide = 0.05% dosed at 1 mg/L (or equivalent)
Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent)

MCL = maximum contaminant level
MFL = million fibers per liter
NA = not analyzed
T = total metal
TT = treatment technique
SU = standard units
WRF = water reclamation facility

µg/L = micrograms per liter
mg/L = milligrams per liter
NNS = no numeric standard
TTHM = total trihalomethanes
< = less than
> = greater than

Reported Value Explanation:

Below all numeric standards

Not detected; analytical detection limit cannot measure to level of one or more numeric criteria

Detected above one or more numeric criteria

Table 3H-2b
National Secondary Drinking Water Standards

Parameter	Units	Rio de Flag WRP Effluent	Secondary Standard
Aluminum	µg/L	**NA**	50 to 200
Chloride	mg/L	**59 to 74**	250
Color		**NA**	15 (color units)
Copper	µg/L	**7.8 to 11**	1,000
Corrosivity		**NA**	Non-corrosive
Fluoride	µg/L	**130 to 500**	2,000
Foaming Agents	µg/L	**NA**	500
Iron	µg/L	**40 to 80**	300
Manganese (as Mn)	µg/L	**<10 to 11**	50
Odor		**NA**	3 threshold odor number
pH	SU	**7.01 to 7.96**	6.5-8.5
Silver (as Ag)	µg/L	**0.7 to 1.1**	100
Sulfate	mg/L	**21 to 31**	250
Total Dissolved Solids	mg/L	**321 to 360**	500
Zinc	µg/L	**<10 to 67**	5000

Source: U.S. Environmental Protection Agency, July 2002

Notes:
[1] = Toxicity values based on water hardness of 154 mg/L as calcium carbonate and a pH of 7.4, all metal concentrations are dissolved unless otherwise indicated
[2] = Lead and Copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L
[3] = Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorhydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

- Acrylamide = 0.05% dosed at 1 mg/L (or equivalent)
- Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent)

MCL = maximum contaminant level
MFL = million fibers per liter
NA = not analyzed
T = total metal
TT = treatment technique
SU = standard units
WRF = water reclamation facility

µg/L = micrograms per liter
mg/L = milligrams per liter
NNS = no numeric standard
TTHM = total trihalomethanes
< = less than
> = greater than

Reported Value Explanation:
Below all numeric standards

As can be seen in the results of these data tables, reclaimed water from the Rio de Flag WRF is below the numeric criteria established for Arizona SWQS and national drinking water standards for those regulated parameters tested. Further discussion of the source of inorganic and organic constituents and disinfection by-products in wastewater is as follows.

Inorganic Constituents

Inorganic chemical elements and compounds generally occur in wastewater as a result of naturally-occurring minerals and inorganic salts present in the parent water supplies. Inorganic constituents are also contributed to wastewater from industrial, commercial, and other human activities, and from chemicals added during water and wastewater treatment and distribution.

Naturally-occurring minerals, such as sodium, calcium, sulfate, and chloride, are commonly found in municipal water supplies at concentrations ranging from one to several hundred milligrams per liter (mg/L). The concentrations of these constituents, and of nitrogen-containing compounds and other inorganic salts, increase as water is used and then collected as wastewater.[251] Except for nitrogen contributed from human bodily wastes, water quality concerns for these common inorganic ions and salts are generally limited to effects on taste, odor, and aesthetics. The presence of naturally-occurring trace metals and ions, such as arsenic, chromium, copper, boron, and fluoride, could pose potential human health and environmental hazards.

Industrial, commercial, and household discharges can contribute inorganic constituents, such as antimony, cyanide, mercury, chromium, cadmium, lead, zinc, selenium, silver, and sulfides, to wastewater which may inhibit the effectiveness of wastewater treatment or may pass through the process without treatment or removal. Proper characterization of wastewater discharges to a treatment plant and appropriate pretreatment and source control at the significant points of industrial discharge can assure the physical, chemical, and biological integrity of the wastewater treatment process and receiving waters.[252]

Human bodily wastes contribute high levels of nitrogen, phosphorous, and ammonia to wastewater that may cause adverse ecological effects to receiving waters if untreated. Phosphorous can be removed efficiently from wastewater by chemical precipitation or various biological processes. Ammonia and nitrogen can be removed by biological nitrification and denitrification.[253]

Organic Constituents

Organic constituents of concern principally include a number of conventional solvents, pesticides, polycyclic aromatic hydrocarbons, polychlorinated biphenyls (PCBs), and dioxin. Toxic substances used in homes, including motor oil, paint, household cleaners, and pesticides, may be found in municipal wastewater. Control of organic constituents in surface waters is necessary to limit impacts to health of downstream users and preserve sensitive aquatic environments. Recent studies of many rivers and waterways downstream from industrial and

[251] National Research Council, 2003
[252] Asano, 1998
[253] National Research Center, 2003

municipal discharges have identified elevated levels of toxic pollutants in water, sediments, and fish tissues.[254] Some of the organic constituents are persistent in the environment and can accumulate in animal tissues. Compounds, such as PCBs and pesticides, that bioaccumulate can pose a greater hazard to animals high in the food chain and may pose human health risks.

Through substantial research, extensive monitoring, and applied studies, EPA identified a number of organic chemicals as "toxic pollutants" during early implementation of the Clean Water Act.[255] 126 of the toxic pollutants, chiefly organic chemicals with a smaller number of metals and other substances, were assigned a high priority for development of water quality criteria and effluent limitation guidelines. The 126 "Priority Pollutants" were generally selected because they are frequently found in wastewater. EPA adopted federal water quality criteria for the Priority Pollutants to identify maximum chemical concentrations deemed protective of aquatic life and human health. These Priority Pollutants have become the basis for evaluating the chemical character of effluent from municipal wastewater treatment plants.

Disinfection By-products

Disinfection by-products (DBPs) are a class of chemical compounds produced during the process of wastewater disinfection. Disinfectants, in addition to killing microorganisms, react with organic and inorganic substances present in the water to produce a variety of DBPs. During chlorine disinfection, chloroform and other trihalomethanes (THMs) and haloacetic acids are commonly formed. Disinfection with ozone may result in the formation of bromate. Nitrosodimethylamine is a by-product of disinfection with chloroamines.

A small number of DBPs are regulated or are being considered for regulation due to potential human health concerns. The EPA established a primary drinking water standard of 100 mg/L for total THMs in 1979, based on the risk of cancer reported in animal studies evaluating chloroform toxicity. Chloroform is the most common THM found in drinking water.[256] By 1998, new epidemiological studies had been published that reported associations between THMs and bladder and colon cancer, as well as adverse pregnancy outcomes.[257] In response to these findings, the drinking water standard for total THMs was revised in December 1998 to 80 mg/L. Limits of 60 mg/L for haloacetic acid and 10 mg/L for bromate were also introduced.

Literature Search and Narrative Description of the Potential Presence of Pharmaceuticals, Pathogens, and Hormones in Class A Reclaimed Water (Indicator)

During the last three decades, the concern about wastewater quality has focused predominantly on conventional industrial pollutants. More recently, it has been recognized that a wide range of other synthetic organic chemicals originating from pharmaceutical drugs and personal care products may persist in the environment. These chemicals are continually released into the environment in large quantities through the manufacture, use (via excretion), and disposal of

[254] U.S. Environmental Protection Agency, 2003a
[255] 42 U.S.C. 13101, et seq.
[256] U.S. Environmental Protection Agency, 1992
[257] Resource Engineering, Inc. et al., 2000

personal care products and drugs.[258] Research has shown that these chemicals enter and disperse into the environment from municipal wastewater treatment effluent, and persist to a greater extent than originally anticipated.[259] Studies[260] indicate that between 50 and 90 percent of a typical drug dosage can be excreted and introduced unchanged into the environment.

Concerns regarding pharmaceuticals and personal care products (PPCPs) have captured recent attention from governments in Europe and North America, the scientific community, the chemical industry, and public interest groups. The core issue centers on the potential harmful impact PPCPs may have on the normal function of the endocrine system[261] in wildlife and humans.[262] Endocrine-disrupting compounds can mimic, stimulate, or inhibit the production of natural hormones, thereby disrupting the endocrine system function.[263] Endocrine-disrupting compounds encompass a variety of chemical classes, including natural and synthetic hormones, pesticides, compounds used in the plastics industry and consumer products, and other industrial by-products and pollutants.[264] It is important to note that PPCPs and endocrine disrupting compounds are not synonymous. Only a small subset of PPCPs are known or suspected of being direct-acting endocrine disrupting compounds.[265]

Much of the concern over endocrine-disrupting compounds stems from the impact that environmentally persistent pesticides and manmade organic compounds have had on exposed wildlife populations and the environment. Colborn et al.,[266] have linked endocrine-disrupting compounds in the environment to aberrant sexual development and behavioral and reproductive problems in animal populations. Colborn further suggested that endocrine disruptors could be responsible for a wide range of human health problems, including declining male sperm counts, growing incidence of infertility and genital deformities, increasing rates of breast and prostrate cancers, and neurological disorders in children. However, the linkage between animal studies and human health effects is controversial. Some scientists question whether the stated human health effects, such as declining sperm counts, are even occurring,[267] and dispute causal linkage of relatively low levels of exposure to synthetic endocrine disruptors.[268]

Municipal wastewater contains a variety of PPCPs that are pharmaceutically active and known to act on the endocrine system at therapeutic doses.[269] Although the occurrence of antibiotics and steroids has generated nearly all the controversy to date, many other classes of drugs, bioactive

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[258] Daughton and Ternes, 1999
[259] Kolpin et al., 2002; Cordy et al., 2003
[260] McGovern and McDonald 2003
[261] The endocrine system is a set of glands and hormones that control biological reproduction, growth, and development.
[262] World Health Organization, 2002
[263] McGovern and McDonald, 2003
[264] World Health Organization, 2002
[265] Daughton and Ternes, 1999
[266] Colborn, T. et al., 1997
[267] National Research Council, 1999
[268] Christensen, 1998; Safe, 2000
[269] McGovern and McDonald, 2003

metabolites and transformation products, and personal care products have yet to be examined.[270] Chemicals found in both non-prescription and prescription medications have been detected in municipal wastewaters and may act as endocrine disruptors.[271] In addition to prescribed human drugs, other PPCPs of potential concern include veterinary and illicit drugs and such common substances as caffeine, cosmetics, food supplements, sunscreen agents, solvents, insecticides, plasticizers, and detergent compounds.

The occurrence of trace concentrations of a variety of PPCPs in surface water and groundwater is becoming progressively more widely recognized. The USGS[272] conducted a national reconnaissance of 139 streams in 30 States and detected PPCPs in 80 percent of the streams sampled. Another study[273] found more than 50 PPCPs in samples of wastewater treatment effluent, surface water, and groundwater. Until recently, the significance has largely gone unnoticed because there have been few analytical methods capable of detecting these compounds at the small concentrations expected in the environment, which are generally less than a microgram per liter (part per billion).

PPCPs and their effects as endocrine disruptors are generally viewed as more of a hazard to the aquatic environment because the introduction of PPCPs into the environment occurs chiefly through aquatic systems.[274] Aquatic organisms are the receptors most affected by uptake of potential endocrine disruptor compounds in the environment and, therefore, are the principal focus of PPCP-related environmental studies.[275]

The fundamental issue related to PPCPs in municipal wastewater is whether or not PPCPs and their transformation products can cause physiological effects on biota at the low concentrations detected.[276] Recent research indicates that endocrine disruptors may have aquatic habitat impacts, but no human health impacts, at concentrations found in receiving waters. [277]

A current and definitive analysis of the issue is given in the *Global Assessment on the State-of-the Science of Endocrine Disruptors*, prepared by an expert panel on behalf of the World Health Organization, the International Labour Organization, and the United Nations Environmental Programme.[278] The scientific evidence, as summarized in this report, indicates that certain effects observed in wildlife can be attributed to chemicals that function as endocrine disruptors. However, in most cases, the evidence of a causal link is weak, with the majority of the effects being observed in areas where exposure to chemical contamination was high at sites of spills and industrial wastewater discharges. The expert panel concluded that most PPCPs considered endocrine disruptors present “suspect”, rather than “known”, risks because our current understanding of the effects posed by endocrine disruptors to wildlife and humans is incomplete.

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[270] Daughton, 2001a and 2001b
[271] Daughton and Ternes, 1999
[272] Kolpin et al., 2002
[273] Daughton and Ternes, 1999
[274] Id.
[275] Sattelberger, 2002
[276] Daughton and Ternes, 1999; Tsuchihashi et al., 2002
[277] Clark, 2001
[278] 2002

With respect to human health, the expert panel stated that the only evidence that humans are susceptible to endocrine disruptor compounds is provided by studies of high exposure levels. Generally, the panel noted that studies investigating endocrine disruption effects in humans have yielded inconsistent and inconclusive results and that more rigorous studies are recommended.

USGS and NAU Studies on Reclaimed Water

The City of Flagstaff has recently funded applied research to screen for the presence of potential endocrine-disrupting compounds and other PPCPs in treated wastewater and to characterize the endocrine-disrupting potential on target vertebrate organisms.[279] The research was conducted in two phases. In the first phase, the USGS, in an extension of their national reconnaissance of organic wastewater contaminants, sampled and quantitatively analyzed treated wastewater samples from City of Flagstaff wastewater for 94 chemicals. The analytes include those PPCPs previously identified in the highest detection frequency and suspected as endocrine-disrupting compounds in the national survey of other water systems. In the second phase, Dr. Catherine Propper of the Northern Arizona University Department of Biological Sciences conducted in vitro (test tube) and in vivo (whole body) tests of Flagstaff wastewater effluent to evaluate vertebrate behavior and physiological effects on the endocrine system.

The results of the USGS reconnaissance screening of organic wastewater constituents in City of Flagstaff reclaimed water are provided in tables 3H-3, 3H-4, and 3H-5. These data tables present the results of screening for human drug compounds in Table 3H-3, veterinary and human antibiotics in Table 3H-4, and industrial and household wastes in Table 3H-5. Results are given for reclaimed water obtained from the Rio de Flag WRF and Wildcat Hill WWTP. Additionally, a groundwater sample from the City of Flagstaff Fox Glenn well was included. The results indicate the number of PPCPs detected and the concentrations at which they were detected is significantly lower in reclaimed water from the Rio de Flag WRF as compared to the Wildcat Hill WWTP. The Rio de Flag WRF is the source of reclaimed water proposed for snowmaking use.

[279] Propper, et al., 2002

Table 3H-3
USGS Reconnaissance Screening of Organic Wastewater Constituents for Human Drug Compounds

Station Name	Inst.Blank	Rio de Flag WRP	Fox Glenn Well	Fox Glenn Well - Blank	Wild Cat WWTP	*Set Blank*	*Set Spike*	Spike % Rec
Date & Time		05/28/2003 10:00 AM	05/29/2003 9:00 AM	05/29/2003 8:00 AM	05/28/2003 1:30 PM			
Volume (ml)		892.4	865.3	845.5	868.2	924.6	931.1	
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
Metformin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Cotinine	< LRL	0.098	< LRL	< LRL	1.27	< LRL	0.571	106
Salbutamol	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.58	108
Cimetidine	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.0731	14
Acetaminophen	< LRL	0.122	0.0005	< LRL	0.543	< LRL	0.459	85
Ranitidine	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.101	19
1,7-dimethylxanthine	< LRL	< LRL	< LRL	< LRL	6.5	< LRL	0.38	71
Enalaprilat	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Trimethoprim	< LRL	< LRL	< LRL	< LRL	0.025	< LRL	0.45	84
Digoxigenin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Diltiazem	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.277	52
Fluoxetine	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.195	36
Warfarin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.461	86
Ibuprofen	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.306	57
Gemfibrozil	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.184	34
Paroxetine metabolite	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Lisinopril	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Furosemide	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Amoxicillin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Caffeine	< LRL	0.057	0.0055	< LRL	5.06	< LRL	0.514	96
Sulfamethoxazole	< LRL	< LRL	< LRL	< LRL	0.159	< LRL	0.306	57
Dehydronifedipine	< LRL	0.029	< LRL	< LRL	< LRL	< LRL	0.516	96
Digoxin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Codeine	< LRL	< LRL	< LRL	< LRL	0.162	< LRL	0.476	89

Table 3H-3
USGS Reconnaissance Screening of Organic Wastewater Constituents for Human Drug Compounds

Station Name	Inst.Blank	Rio de Flag WRP	Fox Glenn Well	Fox Glenn Well - Blank	Wild Cat WWTP	*Set Blank*	*Set Spike*	Spike % Rec
Date & Time		05/28/2003 10:00 AM	05/29/2003 9:00 AM	05/29/2003 8:00 AM	05/28/2003 1:30 PM			
Volume (ml)		892.4	865.3	845.5	868.2	924.6	931.1	
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
Cephalexin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Thiabendazole*	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.316	59
Urobilin	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Diphenhydramine*	< LRL	< LRL	< LRL	< LRL	0.022	< LRL	0.336	63
Azithromycin*	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.0557	10
Erythromycin*	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0.0834	16
Clarithromycin*	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Carbamazapine*	< LRL	0.205	< LRL	< LRL	0.095	< LRL	0.54	101
Miconazole*	0.0036	< LRL	< LRL	< LRL	< LRL	< LRL	0.0375	7
Naproxen*	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0
Nicotinamided4ISTD	1.	1.12	1.16	1.18	1.15	1.08	1.07	100
Ethyl Nicotinate-d4 Surr	< LRL	1.74	1.3	1.32	1.77	1.3	1.18	110
Caffeine13C	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	< LRL	0

Comments:
Red = detected in blank, level < 10X blank detection

Orange = Compound deleted from method

Green = > highest calibration level

Blue = < MDL, * (MDL not determined)

MDL not determined

LRL = Laboratory Reporting Limit

All data is provisional and subject to revision

Table 3H-4
USGS Reconnaissance Screening of Organic Wastewater Constituents - Veterinary and Human Antibiotics (μg/L)

Date & Time	5/28/03 10:00 AM	5/29/03 9:00 AM	5/29/03 8:00 AM	5/28/03 1:30 PM
Location	**Rio De Flag WRP**	**Fox Glenn Well**	**Fox Glenn Well- Blank**	**Wild Cat WWTP**
Sulfamethizole	<0.05	<0.05	<0.05	<0.05
Lincomycin	<0.01	<0.01	<0.01	<0.01
Sulfathiazole	<0.05	<0.05	<0.05	<0.05
Carbadox	<0.05	<0.05	<0.05	<0.05
Sulfamerazine	<0.02	<0.02	<0.02	<0.02
Sulfamethazine	<0.01	<0.01	<0.01	<0.01
Trimethoprim	<0.01	<0.01	<0.01	<0.01
Sulfqchlorpyradazine	<0.05	<0.05	<0.05	<0.05
Sulfamethoxazole	<0.05	<0.05	<0.05	0.27
Sulfadimethoxine	<0.01	<0.01	<0.01	<0.01
Tylosin	<0.02	<0.02	<0.02	<0.02
Virginiamycin	<0.1	<0.1	<0.1	<0.1
Erythromycin-H2O	<0.02	<0.02	<0.02	<0.02
Roxithromycin	<0.01	<0.01	<0.01	<0.01
Tetracycline	<0.02	<0.02	<0.02	<0.02
Methotrexate	<0.02	<0.02	<0.02	<0.02
Demeclocycline	<0.02	<0.02	<0.02	<0.02
Chlortetracy	<0.02	<0.02	<0.02	<0.02
Oxytetracyc	<0.05	<0.05	<0.05	<0.05
Minocycline	<0.02	<0.02	<0.02	<0.02
doxycycline	<0.05	<0.05	<0.05	<0.05
norfloxaxin	<0.01	<0.01	<0.01	<0.01
ciprofloxacin	<0.01	<0.01	<0.01	<0.01
enrofloxacin	<0.01	<0.01	<0.01	<0.01
sarafloxacin	<0.01	<0.01	<0.01	<0.01

Note: *All data provisional and subject to revision*

Table 3H-5
USGS Reconnaissance Screening of Organic Wastewater Constituents - Industrial and Household Wastes (μg/L)

Date & Time		05/28/2003 1:30 PM	05/28/2003 10:00 AM	05/29/2003 8:00 AM	05/29/2003 9:00 AM
Field ID	**Set Blank**	**Wild Cat Treatment Plant**	**Rio De Flag Treatment Plant**	**Fox Glenn Well**	**Fox Glenn Well**
tetrachloroethylene	< 0.5	E 0.056	< 0.5	E 0.082	< 0.5
bromoform	< 0.5	< 0.5	E 0.14	< 0.5	< 0.5
cumene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
phenol	E 0.03	1.1	E 0.1	< 0.5	< 0.5
1,4-dichlorobenzene	< 0.5	E 0.97	E 0.21	< 0.5	< 0.5
d-limonene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
acetophenone	E 0.031	0.61	E 0.13	< 0.5	< 0.5
para-cresol	1	1.2	1	1	1
isophorone	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
camphor	< 0.5	E 0.23	< 0.5	< 0.5	< 0.5
isoborneol	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
menthol	< 0.5	1.3	< 0.5	< 0.5	< 0.5
naphthalene	E 0.0036	< 0.5	< 0.5	< 0.5	< 0.5
methyl salicylate	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
dichlorvos	< 1	< 1	< 1	< 1	< 1
isoquinoline	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2-methylnapthalene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
indole	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
3,4-dichlorophenyl isocyanate	< 0	0.67	< 0	< 0	< 0
1-methylnapthalene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
skatol	< 1	< 1	< 1	< 1	< 1
2,6-dimethylnapthalene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
BHA	< 5	< 5	< 5	< 5	< 5
N,N-diethyltoluamide (DEET)	< 0.5	4.6	E 0.23	< 0.5	< 0.5
5-methyl-1H-benzotriazle	< 2	E 1.6	E 0.81	< 2	< 2

Table 3H-5
USGS Reconnaissance Screening of Organic Wastewater Constituents - Industrial and Household Wastes (μg/L)

Date & Time		05/28/2003 1:30 PM	05/28/2003 10:00 AM	05/29/2003 8:00 AM	05/29/2003 9:00 AM
Field ID	Set Blank	Wild Cat Treatment Plant	Rio De Flag Treatment Plant	Fox Glenn Well	Fox Glenn Well
diethyl phthalate	0.049	0.77	< 0	< 0	< 0
4-tert-octylphenol	E 0.025	1.1	< 1	< 1	< 1
benzophenone	< 0.5	0.52	E 0.28	< 0.5	< 0.5
tributylphosphate	< 0.5	E 0.28	E 0.16	< 0.5	< 0.5
ethyl citrate	< 0.5	E 0.43	E 0.2	< 0.5	< 0.5
cotinine	< 1	E 0.58	< 1	< 1	< 1
para-nonylphenol-total	< 4.8	E 16	< 3.3	< 4	< 3.3
prometon	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
pentachlorophenol	< 2	< 2	< 2	< 2	< 2
atrazine	< 0	< 0	< 0	< 0	< 0
tri(2-chloroethyl)phosphate	< 0.5	0.59	E 0.3	< 0.5	< 0.5
4-n-octylphenol	< 1	< 1	< 1	< 1	< 1
diazinon	< 0.5	E 0.48	< 0.5	< 0.5	< 0.5
phenanthrene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
tonalide (AHTN)	< 0.5	0.84	0.86	< 0.5	< 0.5
caffeine	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
carbazole	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
galaxolide (HHCB)	< 0.5	E 0.16	E 0.22	0.5	0.5
OPEO1	E 0.53	E 5.7	< 1	< 1	< 1
4-cumylphenol	< 1	< 1	< 1	< 1	< 1
carbaryl	< 1	< 1	< 1	< 1	< 1
metalaxyl	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
bromacil	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
metolachlor	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
chlorpyrifos	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
anthraquinone	< 0.5	< 0.5	E 0.094	< 0.5	< 0.5
NPEO1-total	0	25	0	0	0

Table 3H-5
USGS Reconnaissance Screening of Organic Wastewater Constituents - Industrial and Household Wastes (μg/L)

Date & Time		05/28/2003 1:30 PM	05/28/2003 10:00 AM	05/29/2003 8:00 AM	05/29/2003 9:00 AM
Field ID	**Set Blank**	**Wild Cat Treatment Plant**	**Rio De Flag Treatment Plant**	**Fox Glenn Well**	**Fox Glenn Well**
fluoranthene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
triclosan	< 1	1.4	E 0.14	< 1	< 1
pyrene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
OPEO2	< 1	E 0.54	< 1	< 1	< 1
bisphenol A	< 1	< 1	< 1	< 1	< 1
NPEO2-total	< 5	E 25	< 5	< 5	< 5
tri(dichlorisopropyl)phosphat	< 0.5	E 0.43	E 0.36	< 0.5	< 0.5
triphenyl phosphate	< 0.5	E 0.098	E 0.098	< 0.5	E 0.057
ethanol,2-butoxy-,phosphate	< 0.5	E 26	E 0.21	< 0.5	< 0.5
PBDPE4-2	< 0	< 0	< 0	< 0	< 0
diethylhexyl phthalate	0.098	0.92	< 0	0.78	< 0
estrone	< 5	E 0.45	< 5	< 5	< 5
17B-estradiol	< 5	< 5	< 5	< 5	< 5
17-alpha-ethynyl esterdiol	< 5	< 5	< 5	< 5	< 5
equilenin	< 5	< 5	< 5	< 5	< 5
benzo(a)pyrene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
3-beta-coprostanol	< 2	8	< 2	< 2	< 2
cholesterol	< 2	11	< 2	< 2	< 2
beta-sitosterol	< 2	2.6	< 2	< 2	< 2
stigmastanol	< 2	< 2	< 2	< 2	< 2

Note: *All data is provision and subject to revision.*

A summary of Dr. Propper's findings appear in four abstracts given as presentations at the 2004 Annual Meeting for the Society of Integrative and Comparative Biology held January 5-9 in New Orleans, Louisiana and are summarized below.

As described in Westmoreland et al.,[280] testing was performed on bullfrogs to assess changes in activity levels, feeding behavior, overall condition, and endocrine status after exposure to reclaimed water for one month. The results of the experiment suggest that exposure to reclaimed water may have adversely affected the bullfrog's feeding behavior. All other measures of behavior, activity, and stress hormone levels were not statistically significant compared to a control group.

As described in Hortin et al.,[281] and Somley et al.,[282] testing was performed on female Western Mosquitofish (*Gambusia affinis*) to assess changes in anal tail fin length after exposure to reclaimed water for one month. Elongation of the mosquitofish anal tail fin is a bioindicator of endocrine disruption by compounds that mimic male sexual hormones called androgens. During the course of study a significant quantity of fish died, possibly associated with low dissolved oxygen levels or infection by microorganisms. The experiment was repeated after aerating the reclaimed water. The reclaimed water did not cause a change in mosquitofish anal fin length suggesting there is nothing overtly androgenic in the water.

As described in Phillips et al.,[283] testing was performed on African clawed frogs (*Xenopus laevis*) raised in reclaimed water to assess their physiological development. The rate of development and sex ratio was measured in tadpoles until metamorphosis. Tadpoles in reclaimed water underwent metamorphosis in fewer days, weighed less, and were shorter than individuals from control groups. There was no major effect on sex ratio. The findings suggest the reclaimed water is not significantly estrogenic, although exposure to reclaimed water influences endocrine-directed development in this aquatic species.

It should be noted that the studies conducted by Dr. Catherine Propper exposed test animals to 100 percent reclaimed water. As explained further in this chapter, the proposed use of reclaimed water for snowmaking at the Arizona Snowbowl will not result in comparable environmental exposure as investigated by Dr. Propper.

Microbial Constituents

A wide variety of microbial pathogens may be found in wastewater, including enteric bacteria, enteric viruses, and enteric protozoan parasites.[284] Concerns about microbial constituents in water are nearly exclusively related to the human health hazard associated with acute illnesses and infectious disease. The hazards of waterborne disease have been reduced due to improved sanitary conditions, medical advances, and better microbiological and epidemiological methods for identifying outbreaks. Development of large population centers and advancements in civilizations have been directly associated with improvements in managing water supplies and

[280] Westmoreland, K.L, et al., 2004
[281] Hortin, S.M., et al., 2004
[282] Somley, B.L., et al., 2004
[283] Phillips, J.D., et al., 2004
[284] Asano, 1998

wastewater sanitation.[285] Well-known waterborne diseases, although still important worldwide, have decreased substantially in the United States and other industrialized countries.[286] Enteric (intestinal) pathogens still occur and any potable water supply receiving human or animal wastes can be contaminated with microbial agents. Even pristine water supplies have been linked to disease outbreaks, presumably from wildlife in the watershed. Because Giardia is endemic in wild and domestic animals, infection can result from water supplies that have no wastewater contribution.[287]

Enteric microbial pathogens in wastewater are substantially removed by conventional treatment, although they are not completely eliminated even with disinfection. Fecal coliform bacteria, which are used as an indicator of microbial pathogens, are typically found at concentrations ranging from 10^5 to 10^7 colony-forming units per 100 milliliters (CFU/100 ml) in untreated wastewater. Advanced wastewater treatment may remove as much as 99.9999+ percent of the fecal coliform bacteria; however, the resulting effluent has detectable levels of enteric bacteria, viruses, and protozoa, including Cryptosporidium and Giardia.[288] These data suggest that wastewater discharges are contributing enteric pathogens to ambient surface waters, many of which may be used downstream for drinking purposes. It is now known that most documented outbreaks of waterborne disease in the United States are caused by protozoan and viral pathogens in waters that have met coliform standards.[289]

Wastewater Reuse

Literature Search on the Use of Reclaimed Water for Various Recreational and Municipal Purposes (Indicator)

Reuse of municipal wastewater has become increasingly important during the past several decades due to the growth in urban population, constraints on the development of new water sources, and more stringent treatment requirements to protect the quality of the receiving water for aquatic life. The use of reclaimed water for non-potable purposes can greatly reduce the demand on potable water sources in areas lacking sustainable, high-quality water supplies. Reuse is practiced extensively in the United States and around the world. California, Arizona, and Florida are at the forefront of water reuse.[290] In 1995, for example, the USGS[291] reported that more than one billion gallons per day of reclaimed water were used in the United States; reported use for California and Arizona was 334 and 180 million gallons per day, respectively. Reuse of municipal reclaimed water is presently about 4.8 billion gallons per day in the United States, or about one percent of all freshwater withdrawals.[292]

Reclaimed water is most commonly used for non-potable purposes, such as agriculture, landscape irrigation, power plant cooling, industrial processing, dust control, and fire

[285] Bouwer, 1994
[286] National Research Council, 2003
[287] Id.
[288] Rose et al., 1996
[289] National Research Council, 2003
[290] Solley et al., 1998
[291] Id.
[292] U.S. Department of Energy, 2001

suppression. Other non-potable applications include recreational and environmental uses, ranging from aesthetic ponds and ornamental fountains to full-scale development of water-based recreational sites for swimming, fishing, and boating.[293] Non-potable reuse is a widely accepted practice that will continue to grow.[294]

Although most reclaimed water projects have been developed to meet non-potable water demands, a number of projects use reclaimed water indirectly for potable purposes. These projects include numerous groundwater recharge facilities that have operated successfully for many years to replenish public drinking water supplies.[295] Additional treatment of the reclaimed water occurs during groundwater recharge from natural filtration by the underground sediments and rock formations.[296] The resulting soil-aquifer treatment removes essentially all of the suspended solids and microorganisms that may be present and substantially reduces the concentration of metals, nitrogen, phosphate, ammonia, and dissolved organic compounds in the reclaimed water.[297] Further, although there is only limited research available, a recent study indicates that more than 90 percent of the hormonally active compounds (synthetic organic compounds that can block, mimic, stimulate, or inhibit the production of natural hormones) in wastewater are removed during soil-aquifer treatment, primarily by biodegradation.[298]

The use of higher levels of treatment makes reclaimed water a technically and economically feasible source of potable water.[299] The practice of direct potable reuse, however, is generally not practiced due to the lack of public acceptance. In the future as water supplies become scarcer and the costs for acquiring and treating new supplies increase, direct potable reuse may become more acceptable. Residents of Orange County, California have broadly embraced plans for a $487 million "toilet-to-tap" project that promises to provide dependable, cheaper supplies to water scarce Southern California. The project, when it comes on line in 2007, will purify enough wastewater to serve 140,000 households.[300]

Discussion of Existing Water Rights and the Ability to Implement the Proposed Snowmaking With or Without Procuring Additional Water Rights (Indicator)

The City of Flagstaff has agreed to provide the Snowbowl with up to 1.5 million gallons per day (MGD) of Class A+ reclaimed water for snowmaking purposes from the beginning of November through the end of February each winter. The source of water is the Rio de Flag Water Reclamation Facility (WRF). The contract is for a period of five years with terms for renewal of three(3) additional five (5) year periods. Currently, this same water is used to irrigate City parks and school playgrounds, but is mostly unused in the winter. Treated water that is not reused is discharged to Rio de Flag drainage, where it creates a limited reach of dependent riparian habitat in the normally dry river channel. The extent of surface water downstream from the Rio de Flag

[293] U.S. Environmental Protection Agency, 2003a
[294] Id.
[295] U.S. Environmental Protection Agency, 2003a
[296] Bouwer et al., 2002
[297] Bouwer et al., 2002a
[298] Zhang et al., 2003
[299] National Research Council, 2003
[300] Los Angeles Daily News, 2004

WRF is limited by infiltration that occurs via fractures and sink holes in the exposed Kaibab Formation terrain.

In the western United States, the right to use water has developed through a series of federal and state laws and judicial actions. A water right entitles the right-holder to use water; it is not a right of ownership but rather a right of use. The state generally retains ownership of so-called natural or public waters within its boundaries, and state statutes, regulations, and case law govern the allocation and administration of the rights of private parties and governmental entities to use such water. The main types of water rights in Arizona are surface water and groundwater rights. Each type of right is governed by different laws.

In a semi-arid state, such as Arizona, water rights are often controversial and frequently a matter of legal dispute and intervention. The right to the use of reclaimed water in Arizona is no exception, and was established by the 1989 decision of the Arizona Supreme Court in the case of *Arizona Public Service v. Long*.[301] In this case, the Arizona Supreme Court determined that effluent is neither surface water nor groundwater and cities can put the reclaimed water to any reasonable use they see fit, within existing legislative restrictions. In reaching this decision, reclaimed water was determined not to be subject to regulations under Arizona's surface water or groundwater code. The Court ruled that effluent discharges are subject to appropriation by downstream users, but the cities were not obligated to continue discharge of the effluent to satisfy the needs of downstream appropriators.

The case of *Arizona Public Service v. Long* clarifies the legal basis for the City of Flagstaff to sell reclaimed water for reuse. The use of reclaimed water by the Snowbowl, as well as other customers currently using reclaimed water for irrigation, is not restricted by water rights.

RIO DE FLAG WATER RECLAMATION FACILITY

Description and Quantification of the Rio de Flag Water Reclamation Facility's Historic Seasonal Discharges (Indicator)

The Rio de Flag WRF was constructed in 1992 following a comprehensive evaluation of the City of Flagstaff's future water and sewer needs. At that time, the city's wastewater was treated at the Wildcat Hill Wastewater Treatment Plant (WWTP) in east Flagstaff, which was nearing total design capacity. The Rio de Flag WRF was built to provide four millions gallons per day (MGD) of additional wastewater treatment capacity, with the potential for expansion to six MGD. The plant was designed to provide advanced treatment of wastewater to produce Grade A+ reclaimed water (detailed in the Water Quality of the Rio de Flag WRF section, below) for unrestricted non-potable reuse. This requires, in addition to conventional primary and secondary wastewater treatment, advanced treatment for nitrogen removal, ultraviolet disinfection, and filtration. At the time of construction, the city installed approximately 10 miles of distribution piping for the reclaimed water system, allowing for reclaimed water deliveries to major irrigation and recreation users throughout the city.

[301] McGinnis, 1990

Overview of the Rio de Flag WRF Treatment Process

The Rio de Flag WRF receives raw wastewater from the Rio de Flag interceptor sewer at a location where approximately half of the city's sewer flow can be obtained. The process uses screening, primary sedimentation, aeration, secondary sedimentation, filtration, and disinfection.

In the primary treatment stage, solids settle out as sludge in the primary clarification tanks and are sent to the Wildcat Hill WWTP via sewer pipeline for digestion. Scum and odors are also removed at the primary clarification point. Wastewater is then gravity-fed for secondary treatment through the aeration/denitrification process, where biological digestion of waste occurs. The process used for biological treatment is the Bardenpho Process, in which a two-stage anoxic/aerobic process removes nitrogen, suspended solids, and BOD from the wastewater. The secondary clarifiers remove the by-products generated by this biological process, recycle microorganisms back into the process from return activated sludge, and separate the solids from the waste system. The waste sludge is sent to the Wildcat Hill WWTP for treatment. The water for reuse then passes through the final sand and anthracite filters prior to disinfection by ultraviolet light radiation. At this point, the reclaimed water may be either pumped to a two million gallon reclaimed water tank at Buffalo Park to be gravity-fed into the reclaimed water distribution system, or discharged into the Rio de Flag. Water supplied for reuse is further treated with a hypochlorite solution to assure that residual disinfection is maintained in the reclaimed water system.

Due to the close proximity of the Rio de Flag WRF to the central part of the city of Flagstaff, the plant was designed and constructed to minimize impacts to surrounding land uses. The treatment components are fully enclosed and utilize an activated carbon system to remove odors prior to venting the clean air to the atmosphere.

Pre-treatment Program

The national pretreatment program under the CWA controls the discharge of pollutants to municipal wastewater treatment plants by industrial users. Discharges to treatment plants are regulated primarily by the plant operator, rather than the Federal or State government.

The City of Flagstaff has developed a local pretreatment program to control industrial discharges into the city sewer system. The program has been approved by EPA and ADEQ. As part of the pretreatment program, the Industrial Waste Monitoring Division of the City of Flagstaff Utilities Department monitors various industries that discharge wastewater to the municipal sewer system and specifies local limits, as applicable, for dischargers to assist the city in achieving compliance with its AZPDES permit.

According to sewer use records from January 1999 to April 2001, industrial sources contributed approximately 20 percent of the total inflow to the Rio de Flag WRF.[302] Industrial discharges originate from eight significant industrial users (SIUs) to the city sewers. In a recently-completed Local Limits Study, 23 primary pollutants of concern were identified for the Wildcat Hill WWTP and Rio de Flag WRF.[303] The pollutants include 11 metals and inorganic

[302] Pirnie, M., 2002
[303] Id.

compounds, eight organic compounds, nitrogen compounds (nitrate and nitrite), and levels of BOD and suspended solids. These pollutants are considered to represent the greatest risk for non-compliance with permit limitations for discharges under the City's AZPDES permit and APP. Pollutants of concern are identified by evaluating the chemicals present in waste streams from the SIUs, the background levels of the chemicals present in natural waters and non-industrial sources, the efficiency of the city wastewater treatment plants to remove the pollutants, and analysis of relevant regulatory numerical discharge limits. Lastly, although discharges of non-industrial pollutants are difficult to characterize, key non-industrial pollutants, such as pesticides, nitrogen, and volatile organic compounds that present concerns for fire and explosion hazards in the collection system, are included as pollutants of concern.

The Rio de Flag WRF has treated wastewater at an average rate of 681 million gallons per year (1.87 MGD) during the past four years. The most recent data from 2002 indicate that approximately 25 percent of the wastewater treated at the WRF was beneficially reused in the Reclaimed Water System and 75 percent was discharged as Grade A+ treated effluent to the Rio de Flag channel. The reuse is highly seasonal; two thirds of the reuse occurs from May through August, when the average demand for reclaimed water has been about one MGD. In 2003, demand for reclaimed water increased to nearly two MGD due to the opening of the Pine Canyon Golf Course. In contrast, only about 55,000 gallons per day of reclaimed water were used in the winter months of November through February, representing only four percent of the City's annual water reuse from the Rio de Flag WRF.

Description and Quantification of Current Uses of Reclaimed Water Within the City of Flagstaff by Season (Indicator)

The Rio de Flag WRF currently provides reclaimed water for turf irrigation to the Catholic Cemetery; Northern Arizona University; Pine Canyon Golf Course; Flagstaff Medical Center; the Flagstaff public school system; and the city's public parks, facilities, and cemetery. Reclaimed water from the Wildcat Hill WWTP is used for irrigation at golf courses, public parks, and the Christmas tree farm, and for dust control at various locations in east Flagstaff.

WATER QUALITY OF THE RIO DE FLAG WRF

Discussion of the Applicability of the Rio De Flag WRF NPDES Permit to the Proposed Snowmaking Application (Indicator)

Description of the Certification Process for Allowing Class A Water to be Used for Snowmaking (Indicator)

The regulatory programs governing reclaimed water reuse have been developed in a risk-based framework to protect public health and minimize the hazards associated with potential exposures. ADEQ developed the Reclaimed Water Permit Program to define conditions and requirements for reuse of treated municipal wastewater. The program specifies reclaimed water standards and defines five classes of reclaimed water. Class A reclaimed water is the highest quality and is required for reuse applications where there is a relatively high risk of human exposure to treated effluent. For uses where the potential for human exposure is lower, Class B and Class C reclaimed water are acceptable. The Reclaimed Water Quality Standards include two "+" categories of reclaimed water, Class A+ and Class B+. The "+" designation indicates that treatment is used to decrease the total nitrogen concentration to less than 10 mg/L in the

reclaimed water. Wastewater treatment facilities providing reclaimed water for reuse must identify the class of reclaimed water generated by the facility.

The use of reclaimed water for snowmaking was originally studied as a means of storing effluent during winter when land application was not feasible. Studies and full-scale use of reclaimed water in snowmaking have been conducted in Colorado, Michigan, and Maine. The site studies showed that converting wastewater to snow improved its quality upon melting and subsequent discharge to surface waters. Snowmelt from reclaimed water exhibited a substantial reduction in nutrients, BOD, and suspended solids.[304]

According to studies conducted by the U.S. Army Corps of Engineers,[305] the process of freezing and repeated freeze-thaw cycles also destroy bacteria in reclaimed water. Results indicated that more than 99.9 percent of the total coliform bacteria and more than 99 percent of the fecal coliform bacteria were removed in the snowmelt from a non-chlorinated secondary wastewater effluent supply used in snowmaking. Other species of bacteria were affected less. The studies also found that many species of bacteria survived the multiple freeze-thaw cycles and reproduced in the resultant snowmelt. Furthermore, much of the snowmelt infiltrated into the ground, where additional soil-aquifer treatment and contaminant removal occurred before groundwater was discharged into streams.

The use of reclaimed water for snowmaking at commercial skiing operations is beginning to gain recognition. Reclaimed water for snowmaking has been proposed as a method of supplementing snowmaking at ski areas throughout the eastern United States[306] and in Australia.[307] Reclaimed water has been used to make snow since 1985 at the Seven Springs Mountain Resort, located southeast of Pittsburgh, Pennsylvania. Seven Springs has an extensive snowmaking system that is supplemented with up to 600,000 gallons per day of reclaimed water.[308] Reclaimed water used for snowmaking at Seven Springs is gray water derived from wastewater treatment lagoons. The gray water is discharged to a series of ponds, which receive water from springs and on-site stormwater runoff prior to reuse applications. Effluent is also used at the resort in the summer for golf course irrigation.

The State of Arizona allows Class A and A+ reclaimed water for direct reuse in snowmaking. Due to the relatively high risk of human exposure to potential contaminants in reclaimed water, ADEQ has developed strict and specific treatment requirements for reuse applications having higher degrees of public contact, such as skiing, that include secondary treatment, filtration, and disinfection. In meeting these requirements, the reclaimed water is considered acceptable for unrestricted recreational use.

All wastewater treatment facilities providing reclaimed water for reuse must have an Individual Aquifer Protection Permit (APP), or amend their existing APP to contain certification for a

[304] Wright Water Engineers, 1988; Wright-Pierce Engineers, 1999; Maine Lagoon Task Force, 2003
[305] Parker et al., 2000
[306] U.S. Environmental Protection Agency, 1992
[307] Tonkovic and Jeffcoat, 2002; ABC Online, 2003
[308] S. Eutsey, personal communication

particular class of reclaimed water. The Rio de Flag WRF operates under a 1997 APP[309] that was reissued with Significant Amendment in April, 2002. The APP was amended to classify the Rio de Flag WRF for production of Class A+ reclaimed water. The amended APP allows the city to operate the Rio de Flag WRF with a maximum average monthly flow of 4.0 MGD and reuse effluent under a Reclaimed Water Individual Permit[310] that was issued in May 2002. The APP is valid for the life of the facility and the Reclaimed Water Permit must be renewed every five years.

Documentation of Compliance with State and Federal Water Quality Standards Regarding Class A Wastewater and its Uses (Indicator)

The Rio de Flag WRF is authorized to discharge treated wastewater to the Rio de Flag under NPDES Permit[311] (currently referred to as an AZPDES Permit since the program has been delegated to State authority) that was issued in November 1999. Effluent limitations and monitoring requirements are specified for a wide variety of conventional wastewater treatment parameters, trace metals, organic chemicals, and priority pollutants. Additionally, the discharge is periodically monitored for chronic toxicity by prescribed whole effluent toxicity (WET) tests. The WET test replicates, to the greatest extent practicable, the actual environmental exposure of aquatic life to the aggregate toxic effects of a wastewater discharge.[312]

The AZPDES Permit requires that water quality of the reclaimed water meet State Surface Water Quality Standards (SWQS) for discharge to the Rio de Flag. The Arizona Department of Environmental Quality (ADEQ) has assigned designated uses of partial-body contact (PBC) and aquatic and wildlife for effluent-dependent water (A&Wedw) to the receiving waters of the Rio de Flag WRF.

More than 40 years of experience in water reuse has led to formulation of guidelines, rules, and water quality standards for a variety of reuse applications. Arizona, together with California and Florida, are among the few states that have developed enforceable programs and specific requirements for treatment, treatment reliability criteria, and water quality standards for various reuse applications to protect public health and the environment.[313] The level of treatment and water quality criteria are based on the expected degree of contact with reclaimed water by the public and aquatic animals and plants.

As noted in the previous sections, the Rio de Flag WRF has three water permits that govern wastewater reclamation, reuse, and facility discharges. The ADEQ administers these permits.

Monitoring data for the AZPDES Permit is submitted in monthly Discharge Monitoring Reports (DMRs) to ADEQ. Monthly DMRs for 2001 and 2002 were reviewed to document compliance with the permit terms and conditions. All regulated parameters in the reclaimed water met established numerical limits for designated uses of PBC and A&Wedw assigned to the Rio de

[309] APP P-102421
[310] R-102421
[311] AZ0023639
[312] U.S. Environmental Protection Agency, 2003b
[313] National Research Council, 2003

Flag. The reclaimed water also met the numerical criteria for all protected end uses of Arizona surface water, including designated uses with much more restrictive criteria than PBC and A&Wedw.

EPA and ADEQ conduct annual inspections of the Rio de Flag WRF to assure the facility is operated and maintained in compliance with Federal and State regulations. NPDES inspection reports obtained for the past four years indicate that no deficiencies were found in the operation and maintenance of the Rio de Flag WRF.

Monitoring data for the APP and the Reclaimed Water Permit is submitted to ADEQ in quarterly Self-Monitoring Report Forms (SMRFs). Quarterly SMRFs obtained for 2001 and 2002 indicate full compliance with permit terms and conditions. All regulated parameters in the reclaimed water met established numerical limits for Aquifer Water Quality Standards, which are equivalent to EPA Primary Drinking Water Standards. Additionally, of the enteric viruses or parasites tested in reclaimed water, none have been detected.

ADEQ was interviewed to appraise the Rio de Flag WRF operations and confirm the facility compliance status. In a letter dated September 9, 2003, ADEQ stated that its review of the facility file and existing information in the wastewater compliance, enforcement, and tracking database indicates the Rio de Flag WRF is in compliance with the APP and the AZPDES Permits. Further discussions with the Northern Regional Office, Water Permits Section, and Water Quality Compliance Section of the ADEQ Water Quality Division confirmed there were no known compliance issues or operating concerns associated with the Rio de Flag WRF. ADEQ staff openly commended the exemplarily performance of the Rio de Flag WRF and City of Flagstaff Utilities Division.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF ENVIRONMENTAL CONSEQUENCES AND CONCLUSIONS

Major conclusions and determinations of this Watershed Resources analysis are summarized below. A more detailed analysis of the direct and indirect environmental consequences – from which this summary was derived – follows.

Direct Effects

The proposed snowmaking and facility improvements considered in Alternative 2 would have the net effect of increasing groundwater recharge and solute concentrations in groundwater in the areas where snowmaking would be implemented. Under dry year or wet year less overall groundwater recharge – attributable to the applied snowmaking – would result than those calculated for average precipitation conditions. Groundwater recharge occurring in areas of proposed snowmaking would contain larger concentrations of TDS, TOC, total nitrogen, and other dissolved constituents from the reclaimed water than groundwater recharge from natural precipitation. However, the solute concentrations would be decreased substantially from concentrations in the reclaimed water by commingling and blending with natural precipitation. For example, projected average concentrations of TDS and TOC in recharge in the Snowbowl sub-area, where more than 90 percent of the snowmaking activity would take place, are projected to be reduced by a factor of four from reclaimed water concentrations.

Although the proposed implementation of Alternative 2 would increase the amount of groundwater recharge and solute concentrations in groundwater recharge in the immediate vicinity of the Snowbowl, it would not comprise a direct impact on any groundwater users or potential receptors in the Snowbowl sub-area or Agassiz sub-watershed because there are no wells, springs, or other discharges of groundwater in these areas.

The proposed facilities improvements associated with Alternative 3 would not have any consequential direct effects on groundwater recharge or groundwater water quality in the Snowbowl sub-area or the Agassiz sub-watershed.

Indirect Effects

The net effects of additional groundwater recharge and water quality changes from the use of reclaimed water for snowmaking over time may potentially comprise an indirect effect on groundwater users or potential receptors that are outside the immediate areas of proposed snowmaking in Hart Prairie. Snowmaking and associated additional groundwater recharge may potentially increase groundwater availability and the concentration of solutes in groundwater downgradient from the Snowbowl. The nearest known groundwater users and potential receptors are the private wells, springs, and stock tanks in Hart Prairie. As shown in Figure 3H-1, the wells, springs, and stock tanks are located more than 3,500 feet west and down slope from the nearest areas of proposed snowmaking at the Snowbowl.

Due to the complex movement of groundwater through the surficial deposits and underlying volcanic deposits in this area, it is difficult to specifically determine the sources of shallow groundwater for the perched aquifers in the Hart Prairie area. Therefore, the degree to which any change in groundwater availability or water quality resulting from implementation of Alternative 2 actions would impact the wells, springs, and stock tanks in this area can not be projected with certainty. Consequently, the potential contribution and effect of any additional recharge from areas of snowmaking to specific potential receptors in Hart Prairie can not be precisely projected. However, the projections of groundwater recharge and water quality impacts for the Hart Prairie watershed discussed can provide a conceptual approximation of the potential magnitude of impacts to groundwater users in this area. Based on these projections, the snowmaking proposed in Alternative 2 may contribute a minor amount of groundwater to underlying aquifers, including the perched aquifers in the Hart Prairie watershed. The additional groundwater could possibly benefit groundwater users and other potential receptors, such as wildlife and vegetation that are supported by the shallow perched groundwater system and small springs and associated seeps. The overall effect, however, is not expected to be significant due to the small incremental increase to water supply, which is on the order of five percent of the projected existing Hart Prairie groundwater recharge, in years of average precipitation.

The limited degree by which the proposed snowmaking may impact groundwater availability and water quality to potential receptors in Hart Prairie is further substantiated by research conducted by NAU faculty and students in the Fern Mountain Botanical Area and Homestead at Hart Prairie. For example, Gavin[314] created a predictive numerical groundwater flow model to determine what change from average precipitation conditions would be necessary to create a minimum depth to water requirement for Bebb willow germination at one spring location in the

[314] Gavin, A., 1998

Fern Mountain Botanical Area. Model simulations indicate it would require a minimum of an eight percent increase in recharge from average conditions to create minimum conditions favorable to recruit and maintain new willow seedlings.

While the water quality impact to downgradient groundwater users in Hart Prairie can not be projected with any certainty, it is clear there would be substantial attenuation of solute concentrations as the reclaimed water in artificial snow combines with natural precipitation, infiltrates from the area of snowmaking, and blends with other groundwater recharge and groundwater in storage as it moves downgradient to the perched aquifers underlying Hart Prairie. It is expected that certain nutrients and dissolved organic constituents in reclaimed water would be removed though physical, chemical, and biological uptake during infiltration in surficial soils and underlying sediments. Based on calculations of blending and resulting chemical quality of water projected to be available for groundwater recharge in the Hart Prairie watershed, there may be more than an order of magnitude decrease in concentration of solutes, such as TDS and TOC, from the reclaimed water used in snowmaking to the resulting groundwater underflow to the Hart Prairie watershed. Consequently, although there could be potential increases of dissolved salts and other constituents of reclaimed water in groundwater downgradient from the areas of snowmaking, the water quality impact is likely to be limited due to the substantial extent of groundwater recharge resulting from yearly precipitation in all but the driest climatic conditions throughout Hart Prairie and the upper sub-watersheds compared to that derived from proposed snowmaking.

DETAILED ANALYSIS OF DIRECT AND INDIRECT EFFECTS

Quantification of Anticipated Annual Water Use

Use of reclaimed water for snowmaking purposes between November and February of each year could affect aquifer recharge.

Indicators:

Quantification Of Anticipated Snowmaking Water Use in Average Dry, Median, and Wet Years

Quantification of Anticipated Total Consumptive Water Losses (i.e., Evaporation, Evapotranspiration, Sublimation) Resulting from Proposed Snowmaking

Direct and indirect environmental consequences for the three alternatives were evaluated by projecting hydrologic conditions for average, dry, and wet climatic conditions based on calculations of precipitation, snowmaking water use, watershed losses, and groundwater recharge, and by making assumptions for chemical quality of reclaimed water and natural precipitation.

Direct impacts of the proposed use of reclaimed water for snowmaking were estimated by calculating and comparing the volume and chemical quality of groundwater recharge projected to occur in the immediate proximity of snowmaking areas (Snowbowl sub-area and Agassiz sub-watershed, shown on Figure 3H-1).

Indirect impacts were determined by calculating and comparing the volume and chemical quality of groundwater recharge that is assumed may potentially impact users of groundwater yielded

from wells, seeps, or springs in the watersheds that receive groundwater underflow from the snowmaking areas of the Snowbowl sub-area.

Projected hydrologic conditions under all three alternatives for the Snowbowl sub-area, Agassiz sub-watershed, and the Hart Prairie watershed are given in tables 3H-1, 3H-2, and 3H-3.

Alternative 1 – No Action

Under the No Action Alternative, implementation of snowmaking infrastructure would not occur, and current conditions as presented above would be expected to persist. No machine-produced snow would be applied within the project area.

Alternative 2 – The Proposed Action

Under the Proposed Action, a total of 205.2 acres of snowmaking terrain would be implemented at the Snowbowl. This terrain would be primarily implemented within the Snowbowl Sub-area, with smaller acreages implemented in other proximal watersheds.

The depth of snow that would be initially produced on existing and proposed terrain would result in an average coverage depth across all terrain types of slightly more than 25 inches of snow. Estimated operational conditions under the varying climatic scenarios are outlined as follows:[315]

1. Once all the trails have been covered with the specified depth of snow, resurfacing operations would typically commence to recover from any thaws and replenish snow that has become hardened through wear and temperature cycling. The amount of resurfacing required would depend on natural snowfall. In a wet year, it is estimated that only the initial application would be required. This application could be spread out over the season if there was abundant snow early in the year, or it could be concentrated at the beginning of the season if the bulk of the snow arrives after December.

2. On an average year, it is estimated that an additional half-application of machine-produced snow would be required after the initial coverage for a seasonal total of 1.5 coverages.

3. On a dry year, it is estimated one additional full application of machine-produced snow would be required after the initial coverage for a seasonal total of two coverages.

Snowbowl Sub-area

The reader is referred to Table 3H-6 for this discussion of hydrologic impacts to the Snowbowl Sub-area.

[315] Sno.matic, 2003

Average Precipitation Years

The Proposed Action would likely have the net effect of increasing groundwater recharge in the areas where snowmaking would be implemented. In average years, the proposed snowmaking operations in Alternative 2 are estimated to contribute approximately 187 AF of additional recharge within the Snowbowl sub-area. This snowmaking contribution represents an increase of approximately 14 percent when compared to the average volume of natural groundwater recharge estimated to occur in this very limited area of San Francisco Mountain.

Low Precipitation Years

In dry years, when snowmaking is increased, the available water for recharge is substantially decreased due to increased atmospheric losses from evaporation, evapotranspiration, and sublimation in the watershed; snowmaking would contribute a larger fraction of the total recharge, although less water in absolute terms. Table 3H-6 indicates that in the dry-year precipitation analysis, approximately 40 AF of additional water is estimated to be available for recharge due to snowmaking operations; this volume represents a 30-percent increase in recharge from estimated natural ground water recharge.

Above-Average Precipitation Years

In wet years, when snowmaking is not as necessary, much more snowmelt is available to recharge and it contains a substantially smaller proportion of machine-produced snow than in dry and average years. Estimated water losses would comprise a smaller fraction of the available precipitation; therefore, the additional estimated recharge contributed from snowmaking is a smaller fraction of the total estimated recharge. In the wet-year case, approximately 106 AF of additional water is estimated to be available for recharge due to snowmaking operations; this volume represents a four percent increase in recharge from estimated natural ground water recharge.

Table 3H-6
Projected Hydrologic Conditions in the Snowbowl Sub-Area

	Area (Acres)	Pptn (AF/yr)	Snow-making (AF/yr)	Watershed Loss (AF/yr)	Recharge (AF/yr)	Diff. in Recharge compared to Existing (AF/yr)	Projected Groundwater Concentrations			Projected Mass Loading		
							TDS (mg/L)	TOC (mg/L)	Nitrogen (mg/L)	TDS (kg/ha)	TOC (kg/ha)	Total N (kg/ha)
DRY YEAR												
Existing Conditions	1,060.8	1,190.2	0	1,057.5	132.6	--	26.9	0.0	4.5	10.3	0.0	1.7
Alternative 2	1,060.8	1,190.2	446	1,464.1	172.1	*+39.5*	901.9	20.7	19.0	445.9	10.3	9.4
Alternative 3	1,060.8	1,190.2	0	1,033.8	156.4	*+23.8*	22.8	0.0	3.6	10.3	0.0	1.7
AVERAGE YEAR												
Existing Conditions	1,060.8	2,892.0	0	1,545.6	1,346.4	--	6.4	0.0	1.1	24.9	0.0	4.2
Alternative 2	1,060.8	2,892.0	334	1,692.9	1,533.2	*+186.8*	79.7	1.7	2.3	351.2	7.7	9.9
Alternative 3	1,060.8	2,892.0	0	1,522.9	1,369.1	*+22.7*	6.3	0.0	1.1	24.9	0.0	4.2
WET YEAR												
Existing Conditions	1,060.8	4,408.0	0	1,604.4	2,803.6	--	4.7	0.0	0.8	38.0	0.0	6.3
Alternative 2	1,060.8	4,408.0	223	1,681.7	2,909.9	*+106.3*	30.6	0.6	1.2	255.8	5.1	10.2
Alternative 3	1,060.8	4,408.0	0	1,581.9	2,826.1	*+22.5*	4.7	0.0	0.8	38.0	0.0	6.3

Notes: Assumes reclaimed water has: 340 mg/L TDS, 8 mg/L TOC, and 6 mg/L total nitrogen
Assumes precipitation has: 3 mg/L TDS, 0 mg/L TOC, and 0.5 mg/L total nitrogen
Assumes all solute mass is conserved; therefore, solutes are concentrated as watershed losses occur

Pptn = precipitation TDS = total dissolved solids mg/L = milligrams per liter AF/yr = acre feet per year TOC = total organic carbon kg/ha = kilograms per hectare
N = Nitrogen

Agassiz Sub-Watershed

For the Agassiz sub-watershed (Table 3H-7), the proposed snowmaking operations are estimated to contribute limited additional groundwater recharge in average, dry, or wet years. Compared to existing conditions, the volume of recharge for Alternative 2 is estimated to be roughly 17 AF (three percent) greater in an average year, essentially no change in a dry year, and 11 AF (one percent) greater in a wet year.

Table 3H-7
Projected Hydrologic Conditions in the Agassiz Sub-Watershed

	Area (Acres)	Pptn (AF/yr)	Snow-making (AF/yr)	Watershed Loss (AF/yr)	Recharge (AF/yr)	Diff. in Recharge Over Existing (AF/yr)	Projected Groundwater Concentrations		
							TDS (mg/L)	TOC (mg/L)	Total N (mg/L)
DRY YEAR									
Existing Conditions	768.8	790.1	0	790.1	0.0	--	NA	NA	NA
Alternative 2	768.8	790.1	40	830.2	0.0	0	NA	NA	NA
Alternative 3	768.8	790.1	0	790.1	0.0	0	NA	NA	NA
AVERAGE YEAR									
Existing Conditions	768.8	1,919.9	0	1,240.1	679.9	--	8.5	0.0	1.4
Alternative 2	768.8	1,919.9	30	1,276.7	697.3	+17.4	22.9	0.4	1.6
Alternative 3	768.8	1,919.9	0	1,260.6	683.5	+3.6	8.4	0.0	1.4
WET YEAR									
Existing Conditions	768.8	2,926.3	0	1,283.9	1,642.4	--	5.3	0.0	0.9
Alternative 2	768.8	2,926.3	20	1,350.9	1,652.9	+10.5	9.4	0.1	1.0
Alternative 3	768.8	2,926.3	0	1,330.5	1,646.0	+3.6	5.3	0.0	0.9

Notes: Assumes precipitation has: 3 mg/L TDS, 0 mg/L TOC, and 0.5 mg/L total nitrogen
Assumes all solute mass is conserved; therefore, solutes are concentrated as watershed losses occur

Pptn = precipitation TDS = total dissolved solids mg/L = milligrams per liter AF/yr = acre feet per year
TOC = total organic carbon kg/ha = kilograms per hectare N = Nitrogen

Hart Prairie Watershed

As noted, indirect effects from snowmaking activities associated with the Proposed Action may potentially impact the surrounding areas down slope from the Snowbowl SUP area, including: 1) Hart Prairie, with four small springs and associated seeps and a number of shallow wells yielding groundwater from shallow perched aquifers; and 2) along the southwest flank of Agassiz Peak, where four small springs yield groundwater from shallow perched aquifers. Hart Prairie is the primary area of indirect effects because it is in the watershed that receives infiltration from more than 90 percent of the snowmaking areas.

The nearest known groundwater users and potential receptors are the private wells, springs, and stock tanks in Hart Prairie that are more than 3,500 feet downgradient from the area of proposed snowmaking. The reader is referred to Table 3H-8. Implementation of Alternative 2 may contribute a minor amount of groundwater to underlying aquifers including the perched aquifers in the Hart Prairie watershed. Because recharge infiltrates rapidly to underlying aquifers, and the local recharge near the springs is projected to be sufficient to provide the observed discharge, it

is not known if any groundwater recharge from the areas of snowmaking reaches the shallowest perched aquifers down slope at the springs in Hart Prairie. However, to the extent it does contribute to discharge at the springs, the additional recharge from Alternative 2 would benefit groundwater users and other potential receptors, such as wildlife and vegetation that are supported by the shallow perched groundwater system and small springs and associated seeps. The overall effect, however, is not expected to be major due to the small incremental increase to water supply, which is on the order of five percent of the projected existing Hart Prairie groundwater recharge, in years of average precipitation.

Average Precipitation Year

In an average precipitation year, the proposed snowmaking activity in the Proposed Action is projected to contribute approximately 187 AF of additional groundwater recharge from the Snowbowl sub-area within the Hart Prairie watershed. This recharge contribution represents an increase of more than four percent to the volume of groundwater recharge projected to occur due to infiltration of natural precipitation in the Hart Prairie watershed in average precipitation years.

Below Average Precipitation Year

In the dry-year case, approximately 39 AF of additional groundwater recharge is attributed to Alternative 2 activities; this volume is an increase of roughly 17 percent from the projected existing conditions.

Above Average Precipitation Year

In the wet-year case, roughly 198 AF of additional recharge is projected to occur in the Hart Prairie Watershed; this volume is an increase of roughly two-percent from existing conditions.

Table 3H-8
Projected Hydrologic Conditions in the Hart Prairie Watershed

	Area (Acres)	Pptn (AF/yr)	Snow-making (AF/yr)	Watershed Loss (AF/yr)	Recharge (AF/yr)	Diff. in Recharge Over Existing (AF/yr)	Projected Groundwater Concentrations		
							TDS (mg/L)	TOC (mg/L)	Total N (mg/L)
DRY YEAR									
Existing Conditions	4,249.9	4,353.8	0	4,125.5	228.3	--	57.2	0.0	9.5
Alternative 2	4,249.9	4,353.8	446	4,532.1	267.7	31.1	615.2	13.3	18.1
Alternative 3	4,249.9	4,353.8	0	4,101.8	252.1	23.8	50.2	0.0	8.6
AVERAGE YEAR									
Existing Conditions	4,249.9	10,579.1	0	6,295.4	4,283.7	--	7.4	0.0	1.2
Alternative 2	4,249.9	10,579.1	334	6,442.6	4,470.5	186.8	32.5	0.6	1.6
Alternative 3	4,249.9	10,579.1	0	6,272.7	4,306.4	22.7	7.4	0.0	1.2
WET YEAR									
Existing Conditions	4,249.9	16,124.5	0	6,583.5	9,540.9	--	5.1	0.0	0.8
Alternative 2	4,249.9	16,124.5	223	6,569.2	9,738.9	198.0	12.8	0.2	1.0
Alternative 3	4,249.9	16,124.5	0	6,561.0	9,563.4	22.5	5.1	0.0	0.8

Notes: Assumes precipitation has: 3 mg/L TDS, 0 mg/L TOC, and 0.5 mg/L total nitrogen
Assumes all solute mass is conserved; therefore, solutes are concentrated as watershed losses occur

AF/yr = acre feet per year TDS = total dissolved solids Pptn = precipitation TOC = total organic carbon
N = nitrogen mg/L = milligrams per liter

Alternative 3

Proposed vegetation and soil disturbance associated with Alternative 3 would result in a slight calculated difference in watershed losses compared to the existing conditions. In the Snowbowl sub-area, the proposed Alternative 3 improvements are projected to result in approximately one to two percent decrease in atmospheric losses and a corresponding increase in recharge in an average precipitation year. Overall, changes of this limited magnitude are not expected to have any consequential impacts on environmental or hydrologic conditions with respect to the water resource issues.

Snowbowl Sub-Area

Without the addition of snowmaking, Alternative 3 would contribute less additional ground water recharge than the Proposed Action in average, dry, and wet years. As indicated Table 3H-6, in the average year analysis, roughly 23 AF of additional water is estimated to be available for recharge; this volume represents a 1.7-percent increase in recharge from estimated existing conditions. Increases during dry and wet years are estimated to be about 18 percent and about one percent, respectively.

Agassiz Sub-Watershed

The facilities improvements proposed without snowmaking in Alternative 3 have about the same effect as Alternative 2 on estimated volumes of groundwater recharge in dry and wet years (Table 3H-7), and provide less recharge than Alternative 2 in an average year.

Water quality and use of reclaimed water in the snowmaking system.

The application of Class A reclaimed water for snowmaking within the SUP area may affect water quality within the receiving sub-watersheds.

Indicators:

Analysis of Potential Water Quality Effects Of Using Reclaimed Water in the Snowmaking System to Downgradient Users

Alternative 1 – No Action

Under the No Action Alternative, no new construction or watershed modification would occur. Present hydrogeologic conditions would effectively continue during the planning horizon of this document.

Alternative 2 – The Proposed Action

Recharge estimates from simulated hydrologic conditions for average, dry, and wet years were used to project effects on water quality from snowmaking operations. Projected concentrations of total dissolved solids (TDS), total organic carbon (TOC), and total nitrogen in groundwater recharge are given in tables 3H-6 and 3H-7. Projected concentrations were calculated as the weighted average of reported concentrations of these solutes in reclaimed water from the Rio de Flag WRF and precipitation in northern Arizona. Solute concentrations in the source waters are conserved in the mixing calculation and are assumed to be completely retained in the resulting groundwater recharge. Therefore, it is assumed that, although water is lost from the source waters via evapo-sublimation, all of the solute mass in the source waters remains in the resulting recharge. Table 3H-6 also shows the projected mass loading of solutes in annual groundwater recharge within the Snowbowl Sub-area expressed as kilograms per hectare (kg/ha).

This analysis projects solute concentrations only in the water *available* for groundwater recharge. It does not project the absolute solute concentrations in groundwater *resulting from* recharge because: 1) it neglects the complex biogeochemical processes that occur and result in losses and uptake of solutes during interaction with vegetation, soils, and underlying sediments; and 2) there are no data to estimate the seasonal volumes of perched groundwater available to commingle and blend with the recharge water. It is well documented that nutrients and dissolved organic matter are assimilated to varying degrees during infiltration and percolation of water through soil and sediments. Therefore, this analysis provides a conservative, semi-quantitative assessment of potential dilution and attenuation, over large areas, of solute concentrations from reclaimed water when combined with natural precipitation in groundwater recharge and the available amounts of solutes for uptake or migration into groundwater.

TDS was evaluated as a general indicator of inorganic water chemistry and potential changes that may occur in concentrations of inorganic solutes when combined with snowmelt from artificial snow and natural precipitation in the study area watersheds. For the purpose of water quality projections, the TDS concentration in reclaimed water was assumed to be a constant 340 milligrams per liter (mg/L). Actual TDS concentrations in reclaimed water from the Rio de Flag WRF are somewhat variable depending on several factors, including the water sources used for municipal supply by the City of Flagstaff. The City provided TDS concentrations detected in laboratory chemical analyses for nine samples of reclaimed water obtained from the Rio de Flag

WRF from 1993 to 2001. The TDS concentrations ranged from 320 to 360 mg/L; average concentration was 341 mg/L. While data is insufficient to precisely assess seasonal variability, there appears a trend toward higher TDS concentrations in summer than in winter.

Reported TDS concentrations available for natural precipitation in northern Arizona are sparse, and there is no such data for the Snowbowl area. However, data for chemical quality of natural precipitation are available for snow samples obtained from the Mogollon Rim in north-central Arizona and for snow and rainfall samples obtained at the South Rim of Grand Canyon as part of the National Atmospheric Depositional Program.[316] Based on these data, the TDS concentration in natural precipitation at the Snowbowl was assumed to be 3 mg/L.

TOC was evaluated as a general indicator of the dissolved component of organic matter and wastewater compounds and potential changes that may occur in TOC concentrations when combined with natural precipitation. This evaluation did not consider the interaction of dissolved TOC in soils and the subsurface environment which may remove organics through complexation or other physical and chemical processes. TOC is considered in this analysis because it is becoming more common as a surrogate measure of gross organic content and as a practical indicator of the presence of many unidentified and unregulated residual organic contaminants in reclaimed water.[317] For the purpose of water quality projections, TOC concentration in reclaimed water was assumed to be a constant 8.0 mg/L. Actual TOC concentration in reclaimed water is variable. TOC concentrations were detected in laboratory chemical analyses for 19 samples of reclaimed water obtained from the Rio de Flag WRF from 1993 to 2001. The TOC concentrations ranged from 1.7 to 17 mg/L; average concentration was 7.8 mg/L. Data are insufficient to assess seasonal variability

Natural precipitation in Alpine environments is not expected to contain significant concentrations of TOC. Studies[318] indicate that small concentrations (in the magnitude of 20 micrograms per liter) of the organic ions, acetate and formate, were detected in snow throughout the Mogollon Rim and larger concentrations have been reported for snow near major population centers. For the purpose of water quality projections, the TOC concentration in precipitation in the Snowbowl area was assumed to be zero.

Total nitrogen was evaluated as a general indicator of nutrient loading from the presence of nitrogen- and phosphorous-based compounds in reclaimed water and potential changes in concentration when combined with natural precipitation. This evaluation did not consider biological uptake, bacterial decomposition, or other nitrogen removal mechanisms. For the purpose of water quality projections, total nitrogen concentration in reclaimed water was assumed to be 6.0 mg/L. Actual total nitrogen concentration in reclaimed water from the Rio de Flag WRF is measured monthly and reported in quarterly SMRFs submitted to ADEQ for APP compliance. In 2002, total nitrogen concentration ranged from 4.1 to 6.6 mg/L in samples obtained from the reclaimed water. Most of the nitrogen detected was in the form of nitrate, which ranged in concentration from 3.1 to 5.0 mg/L (as nitrogen). Smaller amounts of nitrogen are present as ammonia and other inorganic and organic nitrogen compounds.

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[316] NADP, 2003

[317] McEwen and Richardson, 1996; Crook and Sakaji, 2000

[318] Barbaris and Betterton, 1994

Nitrogen in the form of nitrate and ammonium ions is present at trace concentrations in natural precipitation. According to 2002 NADP precipitation data, the average nitrate and ammonium concentrations were 1.26 mg/L and 0.31 mg/L, respectively. Data collected at the NADP site at the South Rim of Grand Canyon indicates an increasing trend in nitrogen ion species since testing began in 1981. Based on the 2002 data, the total nitrogen concentration in precipitation was assumed to be 0.5 mg/L (as nitrogen).

The proposed implementation of Alternative 2 and additional groundwater recharge associated with use of reclaimed water for snowmaking would increase the concentration of solutes in groundwater. Groundwater recharge that occurs in areas of proposed snowmaking would contain larger concentrations of TDS, TOC, total nitrogen, and other dissolved constituents from the reclaimed water than groundwater recharge from natural precipitation. However, the solute concentrations would be decreased substantially from concentrations in the reclaimed water by commingling and blending with natural precipitation. For example, projected average concentrations of TDS and TOC in recharge in the Snowbowl sub-area, where more than 90 percent of the snowmaking activity is proposed to take place, would be reduced by a factor of four from reclaimed water concentrations.

The additional solute contribution from the reclaimed water used for snowmaking would increase the concentration of solutes in groundwater recharge that occurs in the Hart Prairie watershed. However, the water quality impact to downgradient groundwater users in Hart Prairie can not be projected with any certainty. As described above, it is not known if any groundwater recharge originating in the vicinity of the Snowbowl and areas of proposed snowmaking contributes to the discharge from springs in Hart Prairie; most or all of it may infiltrate to the deeper perched aquifers in Hart Prairie before it reaches the spring areas. It is expected, though neglected in the quantitative projections of impact, that certain nutrients and dissolved organic constituents in reclaimed water would be removed though physical, chemical, and biological uptake during infiltration in surficial soils and underlying sediments. It is also clear there would be substantial attenuation of solute concentrations as the reclaimed water in artificial snow combines with natural precipitation, infiltrates from the area of snowmaking, and blends with other groundwater recharge and groundwater in storage as it moves downgradient to the underlying perched aquifers. Based on calculations of blending and resulting chemical quality of water available for groundwater recharge in the Hart Prairie watershed, there may be more than an order of magnitude decrease in concentration of solutes, such as TDS and TOC, from the reclaimed water used in snowmaking to the resulting groundwater recharge in the Hart Prairie area. Consequently, although there could be potential increases of dissolved salts and other constituents of reclaimed water in groundwater downgradient from the areas of snowmaking, the water quality impact is not likely to be significant due to the substantial extent of recharge that occurs in all but the driest climatic conditions throughout Hart Prairie and the upper sub-watersheds compared to that derived from proposed snowmaking.

Snowbowl Sub-area

Table 3H-1 gives the TDS, TOC, and total nitrogen concentrations and mass loading projected for groundwater recharge in the Snowbowl sub-area for Alternative 2. For an average precipitation year, the projected TDS concentration is about 80 mg/L, TOC concentration is 1.7 mg/L, and total nitrogen concentration (as nitrogen) is 2.3 mg/L. Average precipitation yields an

estimated mass loading of about 350 kg/ha for TDS, 8.0 kg/ha for TOC, and 10 kg/ha for total nitrogen (as nitrogen).

It is important to re-emphasize that these projections are neither absolute nor anticipated concentrations in groundwater because: 1) varying biological, chemical, and physical processes modify solute concentrations as groundwater interacts with vegetation, soils, and subsurface sediments; and 2) there are no data to estimate seasonal volumes of perched groundwater available to commingle and blend with the recharge water. The practical value of these projections is to provide a semi-quantitative assessment of the decrease in solute concentrations in reclaimed water when combined with natural precipitation for groundwater recharge. In this case, it is shown that concentrations of TDS, TOC, and total nitrogen in reclaimed water are decreased substantially by factors ranging from about two to four prior to being further diluted by groundwater in the subsurface and decreased by the other processes described above. In this manner, a proper perspective can be developed for the relative environmental impact of the use of reclaimed water for snowmaking.

For dryer-than-average years, snowmaking would be intensified and atmospheric water losses would be higher, and these conditions would have the effect of increasing solutes in the water infiltrating as recharge. Concurrently, the drier conditions would limit the volume of water available for recharge. In the case of very dry conditions, such as is assumed herein for the range of climatic conditions, precipitation would be very limited and the percolation of groundwater in the unsaturated zone downward to the perched aquifers would be impeded. In very dry climatic conditions, the mobility of dissolved solutes in the unsaturated zone would be effectively slowed until wetter climatic conditions and greater flux of infiltrated water subsequently could remobilize the accumulated solutes. In wetter-than-average conditions, the converse would be true. Increased precipitation and associated groundwater recharge would substantially decrease solute concentrations in the unsaturated zone and eventually in the perched groundwater zones. The net effect of changes in groundwater recharge from alternating dry, average, and wet climatic conditions would be to dilute and attenuate the flux of solute concentrations reaching the underlying perched aquifer system.

Agassiz Sub-watershed

Table 3H-7 provides projected solute concentrations in groundwater recharge in the Agassiz sub-watershed. Inspection of this table indicates that the TDS, TOC, and total nitrogen concentrations are projected to be about 23 mg/L, 0.3 mg/L, and 1.6 mg/L, respectively, in average-year precipitation conditions. Although these concentrations are larger than comparable concentrations assumed for water available for groundwater recharge from natural precipitation, the concentrations of TDS and TOC are decreased by more than an order of magnitude from concentrations in the reclaimed water.

Hart Prairie Watershed

Tables 3H-6 and 3H-8 provide the projected solute concentrations in the water available for groundwater recharge in the Snowbowl sub-area and Hart Prairie watershed. As demonstrated by the projected groundwater recharge, the combined area that comprises the Hart Prairie watershed contributes more natural precipitation to recharge and consequently reduces the projected solute concentrations. The groundwater from this combined area is calculated to have

a bulk concentration of about 33 mg/L TDS, 0.6 mg/L TOC and 1.6 mg/L total nitrogen, assuming groundwater recharge from the Snowbowl sub-area blends with recharge in the surrounding Hart Prairie watershed. The projected values illustrate that resulting concentrations of TDS and TOC are more than an order of magnitude smaller than those in the reclaimed water. The projected total nitrogen concentration is not decreased to the same degree due to the input of total dissolved nitrogen compounds present in natural precipitation.

Due to the distant location of the four small springs downgradient from the Agassiz sub-watershed (Figures 3H-1 and 3H-3) and limited overall change in solute concentrations (Table 3H-7), the anticipated indirect effects to water quality at these springs from Alternative 2 are considered to be negligible.

Alternative 3

The facilities improvements proposed in Alternative 3 have a less significant effect on projected water quality impacts to groundwater recharge. Projected water quality resulting from Alternative 3 is very similar to that projected for existing conditions discussed with Alternative 1.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of the cumulative effects analysis for watershed resources extends from the initial development of the Snowbowl in 1938 into the foreseeable future for which this and other projects can be expected to continue within and surrounding the Snowbowl SUP area.

Spatial Bounds

The physical extent of this cumulative effects analysis comprises the three primary watersheds depicted on Figure 3H-1 (the Hart Prairie watershed, Agassiz sub-watershed, and Snowbowl sub-area) as well as portions of the surrounding Kachina Peaks Wilderness area.

Past, Present, and Reasonably Foreseeable Future Actions

Past, present, and reasonably foreseeable activities having potential to cumulatively affect watershed resources include:

1. San Francisco Mountain Mineral Withdrawal
2. Bebbs Willow Restoration Project
3. Transwestern Lateral Pipeline Project
4. Inner Basin Water Pipeline Maintenance
5. Private Land Development
6. Miscellaneous Recreational Uses
7. Inner Basin Well Field

8. Use of City of Flagstaff Reclaimed Water
9. City of Flagstaff Water Well Fields

Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 - No Action

None of the identified past, present or reasonably foreseeable activities would combine with the effects anticipated under the No Action Alternative to create any major cumulative watershed resource effects. (Refer to Proposed Action discussion.)

Alternative 2 – The Proposed Action

As indicated below, none of the identified past, present or reasonably foreseeable activities would combine with the effects anticipated under the Proposed Action to create any major cumulative watershed resource effects.

San Francisco Mountain Mineral Withdrawal

The Peaks and surrounding area was withdrawn from availability for mineral entry in 2000. This action precludes individuals and entities from staking a mineral claim in preface to planned extraction activities within the withdrawn area. This action has and will provide added protection for soil and watershed resources by limiting potential ground disturbing activities associated with mining.

Bebbs Willow Restoration Project

Activities have been undertaken by The Nature Conservancy, Northern Arizona University, and the Forest Service to improve ecosystem conditions of the Bebbs willow-wet meadow community located in Hart Prairie through prescribed burning and tree thinning. The objective of the restoration project is to improve the hydrologic function in the 170-acre Fern Mountain Botanical Area by increasing groundwater availability in the shallow perched aquifer and springs which support the riparian habitat. The impacts from the prescribed burning and tree thinning are not considered to be long-term or major with respect to cumulative watershed impacts when analyzed cumulatively with the alternatives addressed within this EIS.
As described in the analysis of indirect effects, the snowmaking proposed in Alternative 2 may contribute a minor amount of groundwater to underlying aquifers, including the perched aquifers in the Hart Prairie watershed. The additional groundwater recharge associated with the proposed snowmaking, which is around four percent of the volume of average groundwater recharge projected to occur, is not sufficient to recruit new willow in Hart Prairie. As mentioned previously, research conducted by NAU in the Fern Mountain Botanical Area and Homestead at Hart Prairie indicate it would require a minimum of an eight percent increase in recharge from average conditions to create minimum conditions favorable to recruit and maintain new willow seedlings.[319]

[319] Gavin, 1998

Transwestern Lateral Pipeline Project

This project is not within the spatial or temporal bounds of this cumulative effects analysis related to potential watershed effects; therefore, there are no cumulative effects to watershed resources associated with this project.

Inner Basin Water Pipeline Maintenance

This project is not within the spatial or temporal bounds of this cumulative effects analysis related to potential watershed effects; therefore, there are no cumulative effects to watershed resources associated with this project.

Private Land Development

Private land development within the watershed of the proposed Snowbowl improvements may lead to localized water resource impacts. The primary concern is associated with septic system discharges from the Snowbowl combined with those from a number of scattered private residences in lower Hart Prairie. Septic waste disposal has potential to cause local groundwater bacterial contamination, particularly where shallow groundwater may interfere with proper leach field function. In areas that are more developed, such as Fort Valley, there have been occasional, but major, impacts of enteric bacteria and other septic wastes to shallow wells.[320] Due to the low-density development in the Hart Prairie area, the overall concern for fecal contamination in the watershed is generally low. Private land development in the Hart Prairie watershed is presently limited and likely to remain low density due to Coconino County zoning restrictions and availability of land and water supplies. Additionally, because these homes do not have power or winter road access, they are primarily used during the summer months when wastewater discharges from the Snowbowl are at their lowest levels. Therefore, the overall effect of potential water quality degradation from area-wide septic systems is expected to be negligible. The affects of septic waste disposal may, however, result in localized impacts within the sub-watersheds.

Other land development concerns include land disturbance from road and home-building, waste products from domestic livestock, and groundwater withdrawal from private wells. Due to the low-density of existing and planned private land developments within the analysis area, impacts from such development are considered to be inconsequential with respect the cumulative watershed impacts.

Miscellaneous Recreational Uses

Recreational use in the Hart Prairie area is moderate and will probably increase in the future. Individuals and groups use the area for recreational activities including hiking, camping, horseback riding, bicycling, and cross-country skiing. The recreational land use may cause loss of vegetative ground cover, soil compaction, and biological pollution leading to possible watershed effects. Generally, such disturbances are dispersed, localized, and insignificant with respect to their contribution to cumulative watershed impacts. Additionally, the Forest Service has developed best management practices to mitigate current and future recreational land uses.

[320] Arizona Department of Environmental Quality, 1997

Inner Basin Well Field

The Inner Basin well field for the City of Flagstaff lies outside the proposed areas of snowmaking and associated snowmelt runoff from the proposed Snowbowl operations. Due to the spatial separation of these two areas, both in distance and hydrogeologic features, activities at the Snowbowl can not impact the perched aquifers that supply groundwater within the Inner Basin to city wells.

Use of City of Flagstaff Reclaimed Water

Reclaimed water diverted to the Snowbowl would not be available for other reuse, such as irrigation of turf and dust suppression, within the City of Flagstaff. However, City of Flagstaff Utilities Department records indicate there are only limited demands for reclaimed water during the winter months when the proposed diversion to the Snowbowl would occur. For instance, the Rio de Flag WRF produces, on average, approximately 1.9 million gallons of reclaimed water per day but diverts only around 55,000 gallons of reclaimed water per day for reuse during the period of November through February. Due to limited irrigation demands in the winter months, reuse is not projected to be significant in the future. Therefore, no major cumulative effects were identified for Snowbowl diversion of reclaimed water on water reuse in Flagstaff.

City of Flagstaff Water Well Fields

Public comments submitted as a portion of this analysis process indicated concerns regarding the consumptive use of reclaimed water for snowmaking and the potential impact on recharge to the regional C-aquifer in Flagstaff. The primary concern expressed within the public comments is that the use of reclaimed water for snowmaking would reduce winter discharges of treated wastewater to the effluent-dependent waters of the Rio de Flag, which directly recharges the regional C-aquifer. The comments note that water reuse for snowmaking would result in substantially larger losses due to sublimation and evaporation at the Snowbowl and, therefore, substantially less water would be available for recharge to the regional aquifer.

As previously discussed, the right to the use of reclaimed water in Arizona was established by the 1989 decision of the Arizona Supreme Court in the case of *Arizona Public Service v. Long*.[321] In this case, the Arizona Supreme Court determined that effluent is neither surface water nor groundwater and cities can put the reclaimed water to any reasonable use they see fit, within existing legislative restrictions. Based upon this decision, the authority of the city to provide reclaimed water to the Snowbowl is not subject to decision by the Forest Service and is therefore not within the jurisdictional purview of this analysis.

Although this issue extends well beyond the scope of this EIS, data generated during the preparation of this analysis provides a quantitative basis to assess these public comments. The following discussion is provided as general information but will not be specifically considered in selecting an alternative.

[321] McGinnis, 1990

As noted by Bills et al.,[322] some chemical constituents associated with effluent have been detected at some wells along the Rio de Flag drainage in east Flagstaff. These data, together with increases in groundwater storage in the Rio de Flag area reported by Bills et al., indicate that recharge of effluent occurs in the Rio de Flag area. However, effluent recharge has occurred in this area, particularly in the Fox Glenn area and the Country Club Golf Course reservoirs, long before the Rio de Flag WRF was built. There are presently no data available to provide conclusive estimates for the amount or rate of recharge of treated effluent from the Rio de Flag WRF. Estimates given by Schwartzman and Springer[323] assume that all discharged effluent that escapes evapotranspiration contributes recharge to the regional aquifer; this assumption overestimates the recharge because vadose zone processes and perched groundwater zones are likely to intercept some of the recharge, even where fractures and sinkholes occur along the Rio de Flag. This is not to say that rapid recharge does not occur along fractures in some areas, but the assumption that all of it becomes recharge is not accurate.

The potential changes in recharge to the regional aquifer, assuming effluent discharged to from the Rio de Flag WRF provided such recharge with only evapotranspiration losses, are summarized in Table 3H-9.

Table 3H-9
Comparative Groundwater Recharge Estimates
Analysis of Four-Month Projected Recharge to the Regional Aquifer
as based on Average Year Precipitation

	Existing Conditions (AF)	Proposed Action (AF)	Change in Recharge (AF)
Treated effluent released to the Rio de Flag[a]	632	268	
Evapotranspiration loss from Rio de Flag[b]	10	4	
Projected recharge from Rio de Flag	622	264	-358
Reclaimed water use for snowmaking[c]	0	364	
Projected groundwater recharge from snowmaking[d]	0	204	204
Net Change In Recharge			*-154*

[a] Amount of treated effluent released to the Rio de Flag is based on 2002 monthly discharges for the four-month period from November through February reported by the City of Flagstaff Utilities Department.
[b] Estimated evapotranspiration losses are extrapolated from calculations for evapotranspiration in the water budget prepared by Schwartzman and Springer (2002).
[c] Estimates for reclaimed water requirements for snowmaking are provided for average-year precipitation conditions by Sno.matic Controls and Engineering, Inc. (2003).
[d] Estimates of groundwater recharge are derived from modeling results (Resource Engineering, Inc., 2003) for average-year precipitation in the combined Snowbowl sub-area and Agassiz sub-watershed.

Based on data developed in this study and as noted in Table 3H-9, proposed snowmaking would result in an estimated net average reduction in groundwater recharge to the regional aquifer of 154 AF per year. This calculated reduction represents slightly less than two percent of the City of Flagstaff's total annual water production (as averaged over the 10 year period from 1992 to 2001).

[322] Bills, D.J., et al., 2000
[323] Schwartzman, P., and Springer, A., 2002

The assumed change in average potential recharge to the C-aquifer in east Flagstaff (364 AF per year or 226 gpm) is calculated to cause the equivalent of 20 to 25 feet of additional water level drawdown in the nearest future production well, the Rio well, after five years, but less than one foot at the other existing production wells in east Flagstaff. This calculation is made using the Theis equation with an average transmissivity of 3,000 gallons per day per foot (average of reported values for immediate area), storage coefficient of 0.05 and 0.1 (based on data for immediate area), and distances from the flowing reach of the effluent-dependent Rio de Flag of 0.25 mile for the Rio well and 1.9 miles for the Fox Glenn well. It is recognized that the Theis equation is based on porous media, not fractured media; however, this equation is commonly used for such analyses despite its limitations and is appropriate for this case. For perspective, the Arizona Department of Water Resources criterium for excessive water level drawdown impact on existing wells due to pumping at new wells in an Active Management Area, such as Prescott, is 10 feet of drawdown in the first five years of pumping.

Based on these analyses, the cumulative impact from Snowbowl diversion of treated effluent on the water available for recharge in the Rio de Flag drainage in the Flagstaff city limits is considered to be negligible for overall change in aquifer recharge and for C-aquifer wells more than ½ to ¾ mile from the effluent flow in the Rio de Flag. Cumulative impact is considered to be moderate for C-aquifer wells nearer to the effluent flow in the Rio de Flag. Therefore, there is negligible to moderate cumulative watershed impact identified for this issue in relation to the alternatives analyzed.

Alternative 3

None of the identified past, present or reasonably foreseeable activities would combine with the effects anticipated under Alternative 3 to create any major cumulative watershed resource effects.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

No irreversible or irretrievable effects or commitments to watershed resources are anticipated as a result of implementation any of the alternatives.

3I. SOILS AND GEOLOGY

SCOPE OF THE ANALYSIS

The proposed application of machine-produced snow may have the effect of increasing total water availability, potentially leading to an increase in the duration, intensity, and/or quantity of total annual snowmelt. Therefore, this analysis of soils and geology was limited to existing and proposed areas of disturbance within the Snowbowl SUP area, as well as terrain proposed to receive snowmaking coverage. Eight sub-watersheds in the vicinity of the SUP area having potential to change under the Proposed Action were analyzed in order to make an assessment of current and projected annual water balance for use in addressing the indicators in the Environmental Consequences section.

EXISTING CONDITIONS

CLIMATE

The climate of the San Francisco Peaks, similar to other areas in the state of Arizona, is characterized by a cyclic regime of winter precipitation, spring drought, summer precipitation, and fall drought.[324] Precipitation typically arrives from the northwest in the winter, while its origin is from the southeast in the summer. Winter precipitation, frequently snow at higher elevations, is associated with frontal storms moving into the region from the Pacific Northwest. Surface heating in the winter is less pronounced than in the summer, thus wintertime upslope air movement is comparatively slow. Wintertime cloud cover is common, and precipitation is frequently widespread and relatively low in intensity, promoting infiltration and groundwater recharge.

The primary source of moisture for summer rains is the Gulf of Mexico. This moisture moves into the highlands from the southeast, passes over highly heated and mountainous terrain, rises rapidly, cools, and condenses. Summer storms, primarily convectional, are often intense and local rather than widespread. As a result, summer precipitation creates much less groundwater recharge when compared to the winter season. Summer rains typically begin in early July, breaking the prolonged spring drought and provides relief from the hot weather of June and July.

Winter precipitation is more variable than summer rainfall in amount and time of occurrence from year-to-year. However, yearly variations in precipitation generally decrease with increases in elevation. Winter precipitation is generally responsible for the majority of the annual recharge produced in the region. Spring drought is often more detrimental to most plants and animals in the region than the fall drought, due to the higher temperatures and wind conditions during the beginning of the growing season.

Several weather stations are located near the Snowbowl, but no single station adequately characterizes the Snowbowl's climatic regime. In order to arrive at a site-specific set of climate variables for the purposes of modeling the annual water balance at Snowbowl, several sources were examined. Spatially-distributed precipitation estimates from the Parameter-elevation

[324] Beschta et al., 1974; Campbell et al., 1982

Regressions on Independent Slopes Model (PRISM) [325] were used to characterize the average-year monthly distribution of precipitation for the project area. PRISM is a system that uses point data and a digital elevation model (DEM) to generate gridded estimates of climate parameters. PRISM is well-suited to mountainous regions, because the effects of terrain on climate play a central role in the model's conceptual framework. PRISM provides a robust methodology for inference of the average-year monthly climate distribution. Dry and wet year climate parameters were inferred from the average-year PRISM using modifiers computed from nearby regional SNOTEL sites.

The results of this precipitation analysis procedure are summarized as an average among all delineated sub-watersheds for the Snowbowl SUP area as a whole and are presented in Table 3I-1.

Table 3I-1
Monthly Precipitation
Arizona Snowbowl Project Area

Month	Precipitation (Inches)		
	Average Year	Dry Year	Wet Year
January	2.7	0.6	7.2
February	2.7	0.4	5.1
March	3.4	1.1	5.2
April	2.0	0.4	2.0
May	1.0	0.2	0.7
June	0.7	0.3	0.4
July	4.0	2.1	2.4
August	4.0	1.4	4.5
September	2.4	2.3	5.2
October	1.9	0.9	1.7
November	2.5	0.8	3.0
December	2.8	1.9	8.4
Total	***30.0***	***12.4***	***45.7***

Source: Resource Engineering, Inc., 2003

For temperature, proximal SNOTEL stations provide long-term high-elevation records, although the nearest sites, including Fry, Mormon Mountain, and White Horse Lake, are all at lower elevations. In order to derive temperature data, records from Fry, the SNOTEL site closest to the Snowbowl, were selected and elevation-adjusted via the dry adiabatic lapse rate. Inferred monthly mean, maximum, and minimum temperature trends for the Arizona Snowbowl vicinity are portrayed in Table 3I-2.

[325] Daly et al., 1994

Table 3I-2
Monthly Temperatures
Arizona Snowbowl Project Area

Month	Air Temperature (ºF)		
	Average	Max	Min
January	13.6	31.8	1.2
February	15.7	34.1	3.1
March	20.3	39.2	6.1
April	26.9	46.1	11.2
May	34.2	54.9	15.9
June	40.9	65.0	20.7
July	45.1	73.0	29.2
August	44.7	72.1	29.3
September	39.4	67.6	22.8
October	28.2	55.4	13.5
November	19.1	38.4	6.1
December	13.3	31.3	1.5

Source: Resource Engineering, Inc., 2003

The period of record used in the PRISM model's data averaging and interpolation process reflects composited inputs from many weather observation stations over the 1960-1990 time period, including NOAA-National Weather Service, BLM RAWS, NRCS-SNOTEL, and other climate-recording sites. It is important to note that this time period represents a relatively moist climate in comparison to long-term climatic trends. Based on tree-ring re-constructions of past climate, the last 200 years have been the wettest period within the past 2200 years within the Southwestern United States.[326] Furthermore, the past 20 years reflect precipitation 23 percent higher than the long-term paleoclimatic average.[327] The long-term tree-ring climatic record also shows that periods of much drier climate of long duration are common in the Southwest, including time periods within the late-1200's and the mid-1600's where five-year total precipitation was only 50 to 60 percent of average.

Nonetheless, the need exists within the context of the present study for climate information that uses a robust and high-resolution spatial interpolation mechanism to account for the climatological effects of elevation and topography. The PRISM data provides the best available spatially distributed climate data source. In addition, it is important to recognize that in order to derive the dry-year climate used within the water balance calculations for the present study, the 1960-1990 PRISM average dataset was adjusted using modifier coefficients derived from 2002 SNOTEL data, the dry year of record within the available SNOTEL datasets. Examining a 1,000 year tree-ring historical climate reconstruction specific to Arizona's northwest climate zone, only 22 years within the past 1,000 years were as dry or dryer than 2002.[328] Therefore, the dry-year climate referenced in Table 3I-1 and used within this study's water-balance calculations, does capture a dry extreme even when compared to the long-term climate record.

[326] Merideth 2001.
[327] Id.
[328] CLIMAS 2002.

CLIMATE CHANGE

The reader is referred to the Air Quality section of the document, Chapter 3 Section M, for a more detailed analysis of climate change.

WATER BALANCE

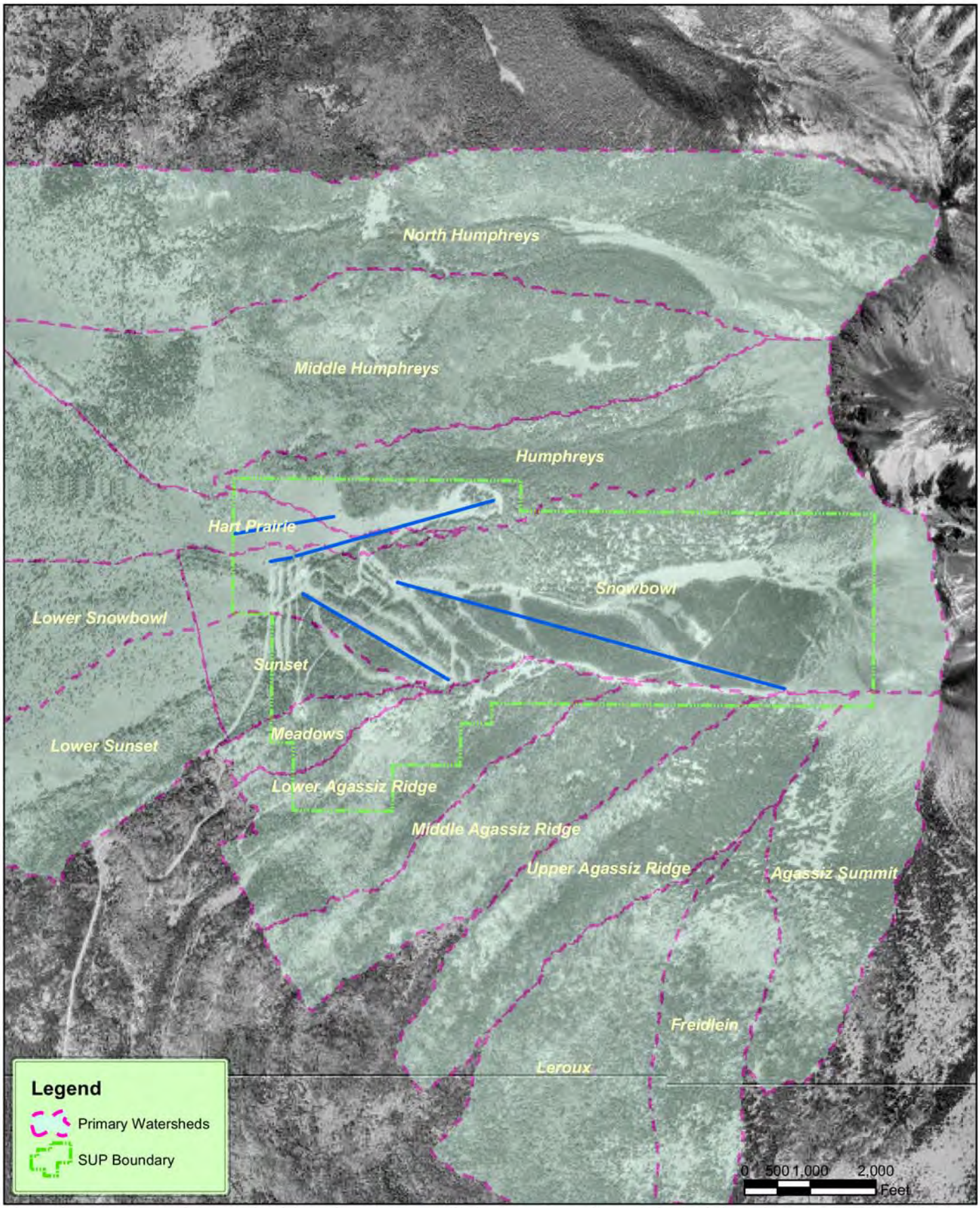
The primary watersheds within the Snowbowl SUP area were derived from available digital elevation data. The spatial extent and acres of existing ski trails within each of these watersheds is outlined in Table 3I-3. The table shows only watersheds that would experience changes under the proposal.

Table 3I-3
Sub-Watershed Characteristics

Watershed	Watershed Area (acres)	Acres of Developed Trails
Hart Prairie	820.2	17.5
Humphreys	284.1	21.1
Lower Agassiz Ridge	232.2	5.5
Middle Agassiz Ridge	229.1	2.8
Snowbowl	648.5	86.3
Sunset	79.6	5.3
Upper Agassiz Ridge	263.2	0.3
Total	***5,692.3***	***138.8***

Source: Resource Engineering, Inc., 2003

The location and extent of these primary watersheds are indicated in Figure 3I-1.



Delineated Watersheds
Figure 3I-1

ARIZONA SNOWBOWL

File: 994-1.0
Date: 09/26/2003

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1 inch equals 2,000 feet

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There are no continuous records available to assess the annual water balance within these small tributary watersheds. Therefore, water balance scenarios for existing conditions for average, dry, and wet years were developed using water balance techniques and snowmelt modeling as outlined in detail in two publications: An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources (WRENSS)[329] and the Water Management Research Project Handbook.[330] Within the infiltrative andesols[331] predominant on the slopes of the San Francisco Peaks, little to no net surface runoff is produced from the basins. Thus, the water balance may be characterized by precipitative input, atmospheric and watershed losses, and re-charge to soil and groundwater.

The present water balance for these watersheds is affected by the existing terrain network. Various land management actions can, intentionally or unintentionally, affect the water balance. For example, numerous studies have demonstrated that timber harvest or eradication, as by wildfire, tends to increase water yield and streamflow.[332] The creation of openings for ski trails involves timber harvest and, as a result, decreases the amount of water loss to the atmosphere. This can potentially increase the amount of water available for routing through the watershed, via either surface runoff or infiltration. The mechanisms for this include: 1) decreasing the amount of evapotranspiration (use of water by plants) through timber removal; 2) decreasing snow loss associated with interception (the trapping of snow in the forest canopy until it is sublimated or evaporated to the atmosphere); 3) accelerating runoff (more rapidly removing water from the forest thereby reducing the amount available on-site for plant use); and 4) increasing deposition in openings (reducing airborne snow particle ablation[333] and loss). In addition, in the case of groomed ski trails, it is theorized that snow grooming may affect water yield through modifications in snowpack density by grooming equipment and skiers.

Assessing the existing water balance requires an estimation of the amount of excess water available from forested and open areas under pre-developed conditions, and a subsequent determination of the relative change produced by the trail system and snowmaking.

To accomplish this, a water balance is computed that determines the amounts of precipitation and evapotranspiration associated with each contributing area, the remainder being water potentially available for recharge. A computer model, called the Subalpine Water Balance Simulation Model,[334] has been developed by the Forest Service to create such a balance.

In concept, the model takes seasonal precipitation applied to a locale that is defined in terms of vegetation, by type and density, and aspect and then subtracts the evapotranspirational demands of the vegetation to compute the amount of water potentially available for runoff or re-charge. To reflect changes in vegetation due to timber removal, the model modifies evapotranspirational demands to reflect altered vegetation density, defined as basal area or cover density.

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[329] Troendle, C.A., and Leaf, C.F., 1980

[330] Leaf, C. F., 1986, Colorado Ski Country USA, 1986

[331] Soils formed mainly in volcanic ash or cinders, exhibiting andic soil properties.

[332] Troendle, C.A. et al., 2001b; Wilm H.G. and E.G., Dunford, 1948; Satturland, D.R. and H.F. Haupt, 1967; Hoover, M.D., 1971; Gary, H.L., 1974; Troendle, C.A., 1979; Schmidt, R.A., 1991; Birkeland, K.W., 1996

[333] Ablation is the mechanical destruction of snow and ice particles.

[334] Leaf and Brink, 1973a and b

The Subalpine Water Balance Model was used to develop a procedure and a set of nomographs[335] to aid analysts in making non-point source pollution assessments. That procedure formed WRENSS. The numerous detailed data inputs required by the model were reduced in the WRENSS procedure by making a large number of model runs and using the results to develop the above-mentioned nomographs. This simplification and the use of evapotranspiration modifier coefficients facilitate the analysis while not significantly diminishing the value of the output.

The water balance of the WRENSS model is coupled with a snowmaking hydrology computation process developed as a result of a 1986 study, commissioned by Colorado Ski Country USA. This study assessed water consumption attributable to snowmaking uses. The study found that initial losses, those essentially occurring at the snowmaking gun, are a function of relative humidity and temperature at the time of snowmaking, and average approximately six percent.[336] Additional watershed losses include sublimation, evaporation, and evapotranspiration, and occur as a function of aspect, elevation, and vegetation. The sublimation loss component is of particular interest in the micro-climate of the San Francisco Peaks. The wintertime climate within the San Francisco Peaks frequently exhibits periods of dry weather with persistent sunshine, interspersed with periodic snowstorms. Meanwhile, high winds frequently occur on the Peaks due to their high elevation in relationship to the predominant elevation of the surrounding terrain. These factors can contribute to substantial snowpack loss via atmospheric sublimation.[337]

Sublimation

Avery et al. conducted a sublimation measurement experiment over the 1990/91 and 1991/92 winter seasons at two sites in Flagstaff, one located on the NAU campus, and a second located at Pulliam Airport.[338] Two sublimation-measurement devices were emplaced at each site: one shielded from open sky conditions; and another exposed to ambient sky conditions. The 1990/91 season exhibited an unusually dry mid-winter period, with the result that the sublimation metering devices were dry, and no data was logged from mid-January through early March. The 1991/92 winter season exhibited above average precipitation due to the influence of El Niño conditions, and provided a more continuous record of sublimation measurements, with only a brief gap in data during early February. Over the course of the experiment the mean daily observed evapo-sublimation loss was 0.06 inch of water equivalent per day, averaged over days with no precipitation. The maximum rate was observed to be 0.31 inch of water equivalent per day, and was observed during dry, clear, and windy conditions.

Sublimation rates are highly spatially variable, and are dependent on temperature, wind speed, solar radiation, and humidity. However, in order to facilitate a reasonable analysis of the effects of snowmaking on the water balance of the project area, an estimate of the amount of snow water equivalent lost from sublimation from the snowpack is required. The results of the 1993 Avery et al. study provide sublimation observations over the course of two seasons of observation,

[335] A graph consisting of curves graduated for a number of variables, establishing a relationship between multiple related values.
[336] Leaf, C.F., 1986
[337] Higgins, 1998
[338] Avery et al., 1993

offering the most temporally extensive dataset available. Therefore, for the average- and wet-year scenarios, Avery et al.'s mean daily rate of 0.06 inch of water equivalent sublimation loss per day was applied to the machine-produced snowpack throughout the course of the snowmaking season. As a conservative assumption, this loss rate was applied uniformly, without consideration for days with cloudy sky conditions or precipitation, during which lower or zero sublimation rates could be realized. For dry-year scenarios, the maximum observed loss rate of 0.31 inch of water equivalent per day, observed during the 1993 Avery et al. study, was applied following the same methodology.

The nomographs and evapotranspiration modifier coefficients of the WRENSS model are grouped into eight regional categories within the continental United States. The Snowbowl project area is situated within region (4): Rocky Mountain/Inland Intermountain Region (snow dominated precipitation regimes). This particular WRENSS region covers a large spatial extent, ranging from Arizona and New Mexico at its southern extreme, to Montana and Southern Idaho at its northern extreme. The WRENSS groupings reflect the experimental watershed data used to derive and calibrate the regional coefficients appropriate to that category. Experimental data from the Forest Service Beaver Creek and Thomas Creek experimental watersheds within Arizona were included in the population of data used in the original WRENSS analyses; however, the preponderance of available experimental data within region (4) was derived from watersheds situated in more northern climates.[339]

Because of the unique wintertime climate of the Arizona mountain regions, in which warm temperatures can influence losses from the snowpack during winter months, the region (4) evapotranspiration nomographs were examined in comparison to data from the Beaver Creek experimental watershed, in order to evaluate the potential need for site-specific adjustments to the regional WRENSS nomographs.

The Beaver Creek Experimental Watershed is located between latitudes 34° 30' and 35° north, and 111° 30' to 112° west longitude in north-central Arizona.[340] The watershed's center is about 50 miles south of Flagstaff, Arizona, in Coconino and Yavapai counties. Established in 1956 by the Forest Service as a center for watershed management research within the pinyon-juniper and ponderosa pine vegetation types, the site encompasses 275,000 acres on the Coconino National Forest.

Nineteen years of precipitation and runoff data (1962-1981) were obtained for sub-watershed 20 within the Beaver Creek watershed. This watershed is at the highest elevation zone within the Beaver Creek drainage, and is dominated by ponderosa pine forest. Over the course of the Beaver Creek program, sub-watershed 20 was used as a hydrologic reference or control watershed, wherein no experimental changes in treatment or management were applied. Comparison of the WRENSS model water balance using the default regional evapotranspiration-precipitation nomographs, versus observed average behavior for sub-watershed 20 provided a basis to adjust the model to more closely match site-specific conditions at Snowbowl. The WRENSS seasonal evapotranspiration nomographs were adjusted upwards by 17 percent, on

[339] Leaf, C.F., 2003
[340] USDA Forest Service, 2001

average, to provide closer agreement with the observed water-balance data from Beaver Creek sub-watershed 20.

The water balance computed via the WRENSS model, modified to reflect the contributions of snowmaking water computed via the above procedures, together provide estimates for water yield typical of sub-alpine mountain watersheds. Tables 3I-4 through 3I-6 portray the water balance characteristics for watersheds within the project area for average, dry, and wet-year conditions. Only those watersheds slated for snowmaking or terrain modification under the Proposed Action are shown.

Table 3I-4
Average Year Water Balance

Watershed	Area (acres)	Precipitation (AF)	Watershed Loss (AF)	Recharge (AF)	Percent Loss
Hart Prairie	820.2	1930.1	1236.9	693.1	64%
Humphreys	284.1	784.0	429.0	355.0	55%
Lower Agassiz Ridge	232.2	568.1	368.3	199.8	65%
Middle Agassiz Ridge	229.1	573.5	373.7	199.8	65%
Snowbowl	648.5	1791.3	940.8	850.5	53%
Sunset	79.6	192.7	111.6	81.1	58%
Upper Agassiz Ridge	263.2	672.4	432.8	239.7	64%
Total	***2,556.9***	***6,512.1***	***3,893.1***	***2,619.0***	***61%***

Source: Resource Engineering, Inc., 2003

Table 3I-5
Dry Year Water Balance

Watershed	Area (acres)	Precipitation (AF)	Watershed Loss (AF)	Recharge (AF)	Percent Loss
Hart Prairie	820.2	794.3	776.7	17.6	98%
Humphreys	284.1	322.6	295.6	27.0	92%
Lower Agassiz Ridge	232.2	233.8	233.8	0.0	100%
Middle Agassiz Ridge	229.1	236.0	236.0	0.0	100%
Snowbowl	648.5	737.2	637.6	99.5	86%
Sunset	79.6	79.3	74.8	4.5	94%
Upper Agassiz Ridge	263.2	276.7	276.7	0.0	100%
Total	***2,556.9***	***2,679.9***	***2,531.2***	***148.6***	***96%***

Source: Resource Engineering, Inc., 2003

Table 3I-6
Wet Year Water Balance

Watershed	Area (acres)	Precipitation (AF)	Watershed Loss (AF)	Recharge (AF)	Percent Loss
Hart Prairie	820.2	2941.8	1296.3	1645.4	44%
Humphreys	284.1	1194.9	443.4	751.5	37%
Lower Agassiz Ridge	232.2	865.9	383.6	482.3	44%
Middle Agassiz Ridge	229.1	874.1	386.0	488.0	44%
Snowbowl	648.5	2730.2	976.2	1754.0	36%
Sunset	79.6	293.8	117.4	176.3	40%
Upper Agassiz Ridge	263.2	1024.9	445.7	579.1	43%
Total	***2,556.9***	***9,925.6***	***4,048.6***	***5,876.6***	***41%***

Source: Resource Engineering, Inc., 2003

Area-normalized results, averaged over all watersheds, are portrayed in Table 3I-7.

Table 3I-7
Area-Normalized Water Balance

Climate	Precipitation (in)	Watershed Loss (in)	Recharge (in)	Percent Loss
Average	31.6	18.3	13.3	58%
Dry	13.0	12.1	0.9	93%
Wet	48.2	19.0	29.3	39%

Source: Resource Engineering, Inc., 2003

The results of the water balance modeling are generally consistent with expected trends for semi-arid forested environments, where evapotranspiration rates are limited by soil moisture availability. In these conditions, dry conditions prevail during much of the growing season, and soil moisture deficits can become substantial. Prior studies of evapotranspiration rates from climatically and vegetatively similar ponderosa pine forests in northern New Mexico over a four-year period extending from 1993 through 1996 yielded an average annual evapotranspiration loss of 18.0 inches, which agrees well with the prediction of the water balance model.[341] The high percentage losses in dry years are related to high atmospheric moisture demand driven by lower relative humidities, paired with higher temperatures. Lower percentage losses in wet years are derived from lower atmospheric demand, paired with increased moisture content in soils and shallow groundwater, leading to greater re-charge fractions.

GEOLOGY

The San Francisco Volcanic Field covers approximately 1,800 square miles in northern Arizona. The Field lies along the southern perimeter of the Colorado Plateau, defined by the Mogollon Rim to the south of Flagstaff. The most prominent peaks within the field are the San Francisco Peaks, including Humphreys Peak, which at 12,633 feet is the highest mountain in Arizona. Collectively, Humphreys Peak, Agassiz Peak (12,356 feet), and Fremont Peak (11,696 feet) are referred to as the San Francisco Peaks. A large portion of the San Francisco Volcanic Field lies

[341] Brandes, David and B. Wilcox, 2000

within the Coconino and Kaibab national forests. This zone of relatively recent volcanism contains more than 600 volcanoes, active at various time periods during the past six million years.[342]

Most of the mountains between Flagstaff and the Grand Canyon are dormant volcanoes, and are comparatively young geologically. Most prominent among these features are basaltic cinder cones such as Sunset Crater, O'Leary Peak, Bill Williams Mountain, and Kendrick Peak. Sunset Crater is the youngest volcano within the field, last erupting less than 1,000 years ago. The oldest volcanic features within the San Francisco field are a series of six million year old basaltic lava flows that extend south and southwest from the San Francisco Peaks vicinity.[343] These basalts overlie the Triassic sand and mudstones of the Moenkopi formation, as well as the horizontally extensive Permian Kaibab limestone.[344] The younger andesites, rhyolites, and dacites of the San Francisco Peaks exist on top of these older basaltic flows.

San Francisco Peaks are a stratovolcano, with moderately steep slopes formed by the gradual accumulation of layers of andesitic lava flows, cinders, and ash, inter-lensed with deposits from volcanic mudflows. The San Francisco Peaks are the only stratovolcano within the San Francisco Volcanic Field. The eruptions that formed the Peaks occurred between 0.4 and one million years ago.[345] The Inner Basin is a prominent glaciated valley along the northeastern slopes of the San Francisco Peaks. Most geologists currently believe that the Inner Basin is a caldera formed by a lateral blast similar to that which occurred at Mt. St. Helens in 1980.[346] Projecting the existing slope of the San Francisco Peaks range upward, it is estimated that the original summit of the San Francisco Peaks reached approximately 15,400 feet[347] Pleistocene era glaciation further sculpted the Inner Basin, and occurred after the most recent period of volcanic orogenic activity.[348]

SOILS

Information on soils within the project area was obtained from the CNF Terrestrial Ecosystem Survey GIS database. Within the CNF Terrestrial Ecosystem Survey database, soils are classified to the family level of Soil Taxonomy. Soils exhibiting very similar profiles comprise a soils family. Allowing for differences in surface texture or underlying layers, soils within a family exhibit major horizons that are similar in thickness, composition, and arrangement. A number of soils families are present throughout the project area; the predominant mapped soils units within the project area are outlined in Table 3I-8 and their locations are graphically depicted in Figure 3I-2.

[342] Priest et al., 2001
[343] Higgins, 1998
[344] Id.
[345] Priest et al., 2001
[346] Id.
[347] Higgins, 1998
[348] Id.

Table 3I-8
Mapped Soil Units
Arizona Snowbowl SUP Area

Map Unit	Component[a]	Component Name	Acres	Percent of Mapped Soils
640	0.1	Pachic Udic Argiborolls	62.1	8%
	0.5	Pachic Udic Haploborolls		
	0.5	Pachic Paleborolls		
715	0.1	Andic Cryoborolls	64.1	8%
	0.5	Pachic Cryoborolls		
740	0.1	Cryic Pachic Paleborolls	271.8	35%
	0.2	Andic Cryoborolls		
	0.5	Pachic Cryoborolls		
770	0.1	Vitrandic Cryochrepts	167.1	21%
	0.2	Talus		
	0.5	Mollic Cryoboralfs		
785	0.1	Andic Cryoborolls	133.0	17%
	0.5	Pachic Cryoborolls		
	0.6	Vitandic Cryochrepts		
790	0.1	Vitrandic Cryochrepts	52.2	7%
	0.5	Vitrandic Cryoborolls		
	0.6	Rock Outcrop		
850	0.1	Pergelic Cryochrepts	27.4	4%
	0.5	Talus		
	0.6	Pergelic Cryorthents		

[a] Components within a soils map unit are identified by a decimal and followed by a number (.l to .4). A maximum of four major named components are allowed in each map unit. Each map unit can have two minor inclusion components (.5 and .6).
Source: USDA Forest Service, 2003

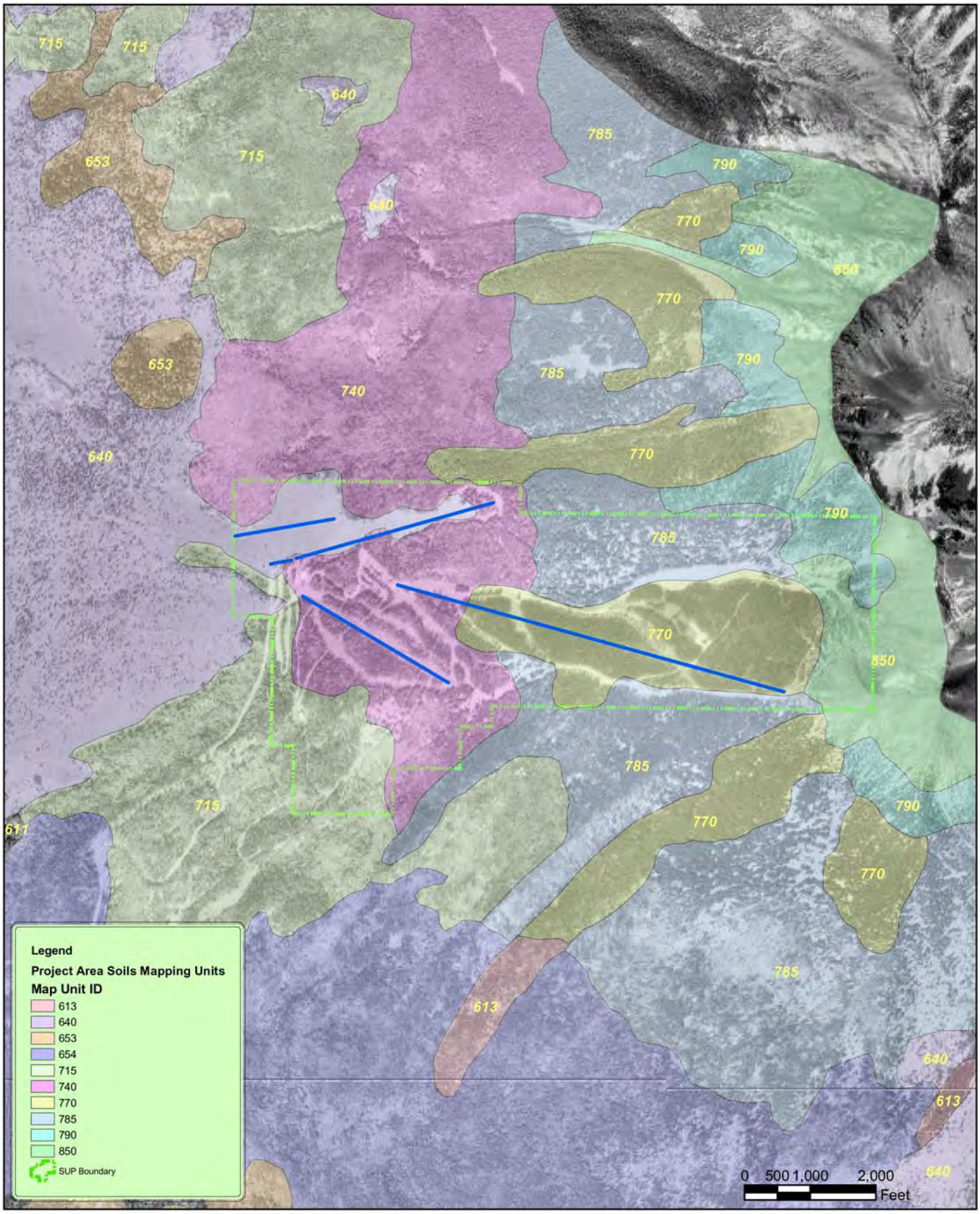

Figure 3I-2
Project Area Soils Mapping

ARIZONA SNOWBOWL

File: 994-1.0
Date: 09/26/2003

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1 inch equals 2,000 feet

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Soils unit 640 is a gravelly loam, dominated by components of Pachic Udic Argiborolls, with inclusions of Haploborolls and Paleborolls, realized as alluvium/colluvium from andesite/dacite parent material. This map unit is classified as a fire disclimax.[349] Fire created and maintained the open park-like conditions of this unit's predominant grasslands prairies in the past. Slopes range from zero to 40 percent. This unit occurs on warmer, dryer aspects than the adjacent mixed conifer map units. This map unit is dependent on recurrent wildfire to maintain the high canopy coverage of grass and low canopy coverage of mixed conifer.

Soils unit 715 is a bouldery sandy loam, dominated by an Andic Cryoborolls component, with Pachic inclusions. The unit is deposited as colluvium from andesite/dacite parent material. Vegetation within this unit is currently in mid- to late seral stage as indicated by the high canopy cover. Exposures of andesite rock outcrop occur throughout the map unit. Slopes range from 25-35 percent.

Soils unit 740 is a gravelly fine sandy loam. The primary soils classification is Cryic Pachic Paleborollos with major inclusions of Andic Cryoborolls and minor inclusions of Pachic Cryoborolls. The soils are formed as colluvium of andesite/dacite parent material, and andesite rock outcrop may occur in the upper end of the slope range. This component has a severe erosion hazard. Natural re-generation potential is high.

Soils unit 770 is a stony fine sandy loam. The primary taxonomic classification is Vitrandic Cryochrepts, with Talus outcrops and Mollic Cryoboralfs inclusions. The soil is derived as colluvium and residuum from andesite/breccia parent material. This shallow to moderately deep soil occurs in the vicinity of rock outcrop and talus. Snow avalanche hazard is moderate in areas with little or no tree canopy cover. Mass wasting hazard is moderate and occurs as debris slide and debris avalanche in and around talus areas. This map unit has a moderate erosion hazard. Natural regeneration and reforestation potentials are low due to surface rock fragments and cold climatic conditions.

Soils unit 785 is a very stony fine sandy loam. The primary taxonomy is Andic Cryoborolls, with minor inclusions of Pachic Cryoborolls and Vitandic Cryochrepts. Most areas within this unit are currently in mid-seral vegetative stage, due to past wildfires. Snow avalanche hazard is moderate in areas with little or no tree canopy cover. This map unit has a severe erosion hazard. Natural re-generation potential is high. Reforestation and re-vegetation potentials are low due to very steep slopes.

Soils unit 790 is a very cobbly sandy loam, with a primary classification of Vitrandic Cryochrepts, with minor inclusions of Vitrandic Cryoborolls and rock outcrops. The soil is a colluvium derived from dacite/andesite parent material. This soil's mass wasting hazard is severe. Snow avalanche hazard is moderate in areas with little or no tree canopy cover. Erosion hazard is severe. Natural regeneration, reforestation and revegetation potentials are low due to steep slopes and cold climatic conditions.

[349] A relatively stable ecological community often including organisms foreign to the region and displacing the climax (the final stage in ecological succession) because of natural fire or anthropogenic disturbance.

Soils unit 850 is an extremely bouldery sandy loam, a colluvium derived from andesite/breccia parent material. The taxonomy is a Pergelic Cryochrepts, with Talus and Cryorthents inclusions. Shallow and moderately deep soils may occur in the vicinity of rock outcrop and talus. Mass wasting hazard is moderate and occurs as debris slide and debris avalanche around talus areas. Snow avalanche hazard is moderate to high. This high-elevation soil supports a fragile alpine tundra habitat. This map unit has a severe erosion hazard. Revegetation potential is low due to surface rock fragments and cold climatic conditions.

The primary use and management considerations for the soils units present in the SUP area are summarized in Table 3I-9.

Table 3I-9
Mapped Soils Units
Management and Usage Limitations

Map Unit	Component	Percent of Mapped Units	Cut and Fill Slope Stability	Unsurfaced Road Stability	Erosion Hazard	Re-vegetation Potential
640	0.1	8%	N/A	Moderate	Moderate	High
	0.5		*	*	*	*
	0.6		*	*	*	*
715	0.1	8%	Moderate	Moderate	Severe	Low
	0.5		*	*	*	*
740	0.1	35%	Moderate	Moderate	Severe	Moderate
	0.2		Moderate	Moderate	Severe	Low
	0.5		*	*	*	*
770	0.1	21%	Moderate	Moderate	Severe	Moderate
	0.2		Moderate	Moderate	Severe	Low
	0.5		*	*	*	*
785	0.1	17%	Severe	Severe	Severe	Low
	0.5		*	*	*	*
	0.6		*	*	*	*
790	0.1	7%	Severe	Severe	Severe	Low
	0.5		*	*	*	*
	0.6		*	*	*	*
850	0.1	4%	Severe	Severe	Severe	Low
	0.5		*	*	*	*
	0.6		*	*	*	*

* = No record.
Source: USDA Forest Service, 2003

Overall, the primary soils units within the SUP area exhibit low to moderate re-vegetation potential and severe erosion hazards. Maintenance of vegetative cover is important to minimize the potential for sheet and rill erosion with these soil units.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF ENVIRONMENTAL CONSEQUENCES AND CONCLUSIONS

Major conclusions and determinations of this Soils and Geology analysis are summarized below. A more detailed analysis of the direct and indirect environmental consequences (from which this summary was derived) follows.

Alternative 1 - No Action

Under the No Action Alternative, the infrastructure and operation of the Snowbowl would remain unchanged from current conditions. The environmental consequences of the No Action alternative would reflect those associated with the on-going operation of the existing ski area, including potential disturbances to vegetative cover, and/or soils associated with routine maintenance and repair requirements, occurring in previously disturbed areas. No consequences to the watershed hydrology or soils chemistry would be realized under the No Action Alternative.

Alternative 2 – The Proposed Action

Anticipated changes in the duration and intensity of annual snowmelt

The Proposed Action's 205 acres of snowmaking would result in a 15 percent increase in recharge in the primary receiving watershed, with a six percent increase overall. These water balance effects alone would be unlikely to increase the risk for surface flow, rilling, or sedimentation on un-graded terrain, where high infiltration rates result in little or no surface runoff. On graded terrain, soils compaction can result in surface runoff generation. In areas where there are no topographic constraints (i.e., confined valleys) to concentrate surface flows, the potential for rilling and sedimentation may be adequately mitigated via careful implementation and maintenance of typical drainage management routing infrastructure (i.e., waterbars). In areas where the surface topography tends to concentrate surface flows, increased water inputs would result in a moderate to high risk of rilling or sedimentation, as evidenced by their occurrence in existing confined graded terrain on *Logjam* (trail #25).

Anticipated changes in erosion/sedimentation

The grading of terrain associated with the Proposed Action would result in a post-disturbance increase of 530 tons of net sediment detachment, which would decrease to 87 tons following six to 10 years of re-vegetation. This represents a substantial potential increase in sediment yield. Preservation of topsoil prior to grading, and re-distribution prior to re-seeding, would enhance re-vegetation potential, and mitigate the risk of increased detachment on slopes of gradients less than 30 percent. On steeper slopes of 30 percent gradient and higher, the rates of anticipated detachment coupled with low soil re-generation potential would make preservation of topsoil difficult. While mitigation measures such as jute-netting or geo-textile mesh can improve soils stability on steeper slopes, the risk of erosion and soil loss would be moderate to high.

Potential changes to soil chemistry due to anticipated increases in soil moisture consistency and nutrient loading

Input of reclaimed water from the City of Flagstaff's Rio de Flag Water Reclamation Plant in the form of snowmaking would alter the soils chemistry for affected soils units. Overall, percolating

treated wastewater through the soil profile would be unlikely to have a negative impact on either the soils or treated water. Existing fecal coliform in the A-horizon soil could be reduced via the percolation of chlorinated wastewater. The acidity of the soil and parent material would be progressively buffered to more alkaline levels by percolation of the treated wastewater. The higher alkalinity would inhibit the leaching and mobilization of soils metals to the groundwater. The increased nitrogen loading via application of the reclaimed wastewater would be likely to initially cause increases in organic and bio-available nitrogen within the soils, until reaching a critical threshold. Subsequently, increases in nitrogen mineralization and inorganic nitrogen would be expected, followed by increased leaching of excess nitrogen through the soils column to groundwater.

Alternative 3

Anticipated changes in the duration and intensity of annual snowmelt

Because Alternative 3 would not implement snowmaking infrastructure with accompanying snowmaking water inputs, the water balance effects of this Alternative would be relatively minor. Trail clearing and grading activities would result in changes in the water balance. Interception and evaporation losses from the forest canopy would be reduced. Vegetation removal would affect the infiltration characteristics of the watershed, generally resulting in quicker runoff generation. Changes in vegetative cover would affect the solar energy balance of the watershed, permitting increased solar radiation and therefore earlier and faster snowmelt in areas where new trails would be implemented.

Anticipated changes in erosion/sedimentation

The grading of terrain associated with Alternative 3 would result in a post-disturbance increase of 369 tons of net sediment detachment, which would decrease to 73 tons following six to 10 years of revegetation. This represents a substantial potential increase in sediment yield. Preservation of topsoil prior to grading, and re-distribution prior to re-seeding, would enhance re-vegetation potential, and mitigate the risk of increased detachment on slopes of gradient below 30 percent. On steeper slopes of 30 percent gradient and higher, the rates of anticipated detachment coupled with low soil re-generation potential would make preservation of topsoil difficult. While mitigation measures such as jute-netting or geo-textile mesh can improve soils stability on steeper slopes, the risk of erosion and soil loss would moderate to high.

Potential changes to soil chemistry due to anticipated increases in soil moisture consistency and nutrient loading

The soils compaction and turnover associated with Alternative 3 grading and trail construction activities would cause compaction of soils and loss of organic matter and tilth,[350] and a decrease in soils aeration, within affected soils units. However, no snowmaking infrastructure would be implemented. Therefore, no changes to soils chemistry would occur due to the input of reclaimed water in the form of snowmaking.

[350] The state of aggregation of a soil especially in relation to its suitability for supporting growth of vegetation

DETAILED ANALYSIS OF DIRECT AND INDIRECT EFFECTS

The Proposed Action has potential to change soil chemistry and moisture due to the application of machine-produced snow.

Indicator:

Anticipated Volume of Machine-Produced Snow Applied Under Various Scenarios: Dry Year, Average Year, and Wet Year

Alternative 1 – No Action

Under the No Action Alternative, implementation of snowmaking infrastructure would not occur, and current conditions as presented above would be expected to persist. No machine-produced snow would be applied within the project area.

Alternative 2 – The Proposed Action

Under the Proposed Action, a total of 205.2 acres of snowmaking terrain would be implemented at the Snowbowl. This terrain would be primarily implemented within the Snowbowl watershed, with smaller acreages implemented in other proximal watersheds (see Table 3I-3 Sub-Watershed Characteristics).

The depth of snow that would be initially produced on existing and proposed terrain would result in an average coverage depth across all terrain types of slightly more than 25 inches of snow. Estimated operational conditions under the varying climatic scenarios are outlined as follows:[351]

1. Once all the trails have been covered with the specified depth of snow, resurfacing operations would typically commence to recover from any thaws and replenish snow that has become hardened through wear and temperature cycling. The amount of resurfacing required would depend on natural snowfall. In a wet year, it is estimated that only the initial application would be required. This application could be spread out over the season if there was abundant snow early in the year, or it could be concentrated at the beginning of the season if the bulk of the snow arrives after December.

2. On an average year, it is estimated that an additional half-application of machine-produced snow would be required after the initial coverage for a seasonal total of 1.5 coverages.

3. On a dry year, it is estimated one additional full application of machine-produced snow would be required after the initial coverage for a seasonal total of two coverages.

Snowmaking water used under average, dry, and wet year conditions are outlined by watershed in Table 3I-10.

[351] Sno.matic, 2003

Table 3I-10
Anticipated Snowmaking Water Use

Watershed	New Snowmaking Acreage	Average Year Snowmaking Diversions (AF)	Dry Year Snowmaking Diversions (AF)	Wet Year Snowmaking Diversions (AF)
Hart Prairie	22.5	39.9	53.3	26.6
Humphreys	28.4	50.4	67.3	33.6
Leroux	0.0	0.0	0.0	0.0
Lower Agassiz Ridge	12.7	22.5	30.1	15.0
Middle Agassiz Ridge	3.9	6.9	9.2	4.6
Snowbowl	131.9	234.0	312.4	156.2
Sunset	5.5	9.8	13.0	6.5
Upper Agassiz Ridge	0.3	0.5	0.7	0.4
Total	***205.2***	***364.0***	***486.0***	***243.0***

Source: Resource Engineering, Inc., Sno.matic, 2003

Alternative 3

Under Alternative 3, implementation of snowmaking would not occur, and current conditions would be expected to persist. No machine-produced snow would be applied.

Indicator:

Modeled Anticipated Changes in the Duration and Intensity of Annual Snowmelt Compared to Historic Natural Variation

Alternative 1 – No Action

Under the No Action alternative, input of additional water in the form of snowmaking would not occur, and no change in the annual snowmelt regime would be likely to occur.

Alternative 2 – The Proposed Action

Selection of the Proposed Action would result in snowmaking coverage on 205.2 acres of existing and proposed terrain. Of this coverage, the largest increases would occur in the following watersheds: Snowbowl (132 acres), Humphreys (28 acres) and Hart Prairie (23 acres). The proposed snowmaking coverage would require approximately 364 AF of snowmaking water use on average.

In addition to increased snowmaking coverage, implementation of the Proposed Action would involve clearing of vegetation on approximately 76.3 acres. Table 3I-11 outlines trail clearing and snowmaking coverage areas by watershed associated with the Proposed Action.

Table 3I-11
Alternative 2 Trail Clearing and Snowmaking by Watershed

Watershed	Trail Clearing (Acres)	Snowmaking Acreage
Hart Prairie	3.7	22.5
Humphreys	9.6	28.4
Lower Agassiz Ridge	7.2	12.7
Middle Agassiz Ridge	1.6	3.9
Snowbowl	54.0	131.9
Sunset	0.2	5.5
Upper Agassiz Ridge	0.0	0.3
Total	***76.3***	***205.2***

Source: Resource Engineering, Inc, 2003

Proposed activities would affect the watershed hydrology in the study area. The application of snowmaking alters the volume and timing of snowmelt. A machine-produced snowpack typically exhibits smaller grain size and higher snowpack density and water equivalent than a natural snowpack. Due to these differences in physical properties, machine-produced snow typically begins to melt later in the season than natural snow. This can increase the average duration of seasonal melt. Trail clearing affects the water balance by decreasing the amount of water removed via evapotranspiration, thus increasing the quantity of water available for infiltration or runoff. Interception and evaporation losses from the forest canopy would be reduced. Vegetation removal would affect the infiltration characteristics of the watershed, generally resulting in quicker runoff generation. Changes in vegetative cover also can affect the solar energy balance of the watershed, permitting increased solar radiation and therefore earlier and faster snowmelt. Together these changes would alter water balance characteristics and snowmelt timing.

Water Balance

The water balance model described previously under the Existing Conditions section was used to provide estimates of expected changes in the volume and distribution of water due to the Proposed Action. Summaries of the anticipated water balance changes for average, dry, and wet climatic conditions are outlined in the following tables.

Average Year Water Balance Characteristics

Table 3I-12
Alternative 2 Average Year Water Balance Characteristics

Watershed	Precipitation (AF)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)
Hart Prairie	1930.1	39.9	1254.0	716.0
Humphreys	784.0	50.4	451.8	382.5
Lower Agassiz Ridge	568.1	22.5	377.5	213.2
Middle Agassiz Ridge	573.5	6.9	376.7	203.7
Snowbowl	1,791.3	234.0	1,043.0	982.3
Sunset	192.7	9.8	116.7	85.7
Upper Agassiz Ridge	672.4	0.5	433.0	239.9
Total	***6,512.1***	***364.0***	***4,052.7***	***2,823.3***

Source: Resource Engineering, Inc, 2003

Table 3I-13
Alternative 2 Change in Average Year Water Balance Characteristics

Watershed	Percent Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	64%	22.8	3%
Humphreys	54%	27.5	8%
Lower Agassiz Ridge	64%	13.3	7%
Middle Agassiz Ridge	65%	3.9	2%
Snowbowl	51%	131.8	15%
Sunset	58%	4.7	6%
Upper Agassiz Ridge	64%	0.3	0%
Total	***60%***	***204.3***	***6%***

[a] Compared to existing conditions.
Source: Resource Engineering, Inc, 2003

Under the Proposed Action, introduction of additional water equivalent in the form of machine-produced snow, coupled with changes in land use due to trail construction activities, would result in a six percent increase in watershed recharge in an average year. The Snowbowl watershed, which would experience the majority of the proposed snowmaking terrain, would experience a 15 percent increase in recharge annually.

Most of the un-graded terrain at Snowbowl exhibits excellent vegetative cover, which binds root structure and stabilizes the surface soil horizon. Introduction of snowmaking water on un-graded trails would be unlikely, in and of itself, to markedly increase the erosion potential, so long as snowmaking is accompanied by implementation and maintenance of typical drainage mechanisms such as adequately spaced waterbars (see Table 2-2).

However, field review of the primary drainage within the Snowbowl watershed, in which most of the proposed snowmaking is slated to occur, reveals that surface runoff does occur during peak snowmelt conditions. Although essentially all of the observed surface flow eventually re-

infiltrates into the soils, in areas where grading activity has resulted in soils turnover and compaction, surface flow has caused rilling and sedimentation.

Field review of heavily graded terrain on *Logjam* (trail #25) indicates that inadequate waterbar spacing has contributed to poor drainage routing, which has contributed to the development of concentrated surface flows, and incised rilling. Contributing to the concerns on *Logjam* (trail #25) is that the terrain modification filled in a historic flow channel, and the topography naturally concentrates flows in this vicinity. A review of graded terrain on *Upper Ridge* (trail # 26) and *Lower Ridge* (trail #21) reveals few instances of concentrated surface flow or rilling on these trails where the topographic constraints do not confine the flow of water. In general, effectively implemented and maintained drainage control mechanisms such as waterbars should adequately reduce the risk of increased erosion on graded terrain, so long as drainage control is accompanied by effective re-establishment of vegetative cover. Re-vegetation in relationship to existing and proposed graded terrain is discussed in the following section analyzing increased sediment yields due to graded terrain modification.

Dry Year Water Balance Characteristics

Table 3I-14
Alternative 2 Dry Year Water Balance Characteristics

Watershed	Precipitation (AF)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)
Hart Prairie	794.3	53.3	817.5	30.1
Humphreys	322.6	67.3	358.8	31.1
Lower Agassiz Ridge	233.8	30.1	263.9	0.0
Middle Agassiz Ridge	236.0	9.2	245.2	0.0
Snowbowl	737.2	312.4	927.2	122.4
Sunset	79.3	13.0	87.8	4.6
Upper Agassiz Ridge	276.7	0.7	277.4	0.0
Total	***2,679.9***	***486.0***	***2,977.8***	***188.2***

Source: Resource Engineering, Inc, 2003

Table 3I-15
Alternative 2 Change in Dry Year Water Balance Characteristics

Watershed	Percent Loss	Recharge Change (AF)	Percent Change
Hart Prairie	96%	12.5	71%
Humphreys	92%	4.0	15%
Lower Agassiz Ridge	100%	0.0	0%
Middle Agassiz Ridge	100%	0.0	0%
Snowbowl	88%	22.8	23%
Sunset	95%	0.1	2%
Upper Agassiz Ridge	100%	0.0	0%
Total	***96%***	***39.4***	***16%***

Source: Resource Engineering, Inc, 2003

Overall, a sixteen percent increase in annual recharge would be anticipated during dry-year conditions, although for the Agassiz ridge watersheds, both existing and Alternative two

conditions reflect 100 percent watershed losses in the dry-year scenario. For the primary snowmaking watershed, a 23 percent increase in recharge would occur. The following tables show anticipated water balance characteristics in the wet-year scenario.

Wet Year Water Balance Characteristics

Table 3I-16
Alternative 2 Wet Year Water Balance Characteristics

Watershed	Precipitation (AF)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)
Hart Prairie	2941.8	26.6	1311.8	1656.6
Humphreys	1,194.9	33.6	461.3	767.2
Lower Agassiz Ridge	865.9	15.0	390.6	490.3
Middle Agassiz Ridge	874.1	4.6	388.4	490.3
Snowbowl	2,730.2	156.2	1055.5	1831.0
Sunset	293.8	6.5	121.6	178.7
Upper Agassiz Ridge	1,024.9	0.4	446.0	579.3
Total	***9,925.6***	***242.9***	***4,175.2***	***5,993.4***

Source: Resource Engineering, Inc, 2003

Table 3I-17
Alternative 2 Change in Wet Year Water Balance Characteristics

Watershed	Percent Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	44%	11.1	1%
Humphreys	38%	15.7	2%
Lower Agassiz Ridge	44%	8.1	2%
Middle Agassiz Ridge	44%	2.3	1%
Snowbowl	37%	77.0	4%
Sunset	40%	2.4	1%
Upper Agassiz Ridge	43%	0.1	0%
Total	***42%***	***116.7***	***2%***

[a] Compared to existing conditions.
Source: Resource Engineering, Inc, 2003

In a wet year, snowmaking represents a very small percentage of the overall water balance. For the Snowbowl watershed, receiving most of the snowmaking input, the change in recharge compared to existing conditions is two percent.

Alternative 3

Implementation of Alternative 3 would not include snowmaking coverage within the Snowbowl SUP area. However, implementation of Alternative 3 would entail trail construction involving clearing of vegetation on approximately 64 acres. Table 3I-18 outlines the trail construction acreage totals associated with the Alternative 3.

Table 3I-18
Alternative 3 Trail Clearing

Watershed	Trail Clearing (ares)
Hart Prairie	1.6
Humphreys	2.0
Lower Agassiz Ridge	7.2
Middle Agassiz Ridge	1.6
Snowbowl	51.4
Sunset	0.2
Upper Agassiz Ridge	0.0
Total	***64.0***

Source: Resource Engineering, Inc., 2003

Trail clearing affects the water balance by decreasing the amount of water removed via evapotranspiration, thus increasing the quantity of water available for runoff. Interception and evaporation losses from the forest canopy would be reduced. Vegetation removal would affect the infiltration characteristics of the watershed, generally resulting in quicker runoff generation. Changes in vegetative cover also can affect the solar energy balance of the watershed, permitting increased solar radiation and therefore earlier and faster snowmelt. Vegetation removal would alter the water balance characteristics and snowmelt timing.

Water Balance

The following tables outline the effects of the proposed trail construction activities under Alternative 3 on the surface water balance for the various project area watersheds in an average year.

Average Year Water Balance Characteristics

Table 3I-19
Alternative 3 Average Year Water Balance Characteristics

Watershed	Precipitation (AF)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)
Hart Prairie	1930.1	0.0	1236.9	693.1
Humphreys	784.0	0.0	428.2	355.8
Lower Agassiz Ridge	568.1	0.0	365.3	202.8
Middle Agassiz Ridge	573.5	0.0	373.1	200.4
Snowbowl	1,791.3	0.0	919.0	872.3
Sunset	192.7	0.0	111.6	81.2
Upper Agassiz Ridge	672.4	0.0	432.8	239.7
Total	***6,512.1***	***0.0***	***3,866.9***	***2,645.3***

Source: Resource Engineering, Inc, 2003

Table 3I-20
Alternative 3 Change in Average Year
Water Balance Characteristics

Watershed	Percent Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	64%	0.0	0%
Humphreys	55%	0.8	0%
Lower Agassiz Ridge	64%	3.0	1%
Middle Agassiz Ridge	65%	0.6	0%
Snowbowl	51%	21.8	3%
Sunset	58%	0.1	0%
Upper Agassiz Ridge	64%	0.0	0%
Total	***60%***	***26.3***	***1%***

[a] Compared to existing conditions.
Source: Resource Engineering, Inc, 2003

In comparison to the combined effects of both snowmaking and trail clearing, the areas of trail construction alone proposed under Alternative 3 represent a fairly minor change in the annual water balance of one percent. The Snowbowl watershed, slated to receive most of the proposed trail construction, would experience a three percent change in the annual water balance.

Dry Year Water Balance Characteristics

Table 3I-21
Alternative 3 Dry Year Water Balance Characteristics

Watershed	Precipitation (AF)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)
Hart Prairie	794.3	0.0	776.7	17.6
Humphreys	322.6	0.0	294.8	27.9
Lower Agassiz Ridge	233.8	0.0	233.8	0.0
Middle Agassiz Ridge	236.0	0.0	236.0	0.0
Snowbowl	737.2	0.0	614.8	122.4
Sunset	79.3	0.0	74.7	4.6
Upper Agassiz Ridge	276.7	0.0	276.7	0.0
Total	***2,679.9***	***0.0***	***2,507.5***	***172.5***

Source: Resource Engineering, Inc, 2003

Table 3I-22
Alternative 3 Change in Dry Year
Water Balance Characteristics

Watershed	Percent Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	98%	0.0	0%
Humphreys	91%	0.8	3%
Lower Agassiz Ridge	100%	0.0	0%
Middle Agassiz Ridge	100%	0.0	0%
Snowbowl	83%	22.8	23%
Sunset	94%	0.1	2%
Upper Agassiz Ridge	100%	0.0	0%
Total	***95%***	***23.7***	***4%***

[a.] Compared to existing conditions.
Source: Resource Engineering, Inc, 2003

During dry years, the Snowbowl watershed, experiencing most of the proposed trail construction, would experience a 23 percent increase in recharge as compared to existing conditions. Changes in vegetative cover would be likely to increase the potential for surface runoff occurrence, which would subsequently re-infiltrate into the soils.

Wet Year Water Balance Characteristics

Table 3I-23
Alternative 3 Wet Year Water Balance Characteristics

Watershed	Precipitation (AF)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)
Hart Prairie	2941.8	0.0	1296.3	1645.4
Humphreys	1,194.9	0.0	442.6	752.3
Lower Agassiz Ridge	865.9	0.0	380.7	485.2
Middle Agassiz Ridge	874.1	0.0	385.4	488.7
Snowbowl	2,730.2	0.0	954.6	1,775.6
Sunset	293.8	0.0	117.4	176.4
Upper Agassiz Ridge	1,024.9	0.0	445.7	579.1
Total	***9,925.6***	***0.0***	***4,022.7***	***5,902.7***

Source: Resource Engineering, Inc, 2003

Table 3I-24
Alternative 3 Change in Wet Year
Water Balance Characteristics

Watershed	Percent Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	44%	0.0	0%
Humphreys	37%	0.8	0%
Lower Agassiz Ridge	44%	2.9	1%
Middle Agassiz Ridge	44%	0.6	0%
Snowbowl	35%	21.6	1%
Sunset	40%	0.1	0%
Upper Agassiz Ridge	43%	0.0	0%
Total	***41%***	***26.0***	***0%***

[a] Compared to existing conditions.
Source: Resource Engineering, Inc, 2003

Under Alternative 3, during wet year conditions, the changes in vegetation caused by trail construction activities would result in water balance changes that would be minor fractions of the overall water input in a wet year. The Snowbowl watershed, experiencing most of the proposed trail construction, would experience a one percent increase in recharge as compared to existing conditions.

Indicator:

Modeled Anticipated Changes in Erosion/Sedimentation Due to Predicted Changes in Total Snowpack

Alternative 1 – No Action

Under the No Action alternative, new trail construction or grading would occur, and no changes in erosion or sedimentation would be expected.

Alternative 2 – The Proposed Action

In order to quantify the potential sediment yield associated with the proposed ground disturbance, the USDA-ARS Water Erosion Prediction Project (WEPP) model was applied to compute increases in sediment detachment for trail construction and improvement areas where grading would be applied, as well as areas of new road construction/improvements.

There are several primary effects to soil resources associated with graded terrain modifications. Grading and re-contouring using heavy machinery causes soils compaction and loss of soil tilth. Loss of top soil and a decrease in soils organic matter associated with disturbances to the rooting zone can reduce the soils productivity. Lastly, soils disturbances, coupled with increased water inputs in the form of snowmaking, increase the risk of soil particle detachment and transport due to surface water erosion, increasing sediment yields.

The Forest Service has developed a set of forest simulation parameters for WEPP based on model calibration and validation to observed forested watershed behavior. These custom WEPP

parameters are described in *Water Erosion Prediction Project Forest Applications*.[352] The WEPP model is a process-based, continuous computation, distributed parameter erosion prediction model implemented as a computer numerical simulation.[353] The model is based on numerical representations of the physical processes influencing runoff and sediment yield. Thus, it permits a simulation of various actual watershed processes, including: rainfall/snowfall, infiltration, runoff, soil moisture accounting, snow accumulation/melt, evapotranspiration, plant growth and litter decomposition, and sediment detachment and deposition. The model parameters include rainfall amounts and intensity, soil textural properties, plant growth parameters, residue decomposition factors, slope shape, steepness, and orientation, and soil erodibility parameters. Soils may be represented in multiple layers with multiple parameters describing texture, rock content, moisture, permeability, organic content, and cation exchange capacity. The model uses a statistically generated synthetic climate dataset to drive its simulations. The synthetic dataset is derived by applying a probabilistic model using statistical parameters computed from observed climate trends. High resolution climate data (including temperature, wind speed and direction, relative humidity, and solar radiation) is derived via a sophisticated spatial algorithm. The PRISM climate data modeling process interpolates these variables based on both geographic position and elevation, from proximal NOAA, BLM RAWS, and NRCS-SNOTEL climate stations.

The soil type chosen for simulation within WEPP was a "sandy loam." CNF Terrestrial Ecology Survey mapping within the Snowbowl SUP confirm that the andesite/dacite-derived soils in the Snowbowl watersheds are sandy loams.

The WEPP model treats hillslope erosion and sediment detachment by modeling overland flow elements (OFE's). The OFE's allow the model to describe different treatment prescriptions, e.g. an upper OFE modeling a disturbed area, delivering sediment into and through a lower OFE which could model a vegetated buffer region.

The WEPP model was executed over a simulation period of 30 years. The model simulations were driven by climatic data derived from the PRISM model, corresponding to average-year conditions. The event-based model output includes rainfall events statistically generated by the USDA-ARS CLIGEN package to produce the synthetic climate dataset, and runoff events resulting from either rainfall or snowmelt. In order to simulate snowmaking water inputs under Alternative 2, the CLIGEN precipitation input was modified to reflect increased precipitation water input commensurate to the proposed quantities of snowmaking water equivalent.

The sediment yield predictions from this simulation period offer an average and maximum value for soil detachment. It should be noted that the model is run over a 30-year period using the same treatment prescription to provide a dataset of sufficient length to compute averages and return periods. The results from a 30-year simulation should not be interpreted to be potential erosion rates for full a 30-year time period following construction. Another factor of note when interpreting the model results is that the model assumes that the full area of construction is disturbed at any one time during the simulation process. In practice, disturbances associated

[352] Elliot, William J and David E. Hall, 1997
[353] USDA Forest Service, 2000

with terrain modification would be phased over a number of years and would thereby minimize the overall extent of disturbance at any point in time.

For purposes of modeling sediment production, only graded and re-contoured areas of *new* grading, re-contouring, or ground disturbance are considered in the WEPP modeling process. Therefore, the modeled results represent potential changes or increases in detachment due to various project elements.

To facilitate the analysis for graded terrain, the surface hydraulic conductivity was selected to be a comparatively low value of 3.5 millimeters per hour to reflect the soil compaction and decreased infiltration exhibited by areas of terrain grading and re-contouring. In order to assess the potential sediment detachment associated with the proposed terrain modifications, the WEPP model was executed for three different land cover prescriptions, alternatively modeling sediment production under the following scenarios through time:

1. **Post-Disturbance**
   Selected Land Cover Prescription: Mechanically disturbed & compacted soils
   Cover Density: 0 percent
   Surface Rock Fraction: 35 percent

2. **Re-vegetated Conditions (1-4 years)**
   Selected Land Cover Prescription: Short Grass
   Cover Density: 35 percent
   Surface Rock Fraction: 35 percent

3. **Future Conditions (5-10 Years)**
   Selected Land Cover Prescription: Tall Grass
   Cover Density: 40 percent
   Surface Rock Fraction: 35 percent

Each of these treatment prescriptions was modeled for a representative 250 foot hillslope upper OFE transitioning into a lower OFE "buffer" of short grass, which can be conceptualized as a vegetated buffer strip. Model runs for each of the above three prescriptions were performed for each of several slope gradients, as described below.

Because land slope is one of the primary determinants driving the potential for detachment of soil particles under the influence of water-driven erosional processes, the graded areas were subdivided into zones by slope gradient as follows:

- 0 - 10 percent slope gradient
- 10 - 20 percent slope gradient
- 20 - 30 percent slope gradient
- 30 - 40 percent slope gradient
- Greater than 40 percent slope gradient

In addition to the above process for modeling regions of trail construction, sediment yield modeling for the new road segment associated with the snowmaking pond access road was performed using the WEPP: Road module, which specifically models sediment detachment and transport from road surfaces on forested lands. The road segment was modeled as a native surface, out-sloped road. Obviously, in modeling road sediment production through time, it was assumed to be a permanent additional sediment source, whose detachment rates do not decrease through time.

The breakdown of graded terrain by slope class for the Proposed Action is outlined in the following table.

Table 3I-25
Alternative 2 Graded Terrain By Slope Class

Soil Unit	<10% (Acres)	10 - 20 % (Acres)	20 - 30 % (Acres)	30 - 40 % (Acres)	> 40% (Acres)	Total[a] (Acres)
Grading						
640	4.4	12.9	5.9	2.2	0.2	**25.6**
715	0.4	1.3	0.2	0.0	0.0	**1.9**
740	2.7	19.1	23.2	12.2	4.6	**61.7**
770	0.0	0.5	1.1	3.1	12.6	**17.3**
785	0.2	3.7	8.1	5.3	2.5	**19.9**
850	0.1	1.9	1.9	0.5	0.0	**4.5**
Total Grading	*7.8*	*39.5*	*40.3*	*23.4*	*19.9*	***130.9[a]***
Agassiz Hiking Trail Construction						
770	0.0	0.0	0.0	0.0	0.6	**0.6**
Road Construction						
715	1.0	0.5	0.0	0.0	0.0	**1.6**
740	0.8	1.2	0.1	0.0	0.0	**2.0**
Total Road Construction	**1.1**	**1.1**	**0.1**	**0.0**	**0.0**	**2.3**

[a] Note: The total graded area reported in this table is greater than that reported in Table 2-4 (Alternatives Matrix/Summary of Environmental Consequences) table in Chapter 2. The reason for this difference is that the graded areas within this table encompass multiple disturbance types, including utility corridors. Therefore, this table considers potential erosion effects caused by all varieties of ground-disturbing activities.
Source: Resource Engineering, Inc., 2003

The options for treatment prescription and slope gradient classes were subsequently used as input to the WEPP model to produce predictions for potential sediment yield. The model results are outlined in the Table 3I-26.

Table 3I-26
Alternative 2 WEPP Model Predicted Erosion Rate
(Slope Class, Tons/Acre)

Slope Gradient (%)	Post Disturbance	After Re-Vegetation, Years 2-5[a]	After Re-Vegetation, Years 6 Onward[a]
<10%	0.05	0.4	0.1
10 - 20 %	0.44	1.7	0.8
20 - 30 %	1.4	2.7	1.3
30 - 40 %	4.4	3.5	1.7
>40%	14.8	4.3	2.1

[a]Note: Years 2-5 use the Disturbed WEPP Short Grass management prescription, while year six and onward use the Tall Grass management prescription. For slopes less than 30%, WEPP predicts more erosion for the re-vegetated prescriptions than for the skid trail prescription used for post-disturbance circumstances. Although this result is counter-intuitive, no adjustments were made during the modeling process, in order to avoid arbitrary adjustment of input parameters, and to maintain a conservative and defensible analysis.
Source: Resource Engineering, Inc, 2003

In implementation, WEPP models hillslope erosional processes, and produces site-specific predictions for both sediment detachment and sediment deposition at each model increment along both the upper and lower OFE. Thus WEPP is capable of predicting the quantity of sediment that ultimately transports through a given vegetated buffer. In practice, modeling each individual hillslope component for every region of terrain modification in the Proposed Action was impractical. Therefore, the general model results for sediment detachment per unit area (tons per acre) for each combination of prescription and slope gradient, as outlined in Table 3I-25, were selectively multiplied by the graded areas (acres) categorized by slope class, as outlined in Table 3I-26, to provide predictions of sediment detachment (tons) per graded area, as provided in Table 3I-27.

Table 3I-27
Proposed Action Graded Areas -
Potential Increased Sediment Detachment Above Existing Conditions

Soil Unit	Post Implementation (tons)	Post Re-Vegetation (Years 2-5[a]) (tons)	Post Re-Vegetation (Years 6 Onward[a]) (tons)
Grading			
640	26.3	48.0	22.5
715	0.9	2.9	1.3
740	162.6	158.5	76.1
770	201.6	68.7	33.5
785	74.2	58.0	28.0
850	6.4	10.3	4.9
Total Detachment Grading	**471.9**	**346.6**	**166.3**
Agassiz Hiking Trail Construction			
770	8.7	8.7	8.7
Road			
715	2.2	2.2	2.2
740	23.3	23.3	23.3
Total Detachment Road	**25.5**	**25.5**	**25.5**
Road De-Commissioning			
715	**-14.3**	**-14.3**	**-14.3**
Total Detachment	***491.8***	***366.5***	***186.2***

No re-vegetation was assumed to occur for road surface.
Source: Resource Engineering, Inc, 2003

While the sediment detachment quantities predicted by this WEPP analysis are measures of potential detachment, and not actual sediment yield or delivery, the anticipated increase in post-implementation detachment of 492 tons is substantial. After re-vegetation, even with de-commissioning of a portion of the existing mountain access road reducing detachment by approximately 14 tons per year, the total increase in detachment is anticipated to be almost 186 tons. This increase is driven primarily by 43.3 acres of the 131 acres of total disturbance that are proposed to occur on slopes of 30 percent slope gradient or higher. Furthermore, five of the six affected soils mapping units have erosion hazards rated as "Severe," while re-vegetation potential is rated as Low to Moderate.

Re-establishment of vegetative cover is of critical importance for control of potential erosion from graded terrain. Field review of graded terrain on the *Logjam* (trail #25) and *Upper Ridge* (trail #26) trails, where grading has occurred within the last six to 10 years, reveals that re-vegetation over that time period has yielded typical vegetation cover densities of only 15 to 20 percent. The surface rock fraction for graded terrain is higher, and loss of topsoil has resulted due to the turnover of graded soils. On existing graded trails, in areas where finer-grained soil particles have settled, re-vegetation has resulted in somewhat higher cover densities, ranging from 30 to 40 percent. The assumptions used for the WEPP analysis incorporate a long-term re-vegetation cover fraction attainment of 40 percent. For comparison, existing trails which have

been flush-cut exhibit excellent vegetative cover, with cover densities ranging from 70 to 80 percent, and well-established (although rocky) topsoils.

In order to sufficiently reduce the risk of increased soil loss, and reach the 40 percent long-term cover densities assumed in the WEPP model, attainment of adequate re-establishment of vegetative cover would be essential. Stockpiling of topsoil prior to grading, preservation, and re-distribution following grading, accompanied by mulching and re-vegetation, would likely result in improved re-vegetation in comparison to existing graded terrain, especially on gentler slopes (less than 30 percent slope gradient). In these areas, post-grading erosion risk would be moderate.

However, a review of Table 3I-26 reveals that for areas with greater than 30 percent slope gradient, potential immediate post-disturbance sediment detachment rates range from approximately 3 to 10 times those exhibited by slopes in the 20 to 30 percent range. Coupled with the severe erosion hazard for the affected soils units, the risk of topsoil loss is severe. Table 2-2 (Mitigation Measures and Best Management Practices) in Chapter 2 outlines several specific erosion control measures, such as jute-netting or geo-textile mesh, designed to enhance soils stabilization and re-vegetation potential for these steeper slopes. Successful implementation of such measures can reduce, but not eliminate the high risk of erosion and topsoil loss on steeper slopes. Successful and secure installation of these measures can be difficult on steeper terrain. Thus, the risk of erosion and topsoil loss following grading on slopes with gradients of 30 percent or greater would likely be moderate to high.

In interpreting the sediment yield predictions, it is important to note that the quantities refer to sediment detachment, and do not represent actual delivery of sediment to stream systems within the watersheds. Furthermore, the WEPP documentation cautions that "At best, any predicted runoff or erosion value, by any model, will be within only plus or minus 50 percent of the [actual] value. Erosion rates are highly variable, and most models can predict only a single value. Replicated research has shown that observed values vary widely for identical plots, or the same plot from year-to-year. Also, spatial variability… of soil properties add[s] to the complexity of erosion prediction." [354]

Alternative 3

Under Alternative 3, there are slight differences in the areas proposed for grading. Because snowmaking would not be implemented, no road would be constructed from the existing maintenance facility to the snowmaking water impoundment location, nor would the impoundment construction create ground disturbance. Further, additional water input in the form of snowmaking would not occur on the graded terrain. The breakdown of graded terrain by slope class for Alternative 3 is outlined in the Table 3I-28.

[354] USDA Forest Service, 2000

Table 3I-28
Alternative 3 - Graded Terrain by Slope Class

Soil Unit	<10% (acres)	10 - 20 % (acres)	20 - 30 % (acres)	30 - 40 % (acres)	> 40% (acres)	Total (acres)
Grading						
640	2.7	10.2	5.6	2.2	0.2	**20.8**
715	0.2	0.5	0.1	0.0	0.0	**0.9**
740	1.9	14.9	21.8	12.2	4.6	**55.3**
770	0.0	0.5	1.1	3.1	12.6	**17.3**
785	0.2	3.7	8.1	5.3	2.5	**19.9**
850	0.1	1.9	1.9	0.5	0.0	**4.5**
Agassiz Hiking Trail Construction						
770	0.0	0.0	0.0	0.0	0.6	**0.6**
Total	***5.1***	***31.7***	***38.5***	***23.4***	***20.5***	***119.3***[a]

[a] Note: The total graded area reported in this table is greater than that reported in Table 2-4 (Alternatives Matrix/Summary of Environmental Consequences) table in Chapter 2. The reason for this difference is that the graded areas within this table encompass multiple disturbance types, including utilities corridors. Therefore, this table considers potential erosion effects caused by a variety of ground-disturbing activities.
Source: Resource Engineering, Inc, 2003

The options for treatment prescription and slope gradient classes were subsequently used as input to the WEPP model to produce predictions for potential sediment yield. The model results are outlined in Table 3I-29.

Table 3I-29
Alternative 3 - WEPP Model Predicted Erosion Rate (by Slope Class, Tons/Acre)

Slope Gradient (%)	Post Disturbance (tons/acre)	After Re-Vegetation, Years 2-5 (tons/acre)[a]	After Re-Vegetation, Years 6 Onward (tons/acre)[a]
< 10%	0.05	0.4	0.1
10 - 20 %	0.44	1.7	0.8
20 - 30 %	1.4	2.7	1.3
30 - 40 %	4.4	3.5	1.7
> 40%	14.8	4.3	2.1

[a]Note: Years 2-5 use the Disturbed WEPP Short Grass management prescription, while years 6 onward use the Tall Grass management prescription. For slopes less than 30%, WEPP predicts more erosion for the re-vegetated prescriptions than for the skid trail prescription used for post-disturbance circumstances. Although this result is counter-intuitive, no adjustments were made during the modeling process, in order to avoid arbitrary adjustment of input parameters, and to maintain a conservative and defensible analysis.
Source: Resource Engineering, Inc, 2003

The general model results for sediment detachment per unit area (tons per acre) for each combination of prescription and slope gradient as outlined in Table 3I-28 were selectively multiplied by the graded areas (acres) categorized by slope class as outlined in Table 3I-29, to yield predictions of sediment yield (tons) per graded area, as provided in Table 3I-30.

Table 3I-30
Alternative 3 Graded Areas
Potential Increased Sediment Detachment
Above Existing Conditions

Soil Unit	Post Implementation (tons)	After Re-Vegetation, Years 2-5 (tons)	After Re-Vegetation, Years 6 Onward (tons)
Grading			
640	24.5	41.8	19.7
715	0.4	0.0	0.0
740	158.6	147.2	70.7
770	201.6	68.7	33.5
785	74.2	58.0	28.0
850	6.4	10.3	4.9
Agassiz Hiking Trail Construction			
	8.7	8.7	8.7
Total Detachment	***474.3***	***336.0***	***166.2***

Source: Resource Engineering, Inc, 2003

The anticipated increase in detachment immediately following project implementation is approximately 474 tons, and is three percent lower than the Proposed Action. The detachment rates are driven primarily by 42 acres of the 119 acres of total grading that are proposed to occur on slopes of 30 percent slope gradient or higher. Furthermore, five of the six affected soils mapping units have erosion hazards rated as "Severe," while re-vegetation potential is rated as Low to Moderate.

In order to sufficiently reduce the risk of increased soil loss, and reach the 40 percent long-term cover densities assumed in the WEPP model, attainment of adequate re-establishment of vegetative cover would be essential. Stockpiling of topsoil prior to grading, preservation, and re-distribution following grading, accompanied by mulching and re-vegetation, would likely result in improved re-vegetation in comparison to existing graded terrain, especially on gentler slopes (less than 30 percent slope gradient). In these areas, post-grading erosion risk would be moderate.

However, a review of Table 3I-29 reveals that for slopes with greater than 30 percent slope gradient, potential immediate post-disturbance sediment detachment rates range from approximately 3 to 10 times those exhibited by slopes in the 20 to 30 percent range. Coupled with the severe erosion hazard for the affected soils units, the risk of topsoil loss is severe. Table 2-2 (Mitigation Measures and Best Management Practices) in Chapter 2 outlines several specific erosion control measures, such as jute-netting or geo-textile mesh, designed to enhance soils stabilization and re-vegetation potential for these steeper slopes. Successful implementation of such measures can reduce, but not eliminate the high risk of erosion and topsoil loss on steeper slopes. Successful and secure installation of these measures can be difficult on steeper terrain. Thus, the risk of erosion and topsoil loss following grading on slopes with gradients of 30 percent or greater would likely be moderate to high.

Indicator:

Analysis of Potential Changes to Soil Chemistry Due to Anticipated Increases in Soil Moisture Consistency and Nutrient Loading

Alternative 1 – No Action

Under the No Action alternative, input of additional water in the form of snowmaking would not occur, and no change in the soil chemistry regime would be likely to occur.

Alternative 2 – The Proposed Action

Summary of the Analysis Procedure

The following analysis is excerpted from the soils column test report produced by ESN Rocky Mountain.[355] The entire report is contained in the official project record. Soils sampling and laboratory analyses were performed in order to assess the potential changes in soil chemistry resulting from the introduction of tertiary-treated reclaimed municipal wastewater in the form of machine-produced snow. Undisturbed, intact, soil cores were collected from a location at the base of slope areas within the SUP area using a "direct push" drilling methods. One undisturbed core was also collected from two to three feet with a California Geotechnical Sampler, in order to test for soils' physical properties. The depth of the cores ranged from 8 to 11 feet.

The site from which the cores were obtained is approximately 900 feet east (upslope) of the existing lower terminal of the Agassiz Lift. The site is located within soils mapping unit 740, within the primary watershed drainage slated to receive snowmaking water input under the Proposed Action. The soils are classified as Andic Cryoborolls. In descending order, the soil profile used in the column experiment consists of a well-decomposed A-horizon, a zone of eluviation (Ae), and B-horizon and C-horizon andesitic parent material.

The soils and parent material retrieved were used to re-construct the "in-situ" soil profile in a 10-foot long PVC column in the laboratory. This column was used to conduct a loading test on the soil using treated wastewater from the City of Flagstaff. Initial baseline soil chemistry was analyzed using representative composited samples from each of the major soils horizons (A, B, and C).

Subsequently, approximately 44 gallons of treated wastewater were percolated through the soil column over a period of roughly 60 hours. This volume is equivalent to 67.6 feet of treated wastewater application to the soil and does not take into account dilution from natural snowfall. The volume corresponds to 38 years of seasonal snowmaking application, for average operational conditions.

Two sets of water samples were collected at different stages of the test. Water samples were drawn from valves installed along the soil column at the A/B and B/C horizon boundaries, as well as at the bottom of the column. Early percolation samples were collected after 6.6 gallons had been pumped through the column. Late percolation water samples were collected after 41 gallons of treated water had passed through the column. Once percolation was complete, the soil

[355] ESN Rocky Mountain, 2003

column was de-constructed and composite soil samples were collected from each horizon, in order to assess the resultant soils chemistry.

Physical Properties of the Soils

Some settling occurred in the column after water pumping commenced. The resulting length of each horizon (after settling) is shown below in Table 3I-31. Also shown is the weight of material removed from the column after separating each horizon and the sand pack intervals. Densities in the column were calculated based on the corrected dry weight of the soil removed from each horizon. The density can be compared to the core densities from the geotechnical sample (refer to Table 3I-32) collected at the site.

Table 3I-31
Soils Column Physical Properties

Soil Horizon Column Section Units	Wet Soil Weight (pounds)	Post-run Soil Moisture (percent)	Calc. Dry Basis Soil Weight (pounds)	Settled Soil Depth (inches)	Dry Basis Soil Density (g/cm^3)
A	12	27.4	8.8	16.0	1.20
B	37	13.9	32.0	51.8	1.35
C	26	22.5	20.1	34.0	1.31
Total	***75***			***102***	

Source: ESN Rocky Mountain, 2003

Table 3I-32
Moisture and Density from Advanced Terra Testing

Core Section Units	Wet Density (lb/ft^3)	Percent Moisture (percent)	Dry Density (lb/ft^3)	Dry Density (g/cm^3)
A	122	13.9	107	1.71
B	112	8.0	104	1.67
C	114	7.0	107	1.71
D	116	5.1	110	1.76

Source: ESN Rocky Mountain, 2003

Soils Baseline and Post-Percolation Chemical Analysis

An evaluation of the soil column analytical results was carried out to:

- Document variations in fecal bacteria, and trace and major cations and anions.
- Assess the environmental impact of these variations on the treated water and flushed soils.

The soil horizons and treated water were sampled and analyzed both before and after percolation of the treated wastewater. The variations of bacteria and trace and major anions and cations in the water and soils were examined both before and after percolation.

The analytical results for the water and soils are also provided in the following tables.

Table 3I-33
Column Test Soils Chemistry

Method Employed		NCA 0103	EPA SW-846 9045C		HACH 9056	SM-4500	9060	SW-846 6010B				
LIMS ID	Sample ID	% Moisture	pH	Fecal Coliform	Total Phosphate	N-Ammonia	TOC	Sb	As	Ba	Be	Cd
Units		%		MPN/100 g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
101293-0001	Initial A	4.58	6.45	400	5083	< 8	1.70	< 50	< 50	188	< 2.5	< 5
101293-0002	Initial B	1.36	7.12	< 20	3802	< 8	0.37	23	32	93	< 1.0	< 2
101293-0003	Initial C	2.28	8.84	< 20	4554	< 8	0.19	16	19	76	0.9	< 1
101293-0004	Final A	27.40	7.48	< 20	4683	< 8	1.95	< 20	< 20	159	< 1.0	< 2
101293-0005	Final B	13.90	7.50	< 20	5168	< 8	0.30	20	23	68	< 0.5	< 1
101293-0006	Final C	22.50	9.30	< 20	4710	< 8	0.23	14	20	93	0.7	< 1

Method Employed		SW-846 6010B										
LIMS ID	Sample ID	Ca	Cr	Cu	Pb	Mg	Ni	K	Se	Ag	Na	Sr
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
101293-0001	Initial A	6003	12	17.1	< 25.00	6414	21	1413	< 125	< 5	< 1250	57
101293-0002	Initial B	5031	11	16.3	11.15	6613	16	576	< 50	< 2	< 500	42
101293-0003	Initial C	6667	7	14.5	8.29	6626	15	528	< 25	< 1	1571	49
101293-0004	Final A	5691	10	15.3	< 10.00	5930	17	1209	< 50	< 2	< 500	42
101293-0005	Final B	4422	8	14.0	8.01	6516	14	533	< 25	< 1	328	33
101293-0006	Final C	7194	5	10.8	9.03	5539	11	529	< 25	< 1	1938	47

Method Employed		SW-846 6010B		EPA SW-846 7471A	EPA SW-846 9056						EPA SW846 1664	
LIMS ID	Sample ID	Tl	Zn	Hg	Br	Cl	F	SO_4	NO_3	NO_2	O&G	
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
101293-0001	Initial A	< 100	63	< 0.03	< 1.0	6	< 1.0	2	51.0	< 1.0	52	
101293-0002	Initial B	< 40	55	< 0.03	< 1.0	1	< 1.0	< 2	< 1.0	< 1.0	64	
101293-0003	Initial C	< 30	45	< 0.03	< 5.0	13	< 5.0	84	< 5.0	< 5.0	56	
101293-0004	Final A	< 50	58	< 0.03	< 1.0	26	< 1.0	8	< 1.0	< 1.0	59	
101293-0005	Final B	< 50	49	< 0.03	< 1.0	10	< 1.0	6	2.0	< 1.0	< 25	
101293-0006	Final C	< 50	37	< 0.03	< 5.0	13	< 5.0	39	< 5.0	< 5.0	126	

Table 3I-34
Column Test Water Chemistry

Method Employed		EPA SW-846 9045C			8048		EPA SW-846 9056	SM-4500		SW-846 6010B			
LIMS ID	**Sample ID**	**pH**	**TDS**	**Fecal Coliform**	**Total Phosphate**	**Dissolved Phosphate**	**Ortho-phostphate**	**N-Ammonia**	**TOC**	**Sb**	**As**	**Ba**	**Be**
Units			**mg/L**	**MPN/100 ml**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
101277-0001	Initial Water	7.47	394	< 2	< 0.5	< 0.5	< 2.00	< 0.8	4.8	<0.1	<0.1	0.27	< 0.005
101277-0002	Early Water (A/B)	6.44	349	7	< 0.5	< 0.5	< 2.00	< 0.8	12.9	<0.1	<0.1	0.26	< 0.005
101277-0003	Early Water (B/C)	6.59	355	< 2	< 0.5	< 0.5	< 2.00	< 0.8	5.8	<0.1	<0.1	0.17	< 0.005
101277-0004	Early Water (Bot. C)	7.08	558	< 2	< 0.5	< 0.5	< 2.00	< 0.8	7.9	<0.1	<0.1	0.22	< 0.005
101277-0005	Late Water (A/B)	7.17	390	14	< 0.5	< 0.5	< 2.00	< 0.8	12	<0.1	<0.1	0.26	< 0.005
101277-0006	Late Water (B/C)	6.98	387	< 2	< 0.5	< 0.5	< 2.00	< 0.8	5.3	<0.1	<0.1	0.14	< 0.005
101277-0007	Late Water (Bot. C)	7.71	404	< 2	< 0.5	< 0.5	< 2.00	< 0.8	5.2	<0.1	<0.1	0.13	< 0.005
101277-0008	Final Water	7.44	396	2	< 0.5	< 0.5	< 2.00	< 0.8	5.3	<0.1	<0.1	0.12	< 0.005

Method Employed		EPA SW-846 6010B											
LIMS ID	**Sample ID**	**Cd**	**Ca**	**Cr**	**Cu**	**Pb**	**Mg**	**Ni**	**K**	**Se**	**Ag**	**Na**	**Sr**
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
101277-0001	Initial Water	< 0.01	32	< 0.005	0.013	< 0.05	17	0.030	14	< 0.25	0.015	91	0.10
101277-0002	Early Water (A/B)	< 0.01	19	< 0.005	0.013	< 0.05	4	< 0.025	18	< 0.25	0.012	87	0.18
101277-0003	Early Water (B/C)	< 0.01	23	< 0.005	0.012	< 0.05	9	0.031	13	< 0.25	0.013	67	0.25
101277-0004	Early Water (Bot. C)	< 0.01	26	< 0.005	0.017	< 0.05	6	0.031	9	< 0.25	0.014	165	0.27
101277-0005	Late Water (A/B)	< 0.01	31	< 0.005	0.015	< 0.05	16	0.037	13	< 0.25	0.015	87	0.25
101277-0006	Late Water (B/C)	< 0.01	26	< 0.005	0.011	< 0.05	12	0.033	12	< 0.25	0.012	3	0.25
101277-0007	Late Water (Bot. C)	< 0.01	26	< 0.005	0.011	< 0.05	11	0.029	11	< 0.25	0.012	90	0.25
101277-0008	Final Water	< 0.01	24	< 0.005	0.011	< 0.05	8	0.031	11	< 0.25	0.011	100	0.23

Table 3I-34, Continued
Column Test Water Chemistry

Method Employed		EPA SW-846 6010B		EPA SW-846 7471A	EPA SW-846 9056						EPA SW846 1664
LIMS ID	**Sample ID**	**Tl**	**Zn**	**Hg**	**Br**	**Cl**	**F**	**SO_4**	**NO_3**	**NO_2**	**O&G**
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
101277-0001	Initial Water	< 0.2	0.08	< 0.0005	< 1.0	101	< 1.0	22	20	< 1.0	1.0
101277-0002	Early Water (A/B)	< 0.2	0.06	< 0.0005	< 1.0	102	< 1.0	22	21	< 1.0	8.6
101277-0003	Early Water (B/C)	< 0.2	0.02	< 0.0005	< 1.0	97	< 1.0	19	33	< 1.0	7.0
101277-0004	Early Water (Bot. C)	< 0.2	0.03	< 0.0005	< 1.0	109	< 1.0	74	29	< 1.0	2.8
101277-0005	Late Water (A/B)	< 0.2	0.07	< 0.0005	< 1.0	102	< 1.0	21	19	< 1.0	1.7
101277-0006	Late Water (B/C)	< 0.2	0.10	< 0.0005	< 1.0	101	< 1.0	24	19	< 1.0	1.0
101277-0007	Late Water (Bot. C)	< 0.2	0.05	< 0.0005	< 1.0	102	< 1.0	23	19	< 1.0	1.0
101277-0008	Final Water	< 0.2	0.04	< 0.0005	< 1.0	103	< 1.0	28	20	< 1.0	< 1.0

Only those analyses that show a noticeable change in the treated water and soil are described and discussed in the following section. These include major cations and anions, acidity and fecal coliform. Trace elements (e.g., Ni, Zn, Cu) were at or near detection limit levels in the water (i.e., below EPA limits for primary drinking water) and these constituents exhibit only minor concentration variations in the soils after water percolation.

Summary of the Changes to Soil and Water Chemistry

Variations noted in the treated water after flow through the soil column

1. Moderate increase of fecal coliform (0-2 MPN/100 ml), strontium (0.096 to 2.3 mg/L), and sulfate (22 to 28 mg/L)
2. Minor increase of nickel, chloride and total organic carbon
3. Minor decrease of barium, magnesium, zinc, calcium and potassium

Changes to the A-horizon soil after water percolation

1. Moderate increase of chloride (6.4 to 26.3 mg/kg), sulfate (2.1 to 8.5 mg/kg), and pH (6.45 to 7.48)
2. Moderate decrease of fecal coliform (400 to 0 MPN/100 g), nitrate (51 to 0mg/kg), phosphate (5,083 to 4,683 mg/kg)
3. Minor decrease of potassium, calcium, magnesium, strontium, barium, chromium, copper, nickel, and zinc

Changes to the B-horizon soil after water percolation

1. Moderate increase of chloride (1.5 to 10.4 mg/kg), sulfate (0 to 5.6 mg/kg), nitrate (0 to 2 mg/kg) and total phosphate (3,802 to 5,168 mg/kg)
2. Minor decrease of potassium, calcium, strontium, barium, chromium, copper, nickel, and zinc

Changes to the C-horizon parent material after water percolation

1. Moderate increase of barium (76 to 93 mg/kg), calcium (6,667 to 7194 mg/kg), and pH (8.84 to 9.3)
2. Minor increase of chloride and total phosphate
3. Moderate decrease of sulfate (84 to 39 mg/kg) and magnesium (6,626 to 5,539 mg/kg)
4. Minor decrease of strontium, chromium, copper, nickel and zinc

Fecal Coliform

As indicated in the results of the column test experiment, all fecal coliform is contained in the A-horizon soil in relatively minor amounts and is a result of animal droppings. Sampling and analysis of waters after 6.6 and 41.2 gallons of percolation reveals most of the fecal coliform in water draining the A-horizon soil as expected. With time, the fecal coliform bacteria are eradicated by the chlorinated treated water, leaving no colonies in the soil after percolation of the 44 gallons. Only traces of fecal coliform remain in the water after percolation of all the water.

Soil Acidity

Sulfate and chloride can contribute to soil acidity by complexing with free hydrogen to form sulfuric and hydrochloric acid respectively. In the case of the Snowbowl soils, sulfate is being flushed out of the C-horizon parent material, but chloride is accumulating in all horizons. Measurements of pH, however, suggest that chloride is not contributing to acidity in these soils. In fact, the natural acidity of the soils is buffered to more neutral values by percolation of treated water through the column. Early water samples from the A/B and B/C intervals are acidic, but later samples from these intervals reveal more neutral values. This is probably the result of the water flushing out organic acids in the A- and B-horizons. Buffering of the A- and B-horizons by the treated water helps prevent the dissolution and loss of toxic metals (e.g., Ni, Cr) to the groundwater and also allows for adequate supply of essential micronutrients (e.g., Fe, Mn, Cu, Zn and Co). The low-level addition of chloride to the soils is not detrimental to plant growth because it is an essential micronutrient at these levels.[356]

Essential Nutrients

In addition to the soils cores collected for the column test, 14 surficial soils samples were collected from various locations within the Snowbowl SUP area. The nutrient content for these soils was analyzed, and the results are outlined in Table 3I-35.

Table 3I-35
Nutrient Analysis of Snowbowl Soils

Method Employed		**EPA SW-846 9056**		**HACH 9056**
LIMS ID	**Sample ID**	**NO_2**	**NO_3**	**Phosphate**
Units		**mg/kg**	**mg/kg**	**mg/kg**
101314-0001	SS-01	< 1.0	297	ND
101314-0002	SS-02	< 1.0	112	ND
101314-0003	SS-03	< 1.0	108	ND
101314-0004	SS-04	< 1.0	79	ND
101314-0005	SS-05	< 1.0	4	ND
101314-0006	SS-06	ND	52	ND
101314-0007	SS-07	ND	24	< 2.0
101314-0008	SS-08	<1.0	123	ND
101314-0009	SS-09	<1.0	176	< 2.0
101314-0010	SS-10	<1.0	33	4.5
101314-0011	SS-11	2.2	153	< 2.0
101314-0012	SS-12	<1.0	100	< 2.0
101314-0013	SS-13	ND	2	ND
101314-0014	SS-14	ND	70	ND

ND = Not Detected ay Specified Reporting Limit
Source: ESN Rocky Mountain, 2003

[356] Brady, 1990

Although the reclaimed water contains high levels of nitrate (approximately 20 mg/L), the soils column experiment shows leaching of nitrate from the soils by the treated wastewater. The soils column test, simulating many years of water loading, removes such processes as vegetative uptake and biological nitrogen fixation from the nutrient dynamics of the soils.

In the 14 soils analyzed the nitrate content ranges from two to 297 mg/kg with a median concentration of 85 mg/kg. The results of the column test suggest that most of this nitrate would leach to groundwater early in the percolation of the treated wastewater. The nitrate would, however, be replenished to the soil through biological fixation of nitrogen from the atmosphere (i.e., conversion of N_2 to ammonia by soil microorganisms) and from deposition of nitrogen compounds from rain and snow.[357] Rates of nitrogen addition to soil by biological fixation and precipitation have been estimated at 15 and 5-8 kg/ha respectively.[358] Ammonia inputs would be oxidized to nitrate during the summer months by the nitrification process. The A-horizon soils promote nitrification because they are well aerated with an abundance of carbon and base-forming cations (e.g., Ca). The laboratory column experiment suggests that although some of the soluble nitrate would be leached in the spring by percolation of treated water from melting snow, it would be replenished during the summer months.

The manner in which these dynamics would be manifested in field conditions is subject to some uncertainty. The addition of reclaimed water had the effect of removing nitrogen from the soils in the accelerated laboratory experiment. However, the laboratory experiment does not consider the important processes of vegetative uptake, or nutrient cycling by soils microbes. Infiltration of reclaimed water snowmelt would occur over seasonal, annual, and decadal time scales. Under field conditions, the increased nitrogen loading via application of reclaimed water would be subject to uptake from vegetation and microbes, and could increase nitrogen availability in the soils.

A controlled experimental nitrogen fertilization study in the Loch Vale and Fraser experimental forests in northern Colorado from 1997-1999 offers some insight into potential soils response to increased nitrogen loading in a coniferous forest.[359] Two sites were treated with an ammonium nitrate (NH_4NO_3) fertilizer at a rate of 25 kg $N/ha^{-1}/yr^{-1}$.[360] The results of the study support the conclusion that generally, in nitrogen-limited forests, the available nitrogen pool does increase in response to fertilization. Initially, the increased nitrogen inputs were realized in the soil as organic nitrogen, and in the vegetation as increased foliar nitrogen levels.[361] This trend continued until the carbon-to-nitrogen (C:N) ratio of the forest soil reached a specific threshold, after which further nitrogen additions increased the rate of nitrogen mineralization by the soil and inorganic soil nitrogen levels.[362] Once this threshold was reached, increased rates of nitrogen cycling, and subsequent increased rates of nitrogen leaching from the soil were observed.[363]

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[357] Id.
[358] Id.
[359] Rueth, et al. 2003.
[360] Id.
[361] Id.
[362] Id.
[363] Id.

It is likely that the response of the soils at the Snowbowl to increased nitrogen inputs would be similar. The increased nitrogen loading via application of the reclaimed wastewater would be likely to initially cause increases in organic and bio-available nitrogen within the soils, until reaching a similar threshold. Subsequently, increases in nitrogen mineralization and inorganic nitrogen would be expected, followed by increased leaching of excess nitrogen through the soils column.

A small amount of potassium was flushed from the soil (approximately 4.0 ppm) early in the percolation, but the overall potassium concentration of the soil is not affected by percolation of the treated water. In the column test, a substantial amount of phosphate leached from the A-horizon and re-precipitated in the B-horizon, but this phosphate was not detected in the early, late, or final water samples. The phosphate was therefore not being flushed from the soils by the treated water.

Total Dissolved Solids

Total Dissolved Solids (TDS) expresses the total concentration of solids remaining when a water sample is evaporated to dryness. The TDS of the treated water increases sharply in the early water sample from the bottom of the C-horizon and this probably reflects rapid flushing of sulfate from the parent material and strontium from soils to the treated water. The overall salinity or TDS of the treated water would not be expected to change noticeably via percolation of treated water through the soil profile.

Total Organic Carbon

Organic carbon creates reducing conditions in aquifers and surface waters, which can create biological oxygen demand (BOD) and hinder aquatic life habitat. The percolated treated water is receiving carbon mainly from the A-horizon, but the amount is inconsequential in relationship to the potential for change in redox conditions in groundwater and discharge areas.

Base-forming Cations

Calcium, which is an important cation for buffering acidity, uptake of nutrients for plants, and nitrification processes can contribute to water hardness depending on the amounts flushed to soil solution and groundwater. The calcium in this case is leached from both A- and B-horizons, but it is re-precipitated or adsorbed in the C-horizon. It would therefore not be flushed out of the soils to potentially contribute to the hardness of the groundwater. Strontium, on the other hand, would be flushed out of the A-horizon mainly, but minor increases in concentration in the treated water does not contribute to higher total dissolved solids.

Conclusions

The primary conclusions of the soil column experiment are:

1. Percolating treated wastewater through the soil profile would be unlikely to have a negative impact on either the soils or treated water.
2. Fecal coliform in the A-horizon soil could be reduced via the percolation of chlorinated wastewater. However, under field conditions, due to the chlorine's volatility and the aerating effect of distribution through snowmaking, the quantity of chlorine within the

snowpack would be reduced, and the subsequent effect on soils bacteria would be less than observed in the laboratory.

3. Chloride and sulfate would be added to both the A- and B-horizon soils. A larger amount of sulfate could be lost from the C-horizon parent material to the groundwater. The low-level addition of these essential nutrients to the soils is generally beneficial to plant growth.
4. The acidity of the soil and parent material would be progressively buffered to more alkaline levels by percolation of the treated wastewater. The higher alkalinity would inhibit the leaching and mobilization of toxic metals to the groundwater, and would allow for an adequate supply of bio-available micronutrients (e.g. Fe, Mn, Cu, Zn, Co) to remain available for plant growth.
5. Nitrate, which is concentrated in A-horizon soil, would leach to the groundwater as the treated wastewater percolates through the column. The nitrate, however, would be replenished during the summer months by the addition of ammonia from the atmosphere through biological fixation and precipitation with subsequent oxidation of the ammonia to nitrate. However, under field conditions the nitrogen dynamics would differ. Due to vegetative and microbial assimilation, the increased nitrogen loading via the application of reclaimed water would initially increase organic nitrogen content and availability in the soils. After reaching a new dynamic equilibrium, however, further nitrogen inputs would be realized as increases in soils nitrogen mineralization, inorganic nitrogen, and leaching from the surface soils horizon. Other essential nutrients (i.e. potassium, phosphate, and sulfate) would not be removed from the A- and B horizon soils in substantial amounts.
6. Although the results of the column test show that salinity of the treated water (TDS) increases initially because of the addition of sulfate and strontium from the parent materials and soils, the overall salinity of the reclaimed water would be unlikely to change substantially through the soils column.
7. The total organic carbon content of the treated wastewater increased slightly, but would be unlikely to produce more reduced conditions in groundwater.

Although the results of the column test show that salinity of the treated water (TDS) increases initially because of the addition of sulfate and strontium from the parent materials and soils, the overall salinity of the reclaimed water would be unlikely to change substantially through the soils column.

The total organic carbon content of the treated wastewater increased slightly, but would be unlikely to produce more reduced conditions in groundwater.

Alternative 3

Under Alternative 3, input of additional water in the form of snowmaking would not occur, and changes in the soil chemistry regime are not anticipated. However, the proposed grading activities, using heavy machinery, would cause soils compaction and loss of soil tilth. Loss of top soil and a decrease in soils organic matter associated with disturbances to the rooting zone could reduce the soils productivity.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal extent for the cumulative effects to soils and geological resources includes the lifespan of past, present, and reasonably foreseeable future projects outlined in Table C-1, located in Appendix C. This time period begins with initial construction of ski area trails and infrastructure in the late 1930s. The listed projects include various on-going activities, including private land development, whose timing is indefinite. For the purposes of this cumulative effects analysis, a period of 10 years from the date of this document has been considered.

Spatial Bounds

The spatial extent for the cumulative effects analysis is limited to the Snowbowl SUP area and adjacent restoration and development activities, as defined below.

Past, Present, and Reasonably Foreseeable Future Actions

Past, present and reasonably foreseeable future projects that, in addition to Snowbowl's exiting and proposed facilities, could cumulatively affect soils and geological resources include:

1. San Francisco Mountain Mineral Withdrawal/White Vulcan Mine Settlement
2. Bebbs Willow Restoration Project
3. Transwestern Lateral Pipeline Project
4. Inner Basin Water Pipeline Development and Maintenance
5. Private Land Development
6. Miscellaneous/ongoing Recreational Uses
7. Miscellaneous facilities and trail construction within Snowbowl's SUP area
8. Patented mining claims on the east slopes of the Peaks are experiencing erosion problems

In addition, three indicators that were addressed in the direct and indirect analysis are repeated in this cumulative effects analysis to provide a conservative analytical reference point from which to compare cumulative basin water balance changes between pre-development conditions and proposed conditions within the SUP area. The analysis assumes that that undeveloped forested conditions exhibited 100 percent cover density. Actual conditions in a forest unaffected by human influences vary over time through cycles of fire, re-growth, and variation in vegetation species and density, and do not necessarily reflect a fully forested, mature vegetative cover.

These effects reflect the differences in the water balance between mature forest, and conditions where the fully forested baseline has been altered by the presence of vegetative clearing to construct existing ski trails and additional snowmaking water applications. The differences in the water balance between two different scenarios were analyzed:

1. Forest environment undisturbed by human activities, with mature trees, and a canopy with 100 percent cover density

2. Forest environment with the existing and proposed trail and snowmaking infrastructure present

San Francisco Mountain Mineral Withdrawal

As part TCP designation, the Peaks and surrounding area were withdrawn from availability for mineral entry in 2000. This action precludes individuals and entities from staking a mineral claim in preface to planned extraction activities within the withdrawn area. In addition, a condition of the White Vulcan Mine Settlement which stimulated TCP designation and mineral withdrawal actions, stipulated that Tufflite Inc. and its affiliates relinquish all of their mining claims within the TCP. This action has and will provide added protection for soils and will decrease erosion potential by limiting potential ground disturbing activities associated with mining. The settlement also requires that the White Vulcan Mine site be completely reclaimed within 10 years of the date of the settlement.

Bebbs Willow Restoration Project

In its Environmental Assessment,[364] the Forest Service anticipates that: "Soil condition will not be significantly affected by the thinning and tree removal aspect of the project." No heavy equipment will be used to harvest trees or pile slash. Most of the tree cutting will be accomplished by hand, producing no impact to the soil surface. Some soil cover and increase in coarse woody debris will result from the boles and limbs of the trees that remain after burning. By removing all trees over 60 acres and thinning trees less than six inches DBH over 288 acres, the grassland character of the prairie will be promoted. Ground cover composition will favor grasses and plant litter over needle cast from conifer trees.

Low-intensity fire can promote sediment production in the short term, before vegetation is re-established. In a natural fire disclimax, however, grassland vegetation re-establishes quickly. Over the long term, frequent, low-intensity fires that mimic the natural fire cycle can reduce sediment production by reducing the probability of a high-intensity fire and subsequent loss of soil organic matter and productivity.

Transwestern Lateral Pipeline

On-going operation and maintenance of the pipeline includes potential soil-disturbing activities, due to equipment and pipeline access. Many of these effects would be temporary during construction activities; however some activities could result in soil compaction and potential loss of productivity that would be cumulative in nature.

Inner Basin Water Pipeline Maintenance

Maintenance of the existing water pipeline operated by the City of Flagstaff within the Inner Basin on the northern slopes of the San Francisco Peaks includes pipeline repair and replacement activities that would involve soils disturbances from equipment access, as well as disturbance of

[364] USDA Forest Service, 2001b.

shallow soil horizons during pipeline repairs. Many of these effects would be temporary during construction activities; however some activities could result in soils compaction and potential loss of productivity that would be cumulative in nature.

Private Land Development

Construction of houses and other buildings and infrastructure on private lands located within the lower Hart Prairie has and may continue to create localized soil disturbances associated with equipment access and construction activities. During construction, when vegetation is removed and soils are exposed, there is the potential for soil loss via erosion and sediment transport. The risk of soil loss typically decreases after landscaping and re-vegetation is complete. Many of these effects would be temporary during construction activities; however some activities could result in soils compaction and potential loss of productivity that would be cumulative in nature. Currently, there are approximately 13 summer homes developed in the lower Hart Prairie area. Additionally there are approximately four parcels of land which could potentially be developed as home sites.

Miscellaneous Recreational Uses

The San Francisco Peaks region is a popular destination for recreational activities, and recreational use is likely to increase in the future.[365] On-going recreational uses include hiking, camping, horse-back riding, bicycling, and off-road vehicle use. Scattered throughout the vicinity, recreational uses can cause loss of vegetative ground cover, soil compaction, localized erosion, and increased runoff. Although these effects are widely distributed in nature, and mitigated by Forest Service BMP's concerning recreational uses, they do represent cumulative impacts to soils resources.

Alternative 1 – No Action

Sediment-related cumulative effects are somewhat difficult to quantify. Existing conditions reflect changes in sediment yield, soils compaction and productivity that are reflective of distinct differences in land use, management, and cover between pre-Snowbowl development conditions and the modern ski area infrastructure, and are difficult to quantify accurately. Nonetheless, ground disturbance associated with past development/construction activities at the Snowbowl have cumulatively impacted soil resources in, and in the vicinity of, the SUP area from time to time. Historic and on-going operational and maintenance activities involve continuing use of existing roads, as well as some level of soils disturbance associated with routine construction and maintenance activities. Many of the effects are temporary during construction activities; however some activities would result in compacted soils and loss of organic matter, which would be ultimately permanent in nature, and therefore cumulative in effect beyond existing conditions.

Nonetheless, two activities noted above - San Francisco Mountain Mineral Withdrawal and Bebbs Willow Restoration – would cumulative benefit soil resources in the area.

[365] USDA Forest Service, 2001b.

Indicator:

Modeled Anticipated Changes In The Duration And Intensity Of Annual Snowmelt Compared To Historic Natural Variation

The cumulative changes in the water balance for Alternative 1 may be portrayed by comparing existing conditions to inferred pre-development conditions. The following tables display this comparison for average, dry, and wet-year climatic scenarios. Because precipitation inputs remain the same as those outlined in the previous sections, the tables show only the areas of trail construction, the projected watershed losses, recharge and the percent change versus pre-development conditions for each pertinent watershed.

Table 3I-36
Alternative 1 Average Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	0.64	1236.9	693.1	64%	9.8	1%
Humphreys	0.59	429.0	355.0	55%	0.2	0%
Lower Agassiz Ridge	13.50	368.3	199.8	65%	5.2	3%
Middle Agassiz Ridge	3.30	373.7	199.8	65%	1.3	1%
Snowbowl	123.10	940.8	850.5	53%	49.7	6%
Sunset	0.00	111.6	81.1	58%	0.0	0%
Upper Agassiz Ridge	0.00	432.8	239.7	64%	0.0	0%
Total	***145.0***	***3893.1***	***2619.0***	***61%***	***66.2***	***3%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

Table 3I-37
Alternative 1 Dry Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	0.64	776.7	17.6	98%	5.2	42%
Humphreys	0.59	295.6	27.0	92%	0.2	1%
Lower Agassiz Ridge	13.50	233.8	0.0	100%	0.0	0%
Middle Agassiz Ridge	3.30	236.0	0.0	100%	0.0	0%
Snowbowl	123.10	637.6	99.5	86%	52.0	109%
Sunset	0.00	74.8	4.5	94%	0.0	0%
Upper Agassiz Ridge	0.00	276.7	0.0	100%	0.0	0%
Total	***145.0***	***2531.3***	***148.7***	***96%***	***57.4***	***63%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

Table 3I-38
Alternative 1 Wet Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	0.64	1296.3	1645.4	44%	9.8	1%
Humphreys	0.59	443.4	751.5	37%	0.2	0%
Lower Agassiz Ridge	13.50	383.6	482.3	44%	5.1	1%
Middle Agassiz Ridge	3.30	386.0	488.0	44%	1.3	0%
Snowbowl	123.10	976.2	1,754.0	36%	49.3	3%
Sunset	0.00	117.4	176.3	40%	0.0	0%
Upper Agassiz Ridge	0.00	445.7	579.1	43%	0.0	0%
Total	***145.00***	***4048.9***	***5876.6***	***41%***	***65.7***	***1%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

A review of the water yield comparisons for the No Action alternative reveals that existing and Alternative 1 conditions reflect an approximate three percent change in annual recharge under average-year conditions, a 16 percent change in dry year conditions, and a one percent change in wet-year conditions, when compared to pre-development conditions. For the primary Snowbowl watershed, which contains the bulk of the existing trail system, the Alternative 1 cumulative changes are six percent, 109 percent, and three percent, for the average, dry, and wet scenarios, respectively.

Alternative 2 – The Proposed Action

The Proposed Action would involve approximately 10.4 acres of permanent ground disturbance and 245.4 acres of temporary ground disturbance both within, and outside of, the SUP area.

The soils compaction and turnover associated with the proposed grading and trail construction activities would cause compaction of soils and loss of organic matter and tilth that would ultimately be permanent in nature, and therefore cumulative when considered with other past, present and reasonably foreseeable future actions, both within and outside of the SUP area. The estimates of increased sediment detachment would result in cumulative increases in sediment production of 186 tons for Alternative 2. Under Alternative 2, the anticipated decrease in detachment associated with decommissioning a section of existing access road would be 14.3 tons. The new road segment to serve the snowmaking water impoundment access road in Alternative 2 would represent an increase of 25.5 tons of sediment detachment. The net result would be an increase in road detachment of 11.2 tons that contributes six percent of the anticipated cumulative increase of 186 tons. These quantities represent detachment, not transport, but highlight the importance of implementation and operational practices designed to manage water drainage, facilitate re-vegetation, and minimize sediment transport.

When considered with the Transwestern Lateral Pipeline construction, Inner Basin water pipeline maintenance, private land development and miscellaneous recreational uses, the Proposed Action represents a cumulative effect to soil resources in the analysis area.

Indicator:

Modeled Anticipated Changes In The Duration And Intensity Of Annual Snowmelt Compared To Historic Natural Variation

The snowmaking and trail construction of the Proposed Action would result in cumulative water balance effects, for average, dry, and wet-year climates as indicated in the following tables.

Table 3I-39
Alternative 2 - Average Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	3.7	39.9	1254.0	716.0	64%	32.6	5%
Humphreys	9.6	50.4	451.8	382.5	54%	27.8	8%
Lower Agassiz Ridge	7.2	22.5	377.5	213.2	64%	18.5	10%
Middle Agassiz Ridge	1.6	6.9	376.7	203.7	65%	5.1	3%
Snowbowl	54.0	234.0	1,043.0	982.3	51%	181.5	23%
Sunset	0.2	9.8	116.7	85.7	58%	4.7	6%
Upper Agassiz Ridge	0.0	0.5	433.0	239.9	64%	0.3	0%
Total	***76.3***	***364.0***	***4052.8***	***2823.3***	***60%***	***270.5***	***8%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

Table 3I-40
Alternative 2 - Dry Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	3.7	53.3	817.5	30.1	96%	17.7	142%
Humphreys	9.6	67.3	358.8	31.1	92%	4.3	16%
Lower Agassiz Ridge	7.2	30.1	263.9	0.0	100%	0.0	0%
Middle Agassiz Ridge	1.6	9.2	245.2	0.0	100%	0.0	0%
Snowbowl	54.0	312.4	927.2	122.4	88%	74.8	157%
Sunset	0.2	13.0	87.8	4.6	95%	0.1	2%
Upper Agassiz Ridge	0.0	0.7	277.4	0.0	100%	0.0	0%
Total	***76.3***	***486.0***	***2977.9***	***188.1***	***96%***	***96.9***	***45%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

Table 3I-41
Alternative 2 - Wet Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	3.7	26.6	1311.8	1656.6	44%	21.0	1%
Humphreys	9.6	33.6	461.3	767.2	38%	16.0	2%
Lower Agassiz Ridge	7.2	15.0	398.7	482.3	45%	5.1	1%
Middle Agassiz Ridge	1.6	4.6	384.6	494.1	44%	7.3	1%
Snowbowl	54.0	156.2	1,090.1	1,796.3	38%	91.6	5%
Sunset	0.2	6.5	121.6	178.7	40%	2.4	1%
Upper Agassiz Ridge	0.0	0.4	446.0	579.3	43%	0.1	0%
Total	***76.3***	***243.0***	***4175.2***	***5993.3***	***42%***	***182.4***	***2%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

A review of the water yield comparisons for the Proposed Action reveals that Alternative 2 conditions reflect an approximate 8 percent change in annual recharge under average conditions, 45 percent in dry year conditions, and two percent in wet year conditions, when compared to pre-development conditions. For the primary Snowbowl watershed, which would experience most of the proposed snowmaking and trail construction, cumulative changes associated with the Proposed Action are 23 percent, 157 percent, and five percent, for the average, dry, and wet scenarios, respectively.

The primary potential cumulative effect of the changes in the water balance, paired with changes in soils properties caused by the proposed trail construction and trail grading, would be enhancement of the potential for concentrated surface flows. In addition, field review reveals that in existing areas of heavily graded terrain, surface overland flow does occur during the snowmelt season. The increases in water input due to snowmaking would be likely to enhance the potential for further rilling and incisement of flow channels, and transport of surface sediments on graded terrain. As discussed in the Direct and Indirect Effects section, the risk of surface flow and rilling would be minimal for ungraded and flush-cut terrain. For graded terrain, implementation of adequately spaced waterbars to route and dissipate surface flows, coupled with successful re-vegetation, would mitigate the risk of surface rilling in areas where topographic constraints do not tend to channelize and concentrate flows. In areas where topographic lows tend to concentrate any occurring surface flows, the risk of rilling and sedimentation would be moderate to high for graded terrain.

Indicator:

Analysis Of Potential Changes To Soil Chemistry Due To Anticipated Increases In Soil Moisture Consistency And Nutrient Loading

Soil Acidity

The laboratory column experiment suggests that application of the reclaimed water product via snowmaking would increase the alkalinity of the receiving soils, thereby resulting in an increased buffering capacity. Mixed and diluted by natural precipitation, this buffering effect would be

reduced. However, over time, the cumulative trend would be towards slightly more alkaline soils over natural conditions.

Essential Nutrients

A review of the existing nitrogen content for the soils within the SUP area reveals nominal levels of nitrate. The laboratory experiment, conducted on an accelerated timescale when compared to natural processes, suggests that nitrate would be leached from the surface soils horizon by the reclaimed water. However, under field conditions the nitrogen dynamics would differ. Due to vegetative and microbial assimilation, the increased nitrogen loading via application of reclaimed water would initially increase organic and bio-available nitrogen content in the soils. Once a critical carbon-to-nitrogen ratio is reached, subsequent increases in nitrogen mineralization and inorganic soils nitrogen content would be realized. Subsequently, excess nitrogen would begin to leach from the soils column to groundwater. Nonetheless, these effects would be limited in spatial extent to the receiving soils within Snowbowl's ski trail corridors. Effects to the native, undisturbed soils under the forest canopy would be minimal. Increased nutrient loading could increase the biomass of grasses on existing trails, and enhance the re-vegetation process on new or recently disturbed ski trails, improving the resultant cover density for the native grass species that would be used for re-seeding and re-vegetation.

Alternative 3

Alternative three would involve approximately 1.7 acres of permanent ground disturbance and 131.4 acres of temporary ground disturbance within the SUP area. The soils compaction and turnover associated with Alternative 3 grading and trail construction activities (after re-vegetation) would cause compaction of soils and loss of organic matter and tilth that would ultimately be permanent in nature, and therefore cumulative when considered with other past, present and reasonably foreseeable future actions, both within and outside of the SUP area. The estimates of increased sediment detachment associated with Alternative 3 would result in cumulative increases in sediment production of 166 tons. The primary difference between alternatives 2 and 3 is the lack of the proposed snowmaking water impoundment and the associated access road. The new road spur would not be present in Alternative 3, nor would de-commissioning of a portion of the existing access road occur. Thus, no net changes in the road sediment detachment would be anticipated under Alternative 3. These quantities represent detachment, not transport, but highlight the importance of implementation and operational practices designed to manage water drainage, facilitate re-vegetation, and minimize sediment transport.

When considered with the Transwestern Lateral Pipeline construction, Inner Basin water pipeline maintenance, private land development and miscellaneous recreational uses, Alternative 3 represents a cumulative effect to soil resources in the analysis area, although it is less than the Proposed Action.

Indicator:

Modeled Anticipated Changes In The Duration And Intensity Of Annual Snowmelt Compared To Historic Natural Variation

Although no snowmaking is proposed under Alternative 3, clearing of vegetation and land cover changes resulting from trail construction would alter the water balance in a cumulative manner. The effects are outlined in the following tables:

Table 3I-42
Alternative 3 - Average Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	1.6	0.0	1236.9	693.1	64%	9.8	1%
Humphreys	2.0	0.0	428.2	355.8	55%	1.0	0%
Lower Agassiz Ridge	7.7	0.0	365.3	202.8	64%	8.2	4%
Middle Agassiz Ridge	1.6	0.0	373.1	200.4	65%	1.9	1%
Snowbowl	54.0	0.0	919.0	872.3	51%	71.6	8%
Sunset	0.2	0.0	111.6	81.2	58%	0.1	0%
Upper Agassiz Ridge	0.0	0.0	432.8	239.7	64%	0.0	0%
Total	***67.1***	***0.0***	***3866.8***	***2645.3***	***60%***	***92.5***	***2%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

Table 3I-43
Alternative 3 - Dry Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	1.6	0.0	776.7	17.6	98%	5.2	42%
Humphreys	2.0	0.0	294.8	27.9	91%	1.1	4%
Lower Agassiz Ridge	7.7	0.0	233.8	0.0	100%	0.0	0%
Middle Agassiz Ridge	1.6	0.0	236.0	0.0	100%	0.0	0%
Snowbowl	54.0	0.0	614.8	122.4	83%	74.8	61%
Sunset	0.2	0.0	74.7	4.6	94%	0.1	2%
Upper Agassiz Ridge	0.0	0.0	276.7	0.0	100%	0.0	0%
Total	***67.1***	***0.0***	***2507.6***	***172.4***	***95%***	***81.2***	***29%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

Table 3I-44
Alternative 3 - Wet Year Water Balance Cumulative Effects

Watershed	Trail Construction (Acres)	Snowmaking (AF)	Watershed Loss (AF)	Recharge (AF)	% Loss	Recharge Change (AF)[a]	Percent Change[a]
Hart Prairie	1.6	0.0	1296.3	1645.4	44%	9.8	1%
Humphreys	2.0	0.0	442.6	752.3	37%	1.0	0%
Lower Agassiz Ridge	7.7	0.0	380.7	485.2	44%	8.1	2%
Middle Agassiz Ridge	1.6	0.0	385.4	488.7	44%	1.9	0%
Snowbowl	54.0	0.0	954.6	1,775.6	35%	70.9	4%
Sunset	0.2	0.0	117.4	176.4	40%	0.1	0%
Upper Agassiz Ridge	0.0	0.0	445.7	579.1	43%	0.0	0%
Total	***67.1***	***0.0***	***4022.8***	***5902.7***	***41%***	***91.8***	***1%***

[a] Compared to pre-development conditions.
Source: Resource Engineering, Inc, 2003

A review of the water yield comparisons for Alternative 3 reveals an approximate two percent change in annual recharge under average conditions, 29 percent in dry year conditions, and one percent in wet year conditions, when compared to pre-development conditions. For the primary Snowbowl watershed, which would experience most of the proposed snowmaking and trail construction, the Alternative 3 cumulative changes are eight percent, 61 percent, and four percent, for the average, dry, and wet scenarios, respectively.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Because pedogenesis (development or generation of new soils) is a process that occurs over the course of decades and centuries, the effects of soils compaction, loss of organic matter and tilth, and soils loss via increased detachment and transport may be considered an irreversible commitment of resources. Careful implementation of the mitigation measures outlined in Chapter 2 would reduce the overall magnitude of these anticipated losses.

3J. VEGETATION

SCOPE OF THE ANALYSIS

The analysis area for vegetation includes the SUP area, Snowbowl Road, and the proposed reclaimed water pipeline alignment between the City of Flagstaff and the SUP. Indirect effects to vegetation are considered in the areas adjacent to the SUP, Snowbowl Road, and the pipeline alignment. This includes undeveloped portions of the CNF, the Kachina Peaks Wilderness, and areas downslope of the SUP area (primarily Hart Prairie). The extent to which adjacent areas are included in the overall analysis area varies with each specific issue analyzed. Vegetation communities in the analysis area are primarily montane conifer forests and grasslands.

EXISTING CONDITIONS

PLANT COMMUNITIES

The SUP is located on the southwestern slopes of the San Francisco Peaks, at elevations ranging from approximately 9,150 feet to 12,040 feet elevation. The predominant biotic community within the Snowbowl SUP is Rocky Mountain Subalpine Conifer Forest and Woodland, within the Engelmann Spruce-Subalpine Fir Series (Table 3J-1).[366] Subalpine or corkbark fir (*Abies lasiocarpa*) is dominant in this community, followed by Engelmann spruce (*Picea engelmannii*), and in places stands of aspen (*Populus tremuloides*) with a spruce-fir understory.

Approximately 21.7 acres of the extreme southwest corner of the SUP is mapped as Mixed Conifer Forest, within the Rocky Mountain Montane Conifer Forest biotic community. These areas support Douglas-fir (*Pseudotsuga menziesii*), limber pine (*Pinus flexilis*), and aspen, but less than five percent subalpine or corkbark fir and few Engelmann spruce.

The upper portion of Hart Prairie, in the northwest corner of the SUP, is best described as Rocky Mountain Subalpine Grassland. This area is dominated by grasses and forbs, including fescue (*Festuca spp*.), squirrel-tail (*Sitanion hystrix*), orchard grass (*Dactylis glomerata*), wheat-grass (*Agropyron trachycaulum*), deers-ears (*Swertia sp*.), silverleaf cinquefoil (*Potentilla anserina*), red-root eriogonum (*Eriogonum racemosum*), Rocky Mountain iris (*Iris missouriensis*), lupine (*Lupinus sp*.), Indian paintbrush (*Castilleja sp*.), and towering delphinium (*Delphinium tenuisectum*).

The extreme eastern extent of the SUP area, on the western slope of Agassiz Peak and above the top terminal of the Agassiz Chairlift, supports Alpine Tundra. Tundra plants are predominantly forbs, with islands of gnarled krummholz of bristlecone pine (*Pinus aristata*), corkbark fir, and Engelmann spruce.[367] The upper portion of Snowbowl Road winds through aspen, spruce-fir, and mixed conifer forest. The remainder of Snowbowl Road below approximately 8,000 feet in elevation and the remainder of the proposed reclaimed water pipeline alignment are located in ponderosa pine forest.

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[366] Brown, 1994.
[367] Id.

The Kachina Peaks Wilderness adjacent to the SUP supports high elevation mixed conifer forest, spruce-fir forest, and alpine tundra. The upper portion of Hart Prairie (above approximately 8,500 feet) represents subalpine grassland.[368] Lower portions of Hart Prairie represent montane meadow grassland, transitioning to plains grassland in the Fort Valley area.

Of the broad categories of vegetation types that occur in the project area, subalpine grassland, spruce-fir forest, and alpine tundra have the most limited extent in this region. The approximate area of these specific vegetation types within the SUP and on the San Francisco Peaks is identified in Table 3J-1 below.[369]

Table 3J-1
Approximate Area of Subalpine Grassland, Spruce-fir Forest, and Alpine Tundra in the SUP and on the San Francisco Peaks[a]

Type	SUP[b]	San Francisco Peaks
Subalpine Grassland	±37 acres	1,027 acres
Spruce-fir Forest	±547 acres	7,170 acres
Alpine Tundra	±20 acres	±1,600 acres

[a] Areas outside SUP. Estimated based in part on descriptions in Brown (1994) and Northland Research (2003)

[b] Excludes developed ski trails (138.6 acres) and other developed areas such as roads, guest service facilities, parking, and buildings (±20 acres). The ±17 acres of Subalpine Grassland disturbed in Hart Prairie is still classified as such.

THREATENED, ENDANGERED, AND SENSITIVE SPECIES

Section 7 of the Endangered Species Act of 1973 (ESA), as amended 1978, 1979, 1982, and 1988 declares that "…all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."[370] Section 7 directs Federal agencies to ensure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their critical habitats.[371] Federal agencies also must consult with U.S. Fish and Wildlife Service whenever an action authorized by the agency is likely to affect a species listed as threatened or endangered or to affect its critical habitat. ESA mandates conference with the Secretary of the Interior whenever an action is likely to jeopardize the continued existence of any species proposed for listing as threatened or endangered, or whenever an action might result in destruction or adverse modification of critical habitat proposed for listing.[372]

Forest Service Sensitive species are defined as "those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: a) major current or predicted downward trends in population numbers or density, or b) major current or predicted downward trends in habitat capability that would reduce a species' existing distribution".[373] It is

[368] Id.
[369] Id.
[370] 16 U.S.C. 1531 et seq.
[371] 16 U.S.C. 1536 et sq.
[372] 16 U.S.C. 1536(a) 4
[373] FSM 2670.5(19)

the policy of the Forest Service regarding Sensitive Species to: 1) assist States in achieving their goals for conservation of endemic species, 2) as part of the National Environmental Policy Act process, review programs and activities, through a biological evaluation, to determine their potential effect on sensitive species, 3) avoid or minimize impacts to species whose viability has been identified as a concern, 4) if impacts cannot be avoided, analyze the significance of potential adverse effects on the population or its habitat within the area of concern and on the species as a whole (the Line Officer, with project approval authority, makes the decision to allow or disallow impacts, but the decision must not result in loss of species viability or create significant trends toward Federal listing), and 5) establish management objectives in cooperation with the State when projects on National Forest system lands may have a major effect on sensitive species population numbers or distributions. Establish objectives for Federal candidate species, in cooperation with the U.S. Fish and Wildlife Service and Arizona State.[374]

A Biological Assessment/Biological Evaluation (BA/BE) was prepared for this project and will be submitted to the U.S. Fish and Wildlife Service for concurrence with the determination of effects to T and E species. The Forest Service will also review and approve the BE according to its determinations for Forest Service Sensitive species.

The Threatened, Endangered, and Sensitive Species (TES) List for the Mormon Lake and Peaks Ranger District was reviewed by the Forest botanist, and a TES list was created for this project in July 2002. One federally-listed threatened plant species occurs in the analysis area: San Francisco Peaks groundsel (*Senecio franciscanus*). Critical habitat designated for this plant includes the extreme eastern portion of the SUP area, above the top terminal of the Agassiz Chairlift. Two Forest Service Sensitive plant species occur within the analysis area: bearded gentian (*Gentiana barbellata*) and Rusby's milkvetch (*Astragalus rusbyi*). Potential habitat exists within the analysis area for the Forest Service Sensitive crenulate moonwort (*Botrychium crenulatum*). This species has not been recorded within the SUP area. There are no other listed, proposed, or candidate species or their habitat in the analysis area. There is no other designated or proposed critical habitat either. Sensitive species that have been eliminated from further analysis due to lack of habitat are listed in Table 3J-2.

Table 3J-2
Forest Service Sensitive Plant Species
Eliminated from Further Analysis

Common Name	Scientific Name
Arizona Bugbane	Cimicifuga arizonica
Cliff Fleabane	Erigeron saxatilis
Flagstaff Beardtongue	Penstemon nudiflorus
Flagstaff Pennyroyal	Hedeoma diffusum
Sunset Crater Beardtongue	Penstemon clutei
Disturbed Rabbitbrush	Chrysothamnus molestus

[374] FSM 2670.32

San Francisco Peaks Groundsel (Senecio franciscanus) - Threatened

San Francisco groundsel is endemic to the San Francisco Peaks and grows on gravelly, sandy loams of talus in alpine fellfield above 10,900 feet in elevation.[375] It is generally found on southeast exposures with 20 percent slope and reproduces mainly via rhizomes, although sexual reproduction also occurs. Flowering is from August to early September, fruits mature in mid-September, and the plant becomes winter-dormant in early October.[376] Critical habitat has been designated and includes a portion of the eastern-most extent of the SUP, above the Agassiz Chairlift top terminal.[377]

Plant populations were originally mapped and described in 1978 and 1980 and have been periodically monitored since that time. Surveys of proposed disturbance areas were completed in 1993 and 2002.[378] Approximately 10 individuals of San Francisco Peaks groundsel were found in an approximate one foot by one inch patch. These occur immediately adjacent to the unnamed catwalk above the Upper Bowl. They have been rocked off from the rest of the catwalk with small boulders. They occur approximately half way between the old lift terminal and the switchback. Consultation with US Fish and Wildlife Service on the effects of recreation is ongoing. The Recovery Plan for San Francisco Peaks Groundsel is currently being updated.

Bearded Gentian (Gentiana barbellata) - Sensitive

Bearded gentian grows on moderately wet rocky slopes, meadows, and open woods in Wyoming, Utah, New Mexico, and northern Arizona. In Arizona, it is known only in the San Francisco Peaks at 8,700 to 12,000 feet.[379]

Surveys were conducted in 2002 for the proposed project elements within the SUP. Six individuals of bearded gentian were found, two on *Lower Bowl* (trail #29) and four on *Lower Sundance* (trail #30).[380] The CNF also conducted surveys over a two-week period on and around the high peaks and ridges east of the SUP area. These surveys covered an estimated 30 percent of potentially suitable habitat identified on aerial photos.[381]

Rusby's Milkvetch (Astragalus rusbyi) - Sensitive

Rusby's milkvetch is a slender perennial that grows on dry basaltic soils in openings or meadows in Ponderosa Pine forest and at the edges of thickets and aspen groves. It occurs in the Flagstaff area and the lower slopes of the San Francisco Peaks at 7,000 to 8,000 feet, and down into Oak Creek Canyon.[382] It is known only from northern Arizona at 5,400 feet to 9,000 feet. This species is fire-adapted and has a high tolerance for disturbance.

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[375] Arizona Rare Plant Committee, 2001 and USFWS 1998
[376] USDI 1983
[377] USDI 1983
[378] Phillips, 1993 and Northland, 2003
[379] Northland Research, 2003 and Kearny and Peebles, 1960 and McDougall, 1973
[380] Northland Research, 2003
[381] CNF Zone Botanist personal communication, 2003
[382] Arizona Rare Plant Committee, 2001

Suitable habitat for Rusby's milkvetch occurs along Snowbowl Road between the SUP and U.S. Highway 180 (US 180). During surveys in 2003, it was found along two distinct segments of the road; the first was within 1-2 miles of US 180, and the second was within about 4-5 miles of US 180. Plants were found mainly in the drainage area next to the road, although some occurred higher up on the hill or cut slope. An estimated total of 120 plants were found along these two segments of Snowbowl Road.

Crenulate Moonwort (Botrychium crenulatum) - Sensitive

The crenulate moonwort is a tiny grape-fern that was described as a separate species in 1981 from the more widespread moonwort (*Bothrychium lunaria*). This plant was first collected in 1884 on Mt. Agassiz at an elevation of 11,000 feet. The 1884 collection has been annotated as *B. crenulatum*. Several more recent collections of *B. lunaria* and other species of *Botrychium* have been made on the Peaks. The more widespread *B. lunaria* has been found on Fremont, the southwest side of Agassiz at 11,700 feet under bristlecone pine, and in the Inner Basin.[383] Habitat for B. crenulatum in California is described as "drier places of damp meadows, boggy areas …".[384]

Surveys were conducted in 1993 for the catwalk between the Agassiz Chairlift mid-station and *Ridge* (trail #26) and for the widening of *Logjam* (trail #25).[385] Additional surveys were conducted in 2002 for the proposed project elements within the SUP.[386] No individuals of crenulate moonwort or any member of this genus were observed during surveys.

NOXIOUS WEEDS

Noxious and invasive weeds are defined as "those plant species designated as noxious and invasive weeds by the Secretary of Agriculture or by the responsible State Official. Noxious and invasive weeds generally possess one or more of the following characteristics; aggressive and difficult to manage, poisonous or toxic, parasitic, a carrier or host of serious insects or disease, and being non-native, new to, or not common to the United States or parts thereof."[387]

Six species included on the Coconino, Kaibab, and Prescott National Forests Invasive Plant Species List of 2001 have been documented within the analysis area (Table 3J-3). The plants on this list have weedy characteristics that include the ability to rapidly colonize a variety of environments and geographic locations, the ability to dominate a plant community or establish a monoculture in severely disturbed areas, become a permanent member of the native plant community or colonize undisturbed native plant communities. Three weedy species have been documented in the SUP: dalmation toadflax (*Linaria dalmatica*), mullein (*Verbascum thapsus*), and houndstongue (*Cynoglossum officinale*). All of these plants were found in disturbed soils around the base of the ski area, including ski trails, roads, buildings, lifts, parking lots, and heavily used pedestrian areas such as Hart Prairie. None of these species were found spreading into undisturbed, unfragmented forest habitat, and no noxious weeds were found above 9,800

[383] Phillips, 1993 and Northland Research, 2003
[384] Phillips, 1993
[385] Phillips, 1993
[386] Northland Research, 2003
[387] FSM 2080

feet in elevation.[388] In addition to these species, the following weedy species were also documented along Snowbowl Road and the reclaimed water pipeline alignment: bull thistle (*Cirsium vulgare*), musk thistle (*Carduus nutans*), and kochia (*Kochia scoparia*). The latter three species were found in relatively few distinct locations, while dalmation toadflax and mullein are fairly common along the length of Snowbowl Road and the length of the potential reclaimed water pipeline alignment.[389]

Table 3J-3
Noxious Plant Species Documented within the Analysis Area and their Distribution

Common Name	Scientific Name	Distribution	Area Occupied
Dalmation toadflax	Linaria dalmatica	SUP	0.04 ac. (21 locations)
		Snowbowl Rd/Pipeline	Throughout
Mullein	Verbascum thapsus	SUP	0.003 ac. (17 locations)
		Snowbowl Rd/Pipeline	Throughout
Houndstongue	Cynoglossum officinale	SUP	0.001 ac. (3 locations)
		Snowbowl Rd/Pipeline	None
Bull thistle	Cirsium vulgare	SUP	None
		Snowbowl Rd/Pipeline	Two plants (1 location)
Musk thistle	Carduus nutans	SUP	None
		Snowbowl Rd/Pipeline	Six plants (1 location)
Kochia	Kochia scoparia	SUP	None
		Snowbowl Rd/Pipeline	30 sq. ft. (1 location)

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF ENVIRONMENTAL CONSEQUENCES AND CONCLUSIONS

Major conclusions and determinations of this vegetation analysis are summarized below. A more detailed analysis of the direct and indirect environmental consequences – from which this summary was derived – follows.

Alternative 1 – No Action

In summary, Alternative 1 would result in no changes to existing ski area operations or to forest management practices within the SUP area. As a result, the CNF would continue treatment of spruce bark beetle infected trees. This type of treatment would not address overall stand health.

Alternative 2 – The Proposed Action

The Proposed Action would affect approximately one percent of the total spruce-fir forest cover on the San Francisco Peaks and approximately 14 percent of the spruce-fir forest within the SUP area. It would also allow for the treatment of 48.4 acres of spruce-fir forest to address a localized spruce bark beetle outbreak. This would result in an improvement to stand health overall. This alternative would result in the temporary ground disturbance along 14 miles of proposed

[388] Northland Research, 2003
[389] Northland Research, 2003 and USDA, 2003

reclaimed water pipeline right-of-way, and the associated removal of 22 aspen trees and 134 pine trees.

Alternative 2 would permanently affect 0.3 percent, and temporarily affect 1.7 percent of subalpine grassland on the San Francisco Peaks. It would result in permanent losses of 7.3 percent and temporary effects to 49.2 percent of the subalpine grassland within the SUP area, most of which has been previously disturbed.

The Proposed Action would result in disturbance within mapped critical habitat for the threatened San Francisco Peaks groundsel, but would not affect actual habitat or plants. It also may impact individuals of the bearded gentian and the Rusby's milkvetch, but it is not likely to result in a trend toward Federal listing or loss of viability. Alternative 2 would have no impact on the crenulate moonwort.

Lastly, the addition of snowmaking to operations at Snowbowl would result in an overall increase in moisture and nutrients and may change plant species composition within the SUP area. Proposed snowmaking is likely to add 31.1 lbs/acre/yr of nitrogen over historic natural deposition. This may increase the dominance of early successional or weedy plant species. In turn, this may reduce overall plant diversity in some portions of the SUP; however, this effect would be restricted to developed ski trails and therefore localized.

Alternative 3

Because Alternative 3 does not propose snowmaking or snowplay, the effects to vegetation resources would be fewer than those disclosed under Alternative 2. With respect to trail clearing, 64.4 acres of permanent overstory clearing would occur in spruce-fir forest (compared to 76.3 acres under Alternative 2). Additionally, Alternative 3 includes the treatment of 48.4 acres of spruce-fir to address a localized outbreak of spruce bark beetle. As stated previously, this would result in an improvement to stand health overall. There would be no removal of trees for construction of a reclaimed water pipeline under this alternative.

Because snowplay facilities are not proposed under Alternative 3, the effects to subalpine grasslands would be greatly reduced as compared to those disclosed in the Proposed Action. This alternative would result in the permanent loss of 0.01 percent, and the temporary disturbance of 1.7 percent, of the subalpine grassland on the San Francisco Peaks.

Alternative 3 would result in disturbance within mapped critical habitat for the threatened San Francisco Peaks groundsel, but would not affect actual habitat or plants. It also may impact individuals of the bearded gentian. Because no pipeline from Flagstaff is proposed, Alternative 3 would have no impact on the Rusby's milkvetch. As with the Proposed Action, this alternative would have no effect on the crenulate moonwort.

DETAILED ANALYSIS OF DIRECT AND INDIRECT EFFECTS

Impacts to T, E, and S plant species, and regionally important plant communities

Plant communities within the SUP area may be altered as a result of the proposed projects.

Indicator:

Acres of High-Elevation Forest Type on the San Francisco Peaks, Within The SUP, and Potentially Affected by the Proposed Action

Alternative 1 – No Action

Under Alternative 1, there would be no overstory tree removal in the analysis area; therefore, the total acreage of mixed conifer and spruce-fir forest on the San Francisco Peaks would not change. The CNF would continue treatment of spruce-fir stands in the SUP infected by spruce bark beetles. These treatments would be limited to specific infected trees, which would be felled and de-barked in-place. These treatments would likely also include the use of an anti-aggregation pheromone to attempt to curtail the spread of bark beetles, but would not address overall stand condition. Past vegetation manipulation activities within the SUP area are further discussed in the Cumulative Effects section.

Alternative 2 – The Proposed Action

This alternative would result in 76.3 acres of permanent overstory vegetation removal within spruce-fir forest in the SUP. This represents about one percent of the total spruce-fir forest cover on the San Francisco Peaks and about 14 percent of the remaining spruce-fir forest in the SUP. Cutting of new ski trails would expose previously interior trees to newly-cleared edges. Some additional (secondary) mortality of trees from wind blowdown along these cleared edges would likely occur. There would be no overstory vegetation removal within the identified mixed conifer forest. Up to 22 aspen trees and 134 pine trees would be removed over 14 miles of right-of-way to allow construction of the reclaimed water pipeline.

In addition to tree removal associated with new ski trails, the Proposed Action would allow treatment of 48.4 acres of spruce-fir forest within the Agassiz and Sunset pods to create gladed skiing terrain and to address a localized spruce bark beetle outbreak. This treatment would consist of removal of up to 20 percent of standing trees and removal of dead and down material. Tree removal would target pockets of overmature and beetle-infested trees. Removal of trees and dead and down materials would result in a more open stand with a higher diversity of size classes and greater proportion of younger vegetation structural stages. Compared with existing treatment that would occur under the No Action alternative, treatment of entire stands would be more effective in addressing the localized spruce bark beetle outbreak. It would reduce the probability of complete loss of this stand and inhibit the potential infestation of other stands in the SUP and in the adjacent Kachina Peaks Wilderness.

Noxious weeds have been found in the analysis areas, including the lower portion of the SUP and areas immediately adjacent to Snowbowl Road. The likelihood or risk of noxious weed spread is rated as moderate. Project activities under Alternative 2 may result in additional areas becoming

infested with invasive weed species even when preventative management actions are followed. However, mitigation measures are incorporated in Chapter 2 for both action alternatives to reduce the likelihood of invasion and spread.

Alternative 3

The effects of this alternative are similar to the Proposed Action, but would result in 12 fewer acres of impact to spruce-fir forest. This alternative would result in 64.4 acres of permanent overstory vegetation removal within spruce-fir forest. This represents less than one percent of the total spruce-fir forest cover on the San Francisco Peaks and about 12 percent of the remaining spruce-fir forest in the SUP. The reduction in impact to this forest type under this alternative is due to the elimination of the snowplay area and snowmaking water impoundment, and fewer acres of developed ski trails. Secondary mortality to trees from wind throw along newly-exposed ski trail edges would be similar to that under the Proposed Action. No trees would be removed along Snowbowl Road or the remainder of the reclaimed water pipeline right-of-way proposed under Alternative 1.

This alternative would also allow treatment of 48.4 acres of spruce-fir forest within Agassiz and Sunset pods to create gladed skiing and address a localized spruce bark beetle outbreak and the effects would be the same as those described under the Proposed Action.

Indicator:

Potential Impacts to Montane Grasslands Within the SUP as a Proportion of Total Grasslands on the San Francisco Peaks

Alternative 1 – No Action

Under Alternative 1, there would be no disturbance in Hart Prairie. As a result, there would be no change in acreage of subalpine grassland either within the SUP area or on the San Francisco Peaks. Past effects to subalpine grasslands in Hart Prairie are discussed in the Cumulative Effects analysis.

Alternative 2 – The Proposed Action

This alternative would result in 2.7 acres of permanent loss, and 18.2 acres of temporary disturbance to subalpine grassland in the SUP. Permanent impacts would be associated with lift realignment/construction, construction of the snowplay area, and construction of facilities associated with snowplay at the upper end of Hart Prairie. Temporary disturbance would consist of recontouring the ground surface, primarily to accommodate the snowplay area near the bottom terminal of the Hart Prairie Chairlift. Disturbed areas would subsequently be reseeded. Due to prior activities, this portion of Hart Prairie already includes introduced plant species such as orchard grass, slender wheatgrass, and timothy. Plant species composition in disturbed and reclaimed areas would likely include more plants and/or biomass of introduced plant species found in seed mixes. Effects of this alternative would be the permanent loss of 7.3 percent, and the temporary disturbance of 49.2 percent of the subalpine grassland in the SUP. Most of the grassland which would be affected was previously disturbed by establishment of *Hart Prairie* (trail #3) and *Aspen Meadows* (trail #1) ski trails and chairlifts. This alternative would result in a

permanent loss of approximately 0.3 percent, and the disturbance of 1.7 percent of the subalpine grassland on the San Francisco Peaks.

Alternative 3

This alternative would result in 0.1 acre of permanent loss, and about 17.7 acres of temporary disturbance to subalpine grassland in the SUP associated with lift realignment/construction and recontouring at the upper end of Hart Prairie. Temporary disturbance would consist of recontouring the ground surface near the bottom terminal of the Hart Prairie Chairlift. Elimination of the snowplay area parking lot under this alternative would reduce permanent impacts to subalpine grassland by 2.6 acres and temporary impacts by 0.5 acres as compared with the Proposed Action. Similar to the Proposed Action, reseeding of temporary disturbance areas under this alternative would likely change plant species composition to include more plants and/or biomass of introduced plant species found in seed mixes. Effects of this alternative are the permanent loss of 0.3 percent, and the disturbance of 47.8 percent of the subalpine grassland in the SUP. Most of the grassland affected was previously disturbed by establishment of the *Hart Prairie* (trail #3) and *Aspen Meadows* (trail #1) ski trails and chairlifts. This alternative would result a permanent loss of approximately 0.01 percent and the disturbance of 1.7 percent of the subalpine grassland on the San Francisco Peaks.

Indicator:

Disclosure of Effects to Potentially Occurring Threatened, Endangered, and/or Sensitive Plant Species

Alternative 1 – No Action

Under this alternative, there would be no changes in the analysis area. There would be No Affect on the endangered San Francisco Peaks groundsel or its habitat, including designated critical habitat in the upper portion of the SUP. This alternative would not affect the Forest Service Sensitive bearded gentian, Rusby's milkvetch, or crenulate moonwort. Past impacts to threatened, endangered, and sensitive species are further discussed in the cumulative effects analysis.

Alternative 2 – The Proposed Action

This alternative would result in disturbance within mapped critical habitat for the threatened San Francisco Peaks groundsel, but would not affect actual habitat or plants. Extending, smoothing, and recontouring of existing runs would result in a total of 2.44 acres of disturbance within "mapped critical habitat." However, field review indicates that the proposed disturbance areas lack the necessary affinities to be actual potential habitat. All of this disturbance would take place within spruce-fir forest below timberline. The proposal would therefore not specifically affect individual plants or habitat for the San Francisco Peaks groundsel. There would be about 0.5 acres of disturbance on the talus slope immediately above the Agassiz Chairlift top terminal; this is within the Alpine tundra zone, but no plants have been found in this area and it is outside designated critical habitat. No known plant populations would be impacted by the proposed activities. Establishing a hiking trail in this area would not increase the number of visitors using the Scenic Sky Ride in the summer months, but it would increase pedestrian activity on the lower slopes of Agassiz Peak. Continued access restrictions, enforcement, monitoring, and construction of interpretive signs along the trail would minimize the potential for impacts to

Alpine Tundra and the San Francisco Peaks groundsel. As documented within the Biological Assessment (BA) prepared for the project, the Proposed Action "may affect, but is not likely to adversely affect" the San Francisco Peaks groundsel. As required by the Endangered Species Act, the USFWS has reviewed and concurred with this determination. The BA and the USFWS concurrence are located in the project record on the Coconino National Forest.

The Proposed Action may impact individuals of the bearded gentian, but it is not likely to result in a trend toward federal listing or loss of viability. Recontouring and rock/stump removal on *Lower Bowl* (trail #29) and *Sundance* (trail #30) would impact six individuals of the bearded gentian. Relatively few populations of this plant are known. Surveys recently completed by CNF found a total of 57 plants in 18 populations, mostly on the steep southern slopes of Agassiz, Fremont, and Doyle peaks, and in Abineau Canyon.[390] Based on these numbers, about 10 percent of the known population occurs within the SUP, although it is likely that not all plants in either the SUP or the surrounding areas have been found. The CNF may allow the collection of some of these plants for genetic research. Impacts to the overall population would be mitigated by the collection of those plants that would be impacted under this alternative.

The Proposed Action may impact individuals of the Rusby's milkvetch, but it is not likely to result in a trend toward federal listing or loss of viability. Construction activities associated with installation of the reclaimed water pipeline along Snowbowl Road would impact up to 120 plants. Most of the plants located during the survey occur in the drainage area adjacent to the road and would likely be impacted by trench excavation and backfilling operations. Some plants growing further up the hill or cut slope would likely be avoided. The Proposed Action would not affect the population viability of Rusby's milkvetch. This plant occurs in a number of other locations around the Peaks and appears to prefer open and disturbed habitats. This plant is expected to reestablish itself in the project area from the seed bank and/or from recolonization of nearby, unaffected plants.

This alternative would have no long-term impact on the crenulate moonwort or its habitat.

Alternative 3

This alternative would result in disturbance within mapped critical habitat for the threatened San Francisco Peaks groundsel, but would not affect actual habitat or plants. The effects of this alternative would be the same as those described under the Proposed Action.

This alternative may impact individuals of the bearded gentian, but it is not likely to result in a trend toward federal listing or loss of viability. The effects of this alternative would be the same as those described under the Proposed Action.

No reclaimed water pipeline would be constructed along Snowbowl Road under this alternative; therefore, this alternative would have no impact on the Rusby's milkvetch. This alternative would have no impact on the crenulate moonwort or its habitat.

[390] CNF Zone Botanist personal communication., 2003

Vegetation Composition

The Proposed Action has potential to change vegetation composition within the SUP area due to the application of machine-produced snow.

Indicator:

Potential Changes to Plant Species Composition Due to the Application of Machine-Produced Snow

Several other indicators were identified pertaining to vegetation issues. Due to their specific relevance to water quality and quantity affects, it was determined that these indicators were most appropriately discussed within the Water Resources section of this chapter.

Alternative 1 – No Action

Under this alternative, there would be no changes in the analysis area and no snowmaking. Vegetation communities in the analysis area would receive only natural precipitation.

Alternative 2 – The Proposed Action

Application of machine-produced snow would result in an overall increase in moisture and nutrients available to plants and may change plant species composition on ski trails within the SUP. Under Alternative 2, machine-produced snow would be applied over 205.2 acres of existing and new ski trails. Application would occur on an annual basis between November and the end of February, extending into March under favorable conditions. Annual total volume of machine-produced snow would average 364 AF per year and would supplement an average annual precipitation volume of about 3,000 AF per year. Nitrogen concentration (as nitrate [NO3-]) in reclaimed water proposed for snowmaking is estimated at 6 mg/L or 428µmol/L. Nitrogen deposition rate with snowmaking would be about 53.5 lbs/acre/yr on average within the Snowbowl Sub-watershed (Table 3J-4). Snowmaking on the 205.2 acres of ski trails in the SUP is estimated to add 31.1 lbs/acre/yr of nitrogen over historic natural deposition.[391]

Table 3J-4
Volume of Snowmaking and Nitrogen Deposition Rate within the Snowbowl Sub-watershed in Dry, Average, and Wet Years

Condition	Snowmaking Volume	Background N Depositional Rate	N Deposition Rate with Snowmaking
Dry Year	486 acre-feet/year	9.23 lbs/acre/yr	50.76 lbs/acre/yr
Average Year	364 acre-feet/year	22.41 lbs/acre/yr	53.51 lbs/acre/yr
Wet Year	243 acre-feet/year	34.18 lbs/acre/yr	54.97 lbs/acre/yr

Additional water and nitrogen from snowmaking would increase plant growth and may change plant species composition on existing and newly developed ski trails. Several studies have looked specifically at the effects of nitrogen loading on soils and plant communities as a result of applying reclaimed water or nitrogen fertilizers. These studies are summarized in Table 3J-5. They have generally documented initial nitrogen retention in the soil due to increased

[391] Schwartzman and Springer, 2002

assimilation by plants and microorganisms, followed by rapid leaching of nitrates to the groundwater as an assimilation threshold is reached.[392]

Effects of supplemental nitrogen on plant communities on ski trails would be dependent on local conditions, nitrogen concentrations in the reclaimed water, and deposition rates. The rate of nitrogen saturation of the soil would be dependent on a number of factors, including soil physical and chemical characteristics, existing soil nutrient content, plant species diversity and density, and climate. Net nitrogen deposition as a result of snowmaking in the SUP area (range: ±50-55 lbs/acre/year) would be anticipated to be from roughly two-fold to over 60-fold lower than that in the studies cited in Table 3J-5 (range: ±85-3,310 lbs/acre/year). Therefore, nitrogen saturation would likely occur over a longer time period. As soils in the SUP reach the assimilation threshold, there may be a shift in dominance of plant species or a change in plant species composition on the cleared ski trails. The availability of additional moisture and nitrogen would likely increase the net primary productivity and dominance of early successional or weedy plant species. This may reduce overall plant species diversity in some portions of the SUP. The combined effects of construction activities and additional moisture and nutrients have potential to increase the local abundance of noxious weeds in the SUP.

Potential changes in plant species composition or dominance would be limited in part by the characteristics of the affected plant communities. Historically, the majority of existing ski trails were seeded with commercial seed mix species, which have become well established. Most of the seed mix species are early seral (successional) annual and perennial plants that exhibit rapid growth under favorable nutrient and moisture conditions. Increased moisture and nitrogen from snowmaking would therefore be expected to increase the biomass or cover of the existing plant community on the ski trails. These conditions may differentially enhance the growth of forbs over that of the perennial cool-season grasses.[393] Since very little vegetative cover on reclaimed ski trails consist of native perennial, mid- to late seral plant species, no substantial change in native plant species diversity would occur in most of the area affected by snowmaking. Reduction of native plant species diversity may occur in areas where native perennial, mid- to late seral species are still important, such as *Hart Prairie* (trail #3) and some of the less disturbed ski trails, such as *Casino* (trail #23). The spatial extent of these potential effects would be dependent on hydrologic characteristics.

[392] Jordan et al., 1997 and McNulty et al., 1996 and Dise and Wright, 1995 and Aber et al., 1998 and Currie et al., 1996 and Rueth et al., 2003

[393] Reed, 1977 and Kirchner, 1977

Table 3J-5
Summary of Studies on the Effects of Nitrogen Addition on Plant Communities

Study/location	Plant community	Application (kg/ha/yr) (lbs/acre/yr)	Application type	Duration (yr)	Results
Sopper (1971) Pennsylvania	Mixed oak stand Red pine plantation Old field	393 2,122	Municipal wastewater	6	No effect on red pine. Increased diameter growth of mixed hardwood species. Height increase in white spruce saplings in old field. Increase in height, density, and dry matter production of herbaceous groundcover.
Chadwick et al. (1974) England	Lowland heath	613 3,310	Polluted river water	2	Increased dry matter production of herbaceous groundcover. No change in plant species composition.
Reed (1977) Michigan	Old field	450 2,430	Dry fertilizer	1	Increased dry matter production of herbaceous groundcover. Reduction in plant species richness. Shift in dominance to C3 dicots.
Kirchner (1977) Colorado	Short-grass prairie	150 810	Dry fertilizer and water	3	Increased dry matter production of C4 plants. Reduction of plant species diversity through shift in dominance to earlier seral species. Increase in arthropod diversity and biomass.
Hunt and Shure (1980) South Carolina	Pine forest	nm (5.3cm/wk applied)	Industrial wastewater	4	Increased dry matter production of herbaceous groundcover. Reduction of plant species diversity through shift in dominance to earlier seral C3 species. Increase in arthropod diversity and biomass.
McNulty et al. (1996) Vermont	Spruce-fir forest	15.7 - 31.4 84.7 - 169.5	Dry fertilizer	7	Initial increase in basal diameter growth of red spruce and birch, subsequent increased mortality of red spruce. Predicted shift in dominance from evergreen to deciduous species.
Jordan et al. (1997) Massachusetts	Pine forest Oak forest Old field	370 - 480 1,998 - 2,592	Municipal wastewater	2	Increase in dry matter production in pine forest, but no change detected in oak forest. Reduction in shrub biomass and shift in dominance to early seral forbs (weedy species) in old fields.
Magill et al (1996) Maine	Mixed deciduous forest	18 - 61 97 - 329	Dry fertilizer	4	Increase in mean wood production. Increased tree mortality at low and high N application rates, resulting in decline in cumulative biomass over the study period.

Local patterns of run-off and infiltration influence the spatial extent over which changes in plant species composition would occur. Snowpack moisture not lost to sublimation predominantly infiltrates the permeable soils in the SUP to reach shallow perched aquifers. Little surface runoff occurs in the SUP or areas downstream of the SUP. The effects of added moisture and nitrogen on plant communities in the SUP would therefore be localized. It is noted that, in one study, weedy plant species persisted after nine years of irrigation with reclaimed water, but did not

spread beyond the treated area.[394] The extent to which added moisture and nutrients influence plant species composition in the SUP would be largely restricted to the cleared ski trails, with limited impacts to the adjacent spruce-fir forest. It was noted a decline in mature spruce and fir trees and increased mortality of seedlings after seven years of nitrogen fertilization at rates between 84.7 – 169.5 lbs/acre/year (15.7 and 31.4 kg/ha/year).[395] This rate is two to three times greater than would occur under this alternative. Nevertheless, some mortality of spruce and fir trees may occur along the edges of the cleared ski runs. Because most of the snowpack would infiltrate in-place, trees in the interior of spruce-fir stands would not be affected.

Alternative 3

This alternative would not include snowmaking. Therefore the effects would be the same as those described in Alternative 1.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of the cumulative effects analysis for vegetation extend from the initial development of Snowbowl as a winter recreational area into the foreseeable future during which recreation-related activities may affect vegetation.

Spatial Bounds

The physical extent of this cumulative effects analysis comprises mainly the Snowbowl SUP area, the proposed reclaimed water pipeline alignment between the City of Flagstaff and the SUP, and adjacent public lands to the extent they would be potentially affected. These adjacent lands include a portion of the Kachina Peaks Wilderness, areas adjacent to the reclaimed water pipeline alignment, and areas downslope of the SUP area (primarily Hart Prairie). Other projects in the Peaks area that affect vegetation are also included in the cumulative effects analysis.

Past, Present, and Reasonably Foreseeable Future Actions

1. Development and Maintenance of the SUP as a Recreational Area
2. Spruce Bark Beetle Control within the SUP
3. Kachina Peaks Wilderness Designation
4. Bebbs Willow Restoration Project
5. Fort Valley Restoration Project
6. Transwestern Lateral Pipeline Project
7. Peaks Segment of the Arizona Trail
8. Private Land Development
9. Miscellaneous/ongoing Recreational Uses
10. Power Line Maintenance
11. Various Aspen Regeneration and Exclosure Fences

[394] Jordan et al., 1997
[395] McNulty et al., 1996

12. Inner Basin Waterline Pipeline Maintenance
13. Snowbowl Road Paving

Appendix C includes the full list of past, present, and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 – No Action

Plant Communities

Cumulative effects of the No Action Alternative on plant communities are primarily related to past development of the SUP area as a winter recreational area; past, present, and future maintenance activities within the SUP to support recreational uses; and natural events and measures implemented to control a spruce bark beetle outbreak. Effects of these activities on plant communities are limited to the SUP area. Other projects in the Peaks area also contribute to cumulative effects on plant communities.

Both management activities and natural events have influenced plant communities in the analysis area. Since inception of the ski area, approximately 160 acres of natural vegetation within the SUP have been modified for recreational use. Of this total, approximately 139 acres have been modified for the establishment and maintenance of dedicated ski trails as well as for support facilities and associated infrastructure. Most the clearing has affected spruce-fir forest, but approximately 17 acres of subalpine grassland was disturbed for the establishment and maintenance of the *Hart Prairie* (trail #3) and *Aspen Meadows* (trail #1) ski trails and chairlifts. In order to rapidly stabilize disturbed soils, reclamation of ski runs has used commercial seed mixes dominated by non-native species (refer to Table 3J-6). As a result, species composition on revegetated ski trails is predominantly non-native. Native species from adjacent or nearby undisturbed areas have not substantially recolonized the ski trails. Conversely, non-native species have not substantially spread to adjacent or nearby undisturbed areas.[396]

Table 3J-6
Plant Species Included In Seed-Mixes for Ski Trail Reclamation

Common Name	Scientific Name	Status
Slender wheatgrass	Agropyron trachycaulum	Exotic
Mountain brome	Bromus marginatus	Native
Timothy	Phleum pratense	Exotic
Sheep fescue	Festuca ovina	Native
Creeping red fescue	F. rubra	Native
Canada bluegrass	Poa compressa	Exotic
Orchard grass	Dactylis glomerata	Exotic
Small burnet	Sanguisorba minor	Exotic
Hairy vetch	Vicia villosa	Exotic
Birdsfoot trefoil	Lotus corniculatus	Exotic
Clover	Trifolium hybridum	Exotic
Wooly pod vetch	Vicia dasycarpa	Exotic

[396] SWCA ,1996a and Van Ommeren, 2001

Periodic maintenance activities within the SUP area include the removal of obstructions and the repair of erosion control features on ski trails and the removal of hazard trees. These activities have had little effect on overall plant community structure or composition.

Measures to control the spruce bark beetle represent a cumulative effect on plant communities in the SUP area. Spruce bark beetles have affected stands of spruce-fir and mixed conifer in the SUP. A cyclonic wind event in the fall of 1999 resulted in a blow down of approximately 25 acres of spruce-fir along the upper portion of the Agassiz Chairlift. This triggered a localized outbreak of the spruce bark beetle which has infected an estimated 1,000 trees. The CNF has implemented a treatment program which involves felling infected trees and the subsequent peeling of the bark to expose and kill beetle larvae. The CNF is also applying an anti-aggregation pheromone to control the spread of bark beetles to adjacent stands of trees. About 150 trees were treated in 2002 and an additional 800 were identified for future treatment. At this time, the spruce bark beetle outbreak is confined to a relatively small area and has not spread to other stands of trees within the SUP area or the adjacent Kachina Peaks Wilderness. Western balsam bark beetle has infected some corkbark fir near Agassiz Lodge, but no treatment has been implemented to date.

Other actions or projects have affected, or have the potential to affect plant communities in the analysis area. Designation of the Kachina Peaks Wilderness in 1984 has resulted in the protection of 18,963 acres of high elevation montane conifer forest and grasslands on the Peaks. Construction of the Transwestern Lateral Pipeline in 1992 resulted in the removal of approximately four acres of predominantly ponderosa pine forest on the south slopes of the Peaks. The ongoing Bebbs Willow Restoration Project includes prescribed burning and thinning of 600 acres of ponderosa pine forest to aid the restoration of a montane riparian plant community. The Fort Valley Restoration Project is thinning approximately 9,100 acres of ponderosa pine forest on the lower south and west slopes of the Peaks. Various fenced plots, totaling about 400 acres, have been established to promote the regeneration of aspen on the Peaks. Development of private lands in Lower Hart Prairie is affecting primarily plains and montane grassland. Maintenance along the power line from Snowbowl Road results in the occasional removal of hazard trees and other vegetation along roughly three acres of right-of-way. Miscellaneous recreational uses on the Peaks contribute primarily temporary impacts on plant communities.

Threatened, Endangered, and Sensitive Species

Recreational use on the Humphreys Trail in the Kachina Peaks Wilderness has resulted in some impacts to the sensitive alpine tundra in the past. However; improved trail markings have minimized those impacts. Recreational activity related to the Scenic Sky Ride within the SUP area has been restricted and monitored to prevent access to Alpine tundra areas. Under the No Action Alternative, closures and trail restrictions would continue to protect this species and also habitat for the sensitive bearded gentian. Past and future avalanche control activities do not result in cumulative effects on plant species. The primary focus of avalanche control is to cause smaller, more frequent, and less damaging slides. These tend to run on snow layers higher in the snowpack. In contrast, naturally-occurring avalanches tend to run on the ground surface and therefore have the potential to disturb soil substrates and plants directly.

Several projects in the Peaks area have the potential to affect the Forest Service sensitive Rusby's milkvetch. The proposed repair of the City of Flagstaff's Inner Basin Waterline across Schultz Pass may impact up to 200 plants near the Weatherford Trail. The proposed Peaks Segment of the Arizona Trail will impact habitat for Rusby's milkvetch. The ultimate trail alignment will be adjusted to avoid directly impacting individual plants. The Fort Valley Ecosystem Restoration Project would impact some Rusby's milkvetch. All of these projects will result in temporary ground disturbance. Since Rusby's milkvetch is often found along disturbed trails and roadways, the cumulative effects of these projects and the continuation of current management practices under the No Action Alternative will be unlikely to affect the population viability of this species or result in a trend toward federal listing.

Noxious Weeds

Under the No Action Alternative, past development, maintenance, and recreational activities have likely increased the local abundance of noxious weeds within the SUP area. Noxious weeds are spread through the use of mechanized equipment and vehicles for clearing, grading, erosion control, and hazard removal on the ski trails, maintenance of existing roadways in the SUP area, and maintenance of the power line from Snowbowl Road to the SUP area. Miscellaneous recreational activities such as weddings, reunions, recreation events, hiking, and bicycling also have the potential to contribute to the introduction or spread noxious weeds. Since the spread of noxious plant species is usually dependent on disturbance, these recreational activities have not affected undisturbed adjacent areas within the SUP area or in the Kachina Peaks Wilderness. Other past, present, and future projects in the Peaks area contribute disturbance of 10,100 acres of Forest land (including Bebbs Willow Restoration Project, Fort Valley Restoration Project, and Aspen Regeneration Projects), 26 miles of pipeline right-of-way (Transwestern Lateral Pipeline, and Inner Basin Water Pipeline), 12 miles of roadway (Snowbowl Road paving), five miles of power line right-of-way (power line maintenance and Snowbowl Road to SUP), 31 miles of trail (Peaks segment of the Arizona Trail), Forest lands affected by other recreational uses, and an unknown number of acres of private land (private land development and , Lower Hart Prairie). The effects of these projects on the actual or potential establishment and spread of noxious weeds vary. The paving of the Snowbowl Road resulted in the establishment and spread of noxious weeds due to the use of imported fill. Initial development of the ski area occurred prior to active management and monitoring of noxious weeds by the CNF. Development of private lands is not subject to Forest Service directives regarding noxious weeds and therefore has a greater potential effect. Recent, ongoing, and future projects on Forest lands are subject to mitigation measures for the control of noxious weeds and therefore contribute substantially less to their potential establishment and proliferation.

Alternative 2 – The Proposed Action

Plant Communities

Cumulative effects of the Proposed Action on plant communities are expected to be the same as those described under Alternative 1, with the following exceptions.

The cumulative effect of past ski area development and proposed additional development under the Proposed Action would be the removal, disturbance, or modification of approximately 305.6 acres of montane conifer forest and grassland within the SUP area. This consists of roughly 160

acres affected as a result of past ski area development and proposed improvements that would remove an additional 76.3 acres of spruce-fir forest, remove 2.7 acres and temporarily disturb 18.2 acres of subalpine grassland, and thin 48.4 acres of spruce-fir forest within the SUP area. Approximately 150 trees have already been removed from the SUP area for the control of spruce bark beetles. The total area within the SUP area subject to maintenance activities (such as erosion control and hazard tree removal) would increase from 138.6 acres (i.e., existing dedicated ski trails) to 233.1 acres to encompass new ski trails and other recreational use areas. The increased area subject to maintenance activities would consist of approximately 76.3 acres of spruce-fir forest and 18.2 acres of subalpine grassland. Under this alternative, the total area subject to reclamation with (and establishment of) predominantly non-native grasses and forbs would increase from 138.6 acres (existing ski trails) to 233.1 (new ski trails and recreational use areas).

Threatened, Endangered, and Sensitive Species

Cumulative effects of the Proposed Action on threatened, endangered, and sensitive species are expected to be the same as those described under Alternative 1, with the following exceptions.

The Proposed Action would result in the removal of approximately six bearded gentian plants from the SUP. The remainder of the known population of this sensitive plant species occurs within the Kachina Peaks Wilderness and is protected by trail closures, access restrictions, and monitoring. The Proposed Action would impact up to 120 Rusby's milkvetch along Snowbowl Road. Other individuals of this plant species were likely impacted during the paving of the Snowbowl Road and individuals and/or habitat will be impacted by the proposed repair of the Inner Basin Waterline across Schultz Pass, construction of the Arizona Trail, and implementation of Fort Valley Ecosystem Restoration Project. All of these projects, including the Proposed Action, would result in temporary ground disturbance and are unlikely to affect the population viability of this species or result in a trend toward federal listing.

Noxious Weeds

Cumulative effects of the Proposed Action with regard to noxious weeds are anticipated to be the same as those described under Alternative 1, with the following exceptions.

This alternative would increase the area actively managed for recreation within the SUP area from 160 acres to 305.6 acres and would increase the total area of disturbance in which noxious weeds could become established or proliferate. Construction of the reclaimed water pipeline would result in temporary disturbance along 14 miles between the City of Flagstaff and the SUP.

Alternative 3

Plant Communities

Cumulative effects of the Proposed Action on plant communities are anticipated to be the same as those described under Alternative 1, with the following exceptions.

The cumulative effect of past ski area development and proposed additional development under this alternative would be the removal, disturbance, or modification of 274.9 acres of montane conifer forest and grassland within the SUP area. This consists of 160 acres affected as a result

of past ski area development and proposed improvements that would remove an additional 66.4 acres of spruce-fir forest, remove 0.1 acre of subalpine grassland, and thin 48.4 acres of spruce-fir forest within the SUP area. The total acreage within the SUP area subject to maintenance activities (such as erosion control and hazard tree removal) would increase from 138.6 acres (i.e., existing dedicated ski trails) to 205 acres to encompass new ski trails and other recreational use areas. The increased area subject to maintenance activities consist of 66.4 acres of spruce-fir forest. Under Alternative 3, the total area subject to reclamation with (and establishment of) predominantly non-native grasses and forbs would increase from 138.6 acres (existing ski trails) to 205 (new ski trails and recreational use areas).

Threatened, Endangered and Sensitive Species

Cumulative effects of this alternative are the same as those described under alternatives 1 and 2, except that this alternative would not contribute to cumulative effects to the Forest Service sensitive Rusby's milkvetch.

Noxious Weeds

This alternative would increase the area actively managed for recreation within the SUP area from 160 acres to 274.9 acres and would increase the total area of disturbance in which noxious weeds could become established or proliferate. No reclaimed water pipeline would be constructed between the SUP area and the City of Flagstaff. Otherwise, cumulative effects are the same as those described under Alternative 1.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The removal of forest cover represents an irretrievable loss of the ecological functions that overstory vegetation provides. However, these effects are not irreversible because the ski area facilities could conceivably be abandoned and trees allowed to re-establish. Irreversible commitments of resources affecting small acreages could stem from the following projects: the construction of additional parking, the snowplay facility, the snowmaking reservoir, realignment of chairlifts and contouring new ski terrain.

3K. WILDLIFE

SCOPE OF THE ANALYSIS

The analysis area for threatened, endangered, and sensitive wildlife; migratory birds; and game and non-game wildlife includes the Snowbowl SUP, Snowbowl Road, the proposed reclaimed water pipeline alignment between the City of Flagstaff and the SUP, and adjacent areas. Because the Snowbowl SUP is managed as a recreation site, analysis of impacts to management indicator species is limited to areas adjacent to the SUP (Kachina Peaks Wilderness) and to areas along and adjacent to the Snowbowl Road and reclaimed water pipeline alignment.

EXISTING CONDITIONS

THREATENED, ENDANGERED, AND SENSITIVE SPECIES

The threatened, endangered, and sensitive Species (TES) list for the Mormon Lake and Peaks Ranger District was reviewed and a TES list for this project was created in July 2002. One federally-listed threatened wildlife species occurs regularly within general the analysis area: Mexican spotted owl (*Strix occidentalis lucida*). The threatened bald eagle (*Haliaeetus leucocephalus*) may occur in the analysis area in winter. The endangered black-footed ferret (*Mustela nigripes*) is not known or expected to occur in the analysis area. Critical habitat for the Mexican spotted owl on NFS lands was proposed for listing November 18, 2003. The final rule for Mexican spotted owl critical habitat was published on August 31, 2004 and became effective September 30, 2004. There is no designated or proposed critical habitat for any other listed or proposed wildlife species. The analysis area includes habitat for two Forest Service sensitive species: Navajo Mountain Mexican vole (*Microtus mexicanus navaho*) and northern goshawk (Accipiter gentilis). There is no habitat in the analysis area for the Region 3 Forest Service sensitive peregrine falcon (*Falco peregrinus anatum*). Sensitive species that have been eliminated from further analysis due to lack of habitat are listed in Table 3K-1.

A Biological Assessment/Biological Evaluation (BA/BE) was prepared for this project and has been reviewed by the U.S. Fish and Wildlife Service (USFWS) for concurrence with the determination of effects to T and E species. Per a letter dated July 8, 2004, the USFWS concurred with the Forest Service's determinations.

Table 3K-1
Sensitive Wildlife Species Eliminated from Further Analysis

Common Name	Scientific Name
Wupatki Arizona Pocket Mouse	Perognathus amplus cineris
Narrow-headed Garter Snake	Thamnophis rufipunctatus
Northern Leopard Frog	Rana pipiens
Arynxa Giant Skipper	Agathymus aryxna
Freeman's Agave Borer	Agathymus baeuri freemani
Early Elfin	Incisalia fotis
Spotted Skipperling	Piruna polingii
Mountain Silverspot Butterfly	Speyeria nokomis nicrotis
Blue-black Silverspot Butterfly	Speyaria nokomis nokomis

Mexican Spotted Owl (*Strix occidentalis lucida*) - Threatened

The Mexican spotted owl was listed as a threatened species in 1993. On the CNF, this species occupies mixed conifer and ponderosa pine-Gambel oak vegetation types, usually characterized by high canopy closure, high stem density, multi-layered canopies within the stand, numerous snags, and down woody material. The CNF lies within the Upper Gila Mountain Recovery Unit.

Primary threats to Mexican spotted owls within the Upper Gila Mountain Recovery Unit include timber harvest and catastrophic wildfire, fuelwood cutting, and grazing.[397] Effects of recreation on Mexican spotted owls and habitat are described in the Recovery Plan and relate to recreation indirect habitat disturbance from recreation, as well as the presence and intensity of allowable recreation activities and spatial and temporal restrictions for the owl.[398]

The majority of the SUP supports spruce-fir forest and is therefore not suitable nesting habitat for Mexican spotted owls. A limited area in the southwest corner of the SUP is mapped as mixed conifer forest, which is classified as Restricted Area in the Recovery Plan. The northwest corner of the SUP (i.e., the upper extent of Hart Prairie) supports subalpine grassland. No Mexican spotted owls (MSO) have been detected within the SUP during consecutive surveys conducted since 1990.

Two MSO Protected Activity Centers (PACs) have been established adjacent to and along the Snowbowl Road, south of the SUP. The Snowbowl PAC is located approximately one to two miles from the SUP. The extreme southwest corner of the SUP is approximately 5,000 feet, or about one mile, in linear distance from the northern-most boundary of this PAC. An approximately 1.5-mile segment of Snowbowl Road is located within the boundaries of this PAC. This PAC has supported owls since 1985 and was occupied in 2003. Since 1992, four known nest sites have been identified within this PAC, ranging in linear distance from about 150 feet to 1,500 feet from Snowbowl Road and 5,000 to 7,500 feet from the southern SUP boundary. Owls using this PAC generally fledge young by the end of June or early July. Fledglings remain near the adults through summer and early fall. The adults are thought to remain in the general area throughout the year.[399]

[397] USDI, 1995
[398] Id.
[399] Jensen, 2003

The Viet Spring PAC extends from the southwest corner of the SUP approximately one to 1.5 miles to the south. Approximately five acres of this PAC overlaps the SUP, in the extreme southwest corner. A section of Snowbowl Road approximately 300-feet in length is within the extreme southwestern PAC boundary; generally this PAC is located 500 to 1,000 feet east of the roadway. The Viet Spring PAC was established in 1997 based on detection of a single roosting male in 1996. This is believed to have been a sub-adult dispersing from a nearby PAC. No MSOs have been detected since that time, and this PAC is believed to have been unoccupied for the last seven years.[400]

Bald Eagle (*Haliaeetus leucocephalus*) - Threatened

Bald eagles are primarily winter visitors to the CNF, occupying all habitat types and elevations. Wintering eagles arrive in the fall, usually late October or early November, and leave in early to mid-April. They feed on fish, waterfowl, terrestrial vertebrates, and carrion. Eagles are often seen perched in trees or snags near water or next to roadways where they feed on road-killed animals. At night, small groups (usually two to 12) or individual eagles roost in clumps of large trees in protected locations such as drainages and hillsides. Eagles usually roost adjacent to or very near food sources.

There are no known nesting areas in the project vicinity. The nearest documented breeding areas are along the upper Verde River, about 35 miles southwest of Flagstaff. Wintering bald eagles may occur occasionally in or near the project area. Perched eagles are sometimes observed in the Flagstaff vicinity, including Fort Valley. Most eagles are seen in ponderosa pine forest, but they are occasionally reported from mixed conifer and spruce-fir forest. The SUP supports mixed conifer and spruce-fir forest and is expected to be rarely visited by eagles in winter. There are two known roost sites in the general project vicinity. A summer roost occurs near Dry Lake, approximately three miles south of the proposed reclaimed water pipeline. A winter roost is located eight miles east of the project area. Bald eagles have been observed perching in snags and dead-topped trees at the fringes of the Fort Valley meadow, including the lower portion of the Snowbowl Road, and near Baderville, Rodgers Lake, Interstates 40 and 17, and Bellemont. There are no significant water bodies in the project vicinity, although eagles may feed on mammalian prey in these areas.

Black-footed Ferret (*Mustela nigripes*) - Endangered

Black-footed ferrets occurred historically in northern Arizona, where their range apparently overlapped that of their primary prey, the Gunnison's prairie dog (*Cynomys gunnisoni*). Wild populations of this species are believed to have been extirpated from the state early in the twentieth century as a result of prairie dog control programs.[401] The only records for the region are one from 1917 at Bacas Ranch, 16 miles northeast of Springerville, Arizona and another record seven miles northeast of Williams in 1929.[402] A report[403] also documented an occurrence from Government Prairie near Parks and another from 12 miles west of Winona.

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[400] Arizona Biological Surveys, 2003
[401] AGFD, 1996 and Hoffmeister, 1986
[402] Hoffmeister, 1986
[403] Cockrum, 1960

There are no records of black-footed ferrets in the analysis area. There is one known Gunnison's prairie dog town within the SUP area. This town is currently active and was estimated to cover about 50 acres in 2002.[404] This is one of six towns that make up a complex. This town was surveyed in 1993 and 1994, but no black-footed ferrets were found. Other prairie dog towns occur in the Flagstaff vicinity.

Prairie dog populations are cyclic and can go from huge numbers to almost no animals within a short time due to disease, weather patterns, predation, and other factors. Population numbers fluctuate yearly, with high numbers in some years and undetectable numbers present in other years. Bubonic plague has been a significant factor in prairie dog colonies in the Flagstaff area in recent years and many recently active colonies have been severely impacted. Other impacts to prairie dogs include predation by coyotes, raptors, and bobcats and legal shooting.

Navajo Mountain Mexican Vole (*Microtus mexicanus navaho*) - Sensitive

Navajo Mountain Mexican voles are found in dry grassy areas in or adjacent to pinyon-juniper woodlands; sagebrush shrublands; and ponderosa pine, mixed conifer forest, and spruce-fir forest in northern Arizona.[405] Navajo Mountain Mexican vole distribution is only known from Navajo Mountain (on the Arizona-Utah border), the south rim of the Grand Canyon, and the Flagstaff and Williams areas.[406] Locations have been reported from 3,800 to 9,700 feet elevation with a number of locations around the San Francisco Peaks. On the San Francisco Peaks, this vole has been found in open grassy areas amid limber pine, spruce, fir, and aspen. They are generally active mid-day and in early evening, but may also be active at night or in winter, depending on temperature.[407] Moisture conditions and the amount of cover are thought to influence the local distribution of voles in the genus Microtus.[408]

Several surveys have been conducted within the Snowbowl SUP. Although no individual Navajo Mountain Mexican voles have been see, numerous signs of their existence were observed. Runways have been found on *Lower Bowl* (trail #29), *Sundance* (trail #30), *White Lightning* (trail #28), *Upper Ridge* (trail #26), *Lower Ridge* (trail #21), *Upper Casino* (trail #23) and in the tree islands between the Hart Prairie Lodge parking lots.

The main threat to the Navajo Mountain Mexican vole is reduced ground cover resulting from increased tree density, grazing or periodic droughts. Recreation use has the potential to reduce habitat for this species.

Northern Goshawk (*Accipiter gentilis*) - Sensitive

Northern goshawks nest in coniferous forest in the mountains and on the high plateaus, including the Kaibab Plateau, the San Francisco Peaks, Flagstaff area, Mogollon Rim, the White Mountains of eastern Arizona, and the high mountain ranges of southeastern Arizona.[409] The

[404] Northland Research, 2003
[405] Arizona Game and Fish Department, 1996 and Hoffmeister, 1986
[406] Hoffmeister 1986, District records
[407] Hoffmeister, 1986; Northland Research, 2003
[408] Kime et al., 1994
[409] Arizona Game and Fish Department, 1996; Snyder and Snyder, 1998

northern goshawk is a forest habitat generalist that uses a wide variety of forest stages in ponderosa pine and mixed conifer habitat. It prefers stands of intermediate canopy cover for nesting and more open areas for foraging. All ponderosa pine and mixed conifer above the rim is considered northern goshawk habitat, including associated pine or mixed conifer stringers that may extend below the rim.

Northern goshawk foraging occurs predominantly in ponderosa pine vegetation. Although juniper or pinyon-juniper habitat types are not heavily used by northern goshawks, some foraging may occur there, especially in transition areas between ponderosa pine and pinyon-juniper habitats. The northern goshawk preys on large to medium sized birds and mammals.

Nest stands are typically in later successional stages, especially old-growth trees. Nest building begins in March and young are typically fledged by the early part of June.[410] Post-fledgling family areas (PFAs) have patches of dense trees, developed herbaceous or shrubby understories, snags, downed logs, and small openings, which provide cover and prey. Fledglings develop their hunting skills here. Foraging areas are a mosaic of various successional stages and cover types.

There are two PFAs within the analysis area, both of which are located along the Snowbowl Road and the reclaimed water pipeline alignment. The Viet Spring PFA largely overlaps the Snowbowl Mexican spotted owl PAC. There are no recent surveys or monitoring data for this PFA, but it is presumed occupied. The Mars Hill PFA is located north and west of Lowell Observatory, with portions on CNF land, private land, and Arizona State Trust Lands. Only observatory lands within the Mars Hill PFA have been surveyed. The only known nest is located within 0.2 miles of the reclaimed water pipeline alignment.

Threats to northern goshawks are generally related to timber management. However, fire suppression, catastrophic fire, livestock grazing, drought, and toxic chemicals may also be involved. Declines may be related to decreases in prey populations associated with changes in structure and composition of forests.

American Peregrine Falcon (*Falco peregrinus anatum*) - Sensitive

The peregrine falcon was removed from the Federal List of Endangered and Threatened Wildlife in August 1999, and it is now a Region 3 Forest Service sensitive species.[411] The essential habitat for the peregrine falcon includes rock cliffs for nesting and a large foraging area. Suitable nesting sites occur on rock cliffs with a mean height of 200 to 300 feet. The subspecies anatum breeds on isolated cliffs and is a permanent resident on the CNF. Peregrines prey mainly on birds found in wetlands, riparian areas, meadows within a 10 to 20 mile radius from the nest site. The peregrine breeding season is from March 1 to August 31.

The project area includes vegetation communities ranging from ponderosa pine forest at lower elevations to mixed conifer forest, spruce-fir forest, subalpine grassland, and alpine tundra at higher elevations on the Peaks. The analysis area lacks steep cliff sites potentially suitable for nesting by this species. Peregrine falcons are not known to nest in the project area or its

[410] Snyder and Snyder, 1998
[411] USDI, 1999

immediate vicinity. The nearest known active eyrie is located over five miles away from the SUP, Snowbowl Road, and any portion of the reclaimed water pipeline alignment.

The main threat to the peregrine falcon is the continued contamination of its environment by synthetic organochlorine contaminants (e.g., DDT). These contaminants result in eggshell thinning and direct mortality to this species. Other threats include disturbance from rock-climbing near eyries and mortality from encounters with power lines.

MANAGEMENT INDICATOR SPECIES

The 1982 National Forest Management Act Regulations set forth a process for developing, adopting, and revising land and resource management plans for the National Forest System, and identify requirements for integrating fish and wildlife resources in Forest Land Management Plans.[412] Key provisions for fish and wildlife resources require that fish and wildlife habitat be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area, where a viable population is considered to be one that has the estimated numbers and distribution of individuals to ensure its continued existence is well distributed through the planning area.[413] By definition, the planning area is the area covered by a regional guide and the forest plan.[414] The Forest Planning Regulations require that certain species, whose population changes are believed to indicate the effects of management activities, be selected and evaluated in forest planning alternatives.[415] Additionally, the Planning Regulations require that the population trends of management indicator species be monitored and relationships to habitat changes determined.[416]

Specific management direction for Management Indicator Species (MIS) is also found in Forest Service Manual (FSM) 2600. Policy and direction that tiers to 36 CFR 219.19 is provided for MIS for application at the Forest Plan and project levels relative to species selection, habitat analysis, monitoring and evaluation, and other habitat and planning evaluation considerations, in FSM 2620. FSM 2630 provides guidance on improving MIS habitat, and conducting habitat examinations, and project level evaluations for MIS within the project area.

Management indicator species were identified for each of the management areas described in the Coconino Forest Plan.[417] There are no MIS identified for developed recreation areas (i.e., the Arizona Snowbowl SUP). The Forest Plan did not assign MIS to certain management areas due to their limited size and high amount of human use and alteration of the landscape. MIS were not assigned to Oak Creek (MA14), Developed Recreation Sites (MA15), Inner Basin (MA 16), and Special Areas (such as Botanical and Geologic Areas [MA17], Environmental Study Areas [MA18] and Highway 180 [MA20]). Each of these areas has a different management emphasis. For MA 15, the management emphasis is developed recreation.

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[412] CFR 219.1, CFR 219.13, CFR 219.19
[413] CFR 219.19
[414] CFR 219.3
[415] CFR 219.19
[416] Id.
[417] USDA Forest Service, 1987

The Snowbowl Road and the proposed reclaimed water pipeline alignment cross Management Areas 3, 4, 5, and 9. The MIS analysis reflects only those acres affected by the pipeline. Table 3K-2 describes MIS and the vegetation types they are indicators for. Some species have already been discussed in previous sections of this document and will not be discussed further here: northern goshawk and Mexican spotted owl. Table 3K-3 lists MIS that were considered, but dropped from detailed analysis because habitat does not exist in the analysis area.

Abert Squirrel (*Sciurus aberti*)

The Forest Plan designates the Abert squirrel as an MIS for early seral stage ponderosa pine forests. More recent research indicates that this species best habitat is the intermediate to older aged forest (trees nine to 22 inches DBH, with trees from 18 to 22 inches DBH preferred), where groups of trees have crowns that are interlocking or close. Uneven-aged stand management is thought to benefit the Abert squirrel. Heavy thinning, such as that which occurs at the urban–interface and as part of restoration treatments, reduces habitat quality due to resulting low tree densities and a lack of interlocking tree crowns.[418] Within the analysis area, dense stands of ponderosa pine suitable for Abert squirrels occur along the lower portion of Snowbowl Road and the proposed reclaimed water pipeline alignment. The Forest-wide habitat trend for Abert squirrel is stable, since the age class distribution of ponderosa pine has essentially remained dominated by mid-seral stage stands, with some loss of old-growth and older trees.[419]

There is very little forest-specific data to determine population trends at the forest level. Data from a few studies indicated stable populations within the study areas, but these research projects were limited to only a few locations on the forest and occurred over two to three year periods.[420] AGFD does not quantify small game populations, but does compile data on the number of squirrels killed per hunter day. From 1988-1999, statewide information indicates a stable trend for hunter harvest of squirrels.

[418] USDA Forest Service, 2002
[419] Id.
[420] Id.

Table 3K-2
Coconino National Forest Management Indicator Species

Management Area (MA)	Species	Habitat
MA 3 (Ponderosa Pine and Mixed Conifer with <40 percent Slopes), MA 4 (Ponderosa Pine and Mixed Conifer with >40 percent Slopes), and MA 6 (Unsuitable Timber Land in Ponderosa Pine)	Abert Squirrel	Early seral ponderosa pine
MA 3 and MA 4	Northern Goshawk	Late seral ponderosa pine
MA 3 and MA 4	Pygmy Nuthatch	Late seral ponderosa pine
MA 3 and MA 4	Turkey	Late seral ponderosa pine
MA 3, MA 4, and MA 6, and MA 7 (Pinyon-juniper Woodland with <40 percent Slopes) and MA 8 (Pinyon-juniper Woodland with >40 percent Slopes)	Elk	Early seral ponderosa pine, mixed conifer, and spruce-fir
MA 3, MA 4, and MA 6	Hairy Woodpecker	Snag component of ponderosa pine, mixed conifer, and spruce-fir
MA 3 and MA 4	Mexican Spotted Owl	Late seral mixed conifer and spruce-fir
MA 3 and MA 4	Red Squirrel	Late seral mixed conifer and spruce-fir
MA 5 (Aspen)	Yellow-bellied (Red-naped) Sapsucker	Late seral and snag component of aspen
MA 5 and MA 6 and MA 7 (Pinyon-juniper Woodland with <40 percent Slopes) and MA 8 (Pinyon-juniper Woodland with >40 percent Slopes)	Mule Deer	Early seral aspen and pinyon-juniper
MA 7 and MA 8	Juniper (Plain) Titmouse	Late seral and snag component of pinyon-juniper
MA 9 (Mountain Grasslands)	Elk, Pronghorn Antelope	Early and late seral grasslands
MA 10 (Grassland and Sparse Pinyon-juniper)	Pronghorn Antelope	Early and late seral grasslands
MA 12 (Riparian and Open Water)	Lincoln's Sparrow	Late seral, high elevation riparian (≥7000')
MA 12	Lucy's Warbler	Late seral, low elevation riparian (<7000')
MA 12	Yellow-breasted Chat	Late seral, low elevation riparian (<7000)
MA 12	Macroinvertebrates	Late seral, high and low elevation riparian
MA 12	Cinnamon Teal	Wetlands/aquatic

Table 3K-3
Management Indicator Species Considered But Eliminated from Detailed Analysis

Management Area	Species	Habitat
MA 7 and 8	Juniper (Plain) Titmouse	Late seral and snag component of pinyon-juniper
MA 12	Lincoln's Sparrow	Late seral, high elevation riparian (≥7000')
MA 12	Lucy's Warbler	Late seral, low elevation riparian (<7000')
MA 12	Yellow-breasted Chat	Late seral, low elevation riparian (<7000')
MA 12	Macroinvertebrates	Late seral, high and low elevation riparian
MA 12	Cinnamon Teal	Wetlands/aquatic

Pygmy Nuthatch (*Sitta pygmaea*)

The pygmy nuthatch is tied to old ponderosa pine within younger stands, stands of old-growth ponderosa trees, old large oak trees, and cavities. Populations are thought to be stable on the CNF and state-wide. Ponderosa pine snags, a key habitat component for this species, are currently being lost faster than they are replaced and may affect populations of the pygmy nuthatch in the future.[421]

Wild Turkey (*Meleagris gallopavo merriamii*)

Wild turkey is an indicator of late seral stage ponderosa pine forests, based on roost habitat requirements. Although the age class distribution of ponderosa pine has remained dominated by mid-seral stage stands, there has been some loss of old-growth and older trees, resulting in a decline in forest-wide habitat trend for late seral ponderosa pine habitat. Turkey roosts and nesting habitat occur in steep drainages and on hills. Turkey populations on the CNF declined in the early 1990s and have increased since the mid 1990s in probable response to favorable overwintering conditions, changes in hunt design in the game management unit, and contributions to overall mast production from trees from the 1919 seed year. The age class distribution of ponderosa pine has remained the same during Forest Plan implementation. Late seral stage trees have remained largely unchanged on slopes greater than 40 percent. The loss of large old trees occurred on slopes less than 40 percent during the early stages of Forest Plan implementation. The rate of loss due to timber harvest is now much reduced and for trees over 24 inches dbh rarely occurs. Other factors affecting turkey populations are lack of cover in key areas (including travel corridors), water availability, and forage availability are important factors.[422] Turkey habitat in the analysis area consists of ponderosa pine and mixed conifer forest with openings and small meadows for foraging during summer months. Ponderosa pine mast is the key habitat attribute and steep drainages and hillsides provide roosting and nesting habitat.

Although late seral ponderosa pine habitat has declined some since the Forest Plan was initiated in 1987, and turkey population trends in the early 1990's probably declined, data from the last five years show that populations are increasing on the CNF.

[421] Id.
[422] Id.

Elk (*Cervus elaphus*)

Elk are indicators of early seral stage ponderosa pine, mixed conifer, and spruce-fir forest. Grasslands are also important to elk. Forest-wide, early seral stage ponderosa pine has not increased in any large degree, although there has been some increase in early stage mixed conifer and spruce fir[423]. Elk are associated with deciduous thickets and early seral forest with interspersed grasses and forbs. They typically summer in mountain meadows and conifer forests and winter in pinyon-juniper woodlands and grasslands at lower elevations. Elk feed mainly on grasses, but will also feed on forbs and browse species. Forest-wide population trend is essentially stable. There was an increase in elk numbers in the early to mid 1990's, with a gradual decline back to late 1980's levels.

The analysis area provides summer range for elk and is located within Arizona Game and Fish Department's Game Management Unit (GMU) 7. This unit shows generally increasing elk numbers since 1986.[424] Elk tend to stay in the higher elevations during the summer months, moving into lower elevation pinyon-juniper woodlands and ecotonal areas north of the Peaks after significant snowfall.[425] Within the analysis area, ecotonal areas between conifer forest and grasslands are important to elk.[426] Recreational activities such as hiking may cause disturbance to elk foraging in meadows or resting in forested or edge areas.

Hairy Woodpecker (*Picoides villosus*)

This species is an indicator of snags in ponderosa pine, mixed conifer, and spruce fir forest. Hairy woodpeckers are over-wintering cavity nesters associated with larger trees and dense forest canopy. They nest in holes in dead or dying trees and appear to be limited primarily by the availability of suitable cavity trees. Data from the CNF indicate that hairy woodpecker populations are stable or slightly increasing on the Forest.[427] Forest-wide, the snag component in ponderosa pine forest has declined, but has increased in mixed conifer and spruce-fir forest due to wildfire and insect outbreaks/disease.[428] Hairy woodpeckers are fairly common in conifer forest types within the analysis area.

Red Squirrel (*Tamiasciurus hudsonicus mogollensis*)

The Forest Plan designates the red squirrel as a MIS for late seral stage mixed conifer and spruce-fir forests. Red squirrels are generally found at higher elevations in stands of spruce or a mixture of spruce and Douglas-fir. They are cavity nesters and feed on Engelmann spruce, Douglas-fir, white fir, fungi, buds, and fruits. They harvest the cones from trees to get to the seeds. Dwarf mistletoe creates witches broom, which may be helpful for nesting purposes. Approximately 12 percent of mixed conifer and spruce fir habitat on the Forest has shifted to early seral stages due to wildfires, and aspen and pine within mixed conifer is being replaced by

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[423] Id.
[424] Id.
[425] AGFD, 2003
[426] Arizona Game and Fish Department Wildlife Manager, pers. comm. 2003
[427] Id.
[428] Id.

white fir and Douglas-fir.[429] As pine is replaced by fir, the future trend of mixed conifer will be towards smaller and younger forests, which could affect red squirrels. Snags are probably increasing due to wildlife, insect, and disease, but the longevity of these snags is uncertain. Overall, the forest-wide trend for late seral stage mixed conifer and spruce-fir forests for red squirrels has probably declined somewhat. Due to the importance of mast producing trees, red squirrel populations probably fluctuate due to weather and cone crops.[430]

A query of the NatureServe database in 2002 showed a heritage rating in Arizona of S5, indicating a secure population in the state.[431] On the Forest, the population trend for red squirrels is inconclusive, due to lack of information on populations.[432]

Red-naped (Yellow-bellied) Sapsucker (*Sphyrapicus nuchalis*)

The red-naped sapsucker is a MIS for the late seral stage and snag component of aspen. Red-naped sapsuckers nest primarily in aspen, or in deciduous/mixed conifer forest, often near water. Live trees are preferred although dead trees (usually spruce or other conifers) are used at times. This species excavates a new hole each year. They extricate sap and the soft cambium layer around willows, cottonwoods, aspens, and walnuts. Nest trees are a minimum DBH of 10 inches with a minimum height of 15 feet. They favor groups of large aspens near heads of higher elevation canyons during the summer.

On the Forest, mid- to late-seral stage aspen are declining, due to both natural causes and management actions to regenerate stands. Some early seral stage stands are being created through wildfire and management activities, but recruitment is limited primarily due to grazing by animals. The Forest-wide snag distribution of aspen has been declining throughout the Forest Plan implementation period. Currently, most aspen on the Forest is in the older age classes, providing habitat for sapsuckers, but future Forest-wide trends are of concern, since aspen regeneration remains a on-going problem.

Available population data on the Forest comes from Christmas Bird Counts, Breeding Bird Surveys, and long-term research conducted along the Mogollon Rim. Collectively, these data indicate that red-naped sapsucker populations fluctuate over time, but are stable overall on the Coconino National Forest.[433]

Mule Deer (Odocoileus hemionus)

The mule deer was selected as an MIS of early-seral stages of aspen and pinyon-juniper woodlands. Early-seral stages of ponderosa pine, mixed-conifer, and chaparral habitats are also important for this species. Mule deer are primarily browsers on green shoots and fruits of shrubs and trees, but also feed on grasses and forbs. Mule deer populations have not done well on the

[429] Id.
[430] Id.
[431] Id.
[432] Id.
[433] Id.

CNF since Forest Plan implementation, due to many factors, such as disease, poaching, climatic conditions, and habitat changes, resulting in a declining Forest-wide trend.[434]

Although age class distribution has remained relatively stable in pinyon-juniper, the vigor of understory components, such as grasses, forbs, and browse species, continues to be affected in areas with numerous young pinyon-juniper trees. In aspen, mid- to late-seral stages are declining due to both natural causes and management actions to regenerate stands, and successional processes continue to convert aspen stands to pine or mixed conifer. Creation of early seral aspen and pinyon-juniper through wildfire or management actions has not occurred at a sufficient scale to positively influence browse production that would benefit mule deer.[435] Consequently, the Forest-wide habitat trend for mule deer has declined somewhat overall.

The project area occurs within a portion of Game Management Unit (GMU) 7. There appears to be population interchange with the herd in GMU 9 on the adjacent Kaibab National Forest.[436] The highest densities of mule deer are found in previously burned areas north of the San Francisco Peaks and project area.[437] AGFD data for GMU 7 shows a decline in number of mule deer seen per hour and the number of fawns per 100 does.[438]

Pronghorn Antelope (*Antilocapra americana*)

Pronghorn antelope is the only MIS identified for mountain grassland, and grassland and sparse pinyon-juniper. Populations are declining, although not equally, on the CNF. Arizona Game and Fish Department surveys of GMUs suggest declining trends in number of observed animals in most areas of the CNF and most areas have remained below the break even point of 20 to 35 fawns per 100 does in many years. Since the implementation of the Forest Plan, the amount of grassland Forest-wide has generally remained stable, with the exception of about a four percent increase in seral grasslands due to fuelwood treatments and fire. Forest-wide habitat trend is stable to declining due to tree encroachment, fire suppression, long and short-term climate shifts, and ungulate grazing. Establishment of woodland and pine seedlings and saplings in meadows and previously treated openings decreases habitat quality.[439] A number of factors have been identified that affect pronghorn, including: severe weather; amount and timing of precipitation; long-term climatic trends; habitat fragmentation; diet overlap with other grazers; reductions in fawn hiding cover; woody vegetation encroachment; fences; human disturbance and development; water availability; predators; parasites and diseases; and nutritional concerns.

Forest-wide grassland condition trends vary from downward to upward and the overall trend is stable to declining. Cool season grasses and species diversity have increased since the 1950s in probable response to climate change and a recovery from land abuses near the turn of the century. Tree encroachment, increasing canopy cover, fire suppression, long-term climatic

[434] Id.
[435] Id.
[436] Id.
[437] AGFD, 2003
[438] USDA Forest Service, 2002
[439] Id.

changes, drought, and ungulate grazing are mainly responsible for downward trends. GMU 7 shows the most stable population of pronghorn.[440]

Little pronghorn habitat occurs in the analysis area. Grassland areas are limited and there is no pinyon-juniper woodland. Pronghorn are not expected to use high elevation subalpine grasslands near the SUP. Montane grassland associated with Fort Valley provides very limited pronghorn habitat due to the degree of human development and fencing.

MIGRATORY BIRDS

Executive Order 13186 was signed on January 10, 2001, placing emphasis on conservation of migratory birds. This order requires that an analysis be made of the effects of Forest Service actions on Species of Concern listed by Partners in Flight, the effects on Important Bird Areas (IBAs) identified by Partners in Flight, and the effects to important overwintering areas.[441] There are no IBAs or important wintering areas within the analysis area. The closest IBA exists at Mormon Lake. The following describes each habitat type found within the analysis area and the associated bird species of concern.

Habitat Types

Alpine

Alpine habitat occupies about 20 acres above timberline in the SUP area and covers an estimated 1,600 acres on the San Francisco Peaks, generally above 11,500 feet. Only the water pipit is known to breed in this habitat type.

Spruce-fir

Four species of concern have been identified for spruce-fir habitat types: Swainson's thrush, pine grosbeak, golden-crowned kinglet, and three-toed woodpecker. Spruce-fir forest covers the majority of the SUP area, adjacent areas within the Kachina Peaks Wilderness, and the upper mile of the Snowbowl Road.

Mixed Conifer

Three species of concern have been identified for mixed conifer habitat types: northern goshawks, Mexican spotted owls, and olive-sided flycatchers. Mixed conifer forest occupies approximately 21.7 acres in the southwestern portion of the SUP. It also occurs along the upper portion of Snowbowl Road above 8,000 feet in elevation and on adjacent Forest lands.

Pine

Ponderosa pine habitat types occur along Snowbowl Road below 8,000 feet and along forested portions of the reclaimed water pipeline alignment from Fort Valley to Flagstaff. Four species have been identified as species of concern in pine habitats. They are northern goshawks, olive-sided flycatchers, Cordilleran flycatchers, and purple martins.

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[440] USDA, 2002
[441] Latta, et al. 1999

High Elevation Grassland

High elevation grassland habitat types include the upper portion of Hart Prairie in and near the SUP (subalpine grassland), Fort Valley (montane grassland) along the reclaimed water pipeline alignment. Four species have been identified as species of concern for high elevation grasslands. They are ferruginous hawks, Swainson's hawks, burrowing owls, and grasshopper sparrows.

Northern goshawk and Mexican Spotted owl are discussed in the TES section of the Wildlife section. Table 3K-4 lists migratory bird species considered, but not taken through detailed analysis because no habitat occurs and/or the analysis is outside the geographic range of the species.

Species

Water Pipit (*Anthus spinoletta alticola*)

The water pipit breeds above timberline in the San Francisco Peaks and White Mountains of northern and eastern Arizona.[442] The water pipit is one of only two vertebrate species known to breed in Alpine Tundra habitats in the state. Recreation is the greatest potential threat to habitat for this species.[443]

Swainson's Thrush (*Catharus ustulatus*)

Swainson's thrush is described as a rare summer resident in the cork-bark fir forest of the San Francisco Peaks and the White Mountains. At times it may be locally common. Important habitat components in fir forest are dense herbaceous and shrub vegetation, multiple forest layers, and downed logs.[444] Management recommendations for this species include incorporating of irregular thinning, leaving random clumps of dense saplings or vegetation in the lower or middle forest layers.[445]

Pine Grosbeak (*Pinicola enucleator*)

Pine grosbeaks are uncommon permanent residents of high elevation conifer forests in the White Mountains. This species prefers stands of spruce-fir with large trees and intermediate canopy cover, near edges. They forage both in trees and in open grass areas on seeds, buds, mast, and insects. Pine grosbeaks flock outside the breeding season, preferably in juniper habitats. Pine grosbeaks are not known to breed on the San Francisco Peaks, although there are a few reports of wintering flocks.[446] Species-specific surveys conducted during the breeding season in 1995 failed to detect any pine grosbeaks.[447] Management recommendations for this species are no large-scale removal of overstory Engelmann spruce and promotion of activities that reduce fire risk.[448]

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[442] Monson and Phillips, 1981
[443] Latta et al., 1999
[444] Monson and Phillips, 1981 and Latta, 1999
[445] Latta et al., 1999
[446] Monson and Phillips, 1981 and Latta, 1999
[447] SWCA, 1996b
[448] Latta et al., 1999

Table 3K-4
Migratory Bird Species Considered But Eliminated from Detailed Analysis

Species	Habitat/Elimination Rationale
Swainson's Hawk	High Elevation Grassland. Not known to occur regularly in higher elevation montane and subalpine grasslands.
Burrowing Owl	High Elevation Grassland. Not known to occur regularly in higher elevation montane and subalpine grasslands.
Grasshopper Sparrow	High Elevation Grassland. Breeding range generally restricted to southeastern Arizona and at lower elevations.
Gray Flycatcher	Pinyon-juniper
Pinyon Jay	Pinyon-juniper
Gray Vireo	Pinyon-juniper
Black-throated Gray Warbler	Pinyon-juniper
Juniper Titmouse	Pinyon-juniper
Elegant Trogon	High Elevation Riparian
McGillivray's Warbler	High Elevation Riparian
Red-Faced Warbler	High Elevation Riparian

Golden-crowned Kinglet (*Regulus satrapa*)

In Arizona, golden-crowned kinglets breed in spruce-fir, mixed conifer, deciduous and single species stands in mountainous areas from the Kaibab Plateau eastward. They prefer to nest in dense stands of conifers, often near the edges of clearings. Nesting stands have both open and closed canopy and density of understory vegetation is not thought to be important. Management recommendations are to avoid large-scale removal of overstory and larger trees, manage forests to reduce fire risk, and minimize recreational activity around breeding sites in April through June.[449]

Three-toed Woodpecker (*Picoides tridactylus*)

Three-toed woodpeckers breed and forage preferentially in spruce-fir forest, particularly where insect populations are high due to tree disease of fire. They are also found in ponderosa pine and Douglas-fir forests. This woodpecker plays an important role in the control of bark beetles, which may comprise up to 65 percent of its diet. It is thought to be the only woodpecker capable of excavating cavities in the dense wood of living spruce trees. Three-toed woodpeckers typically nest in dead or dying trees, showing a preference for trees with 75 percent of the bark and 10-80 percent of the limbs remaining, but no dead needles left on branches. Snags dead for less than three years are thought to be an important habitat component. Management recommendations include retention of snags greater than 12 inches DBH for nesting and trees averaging 25 inches DBH for foraging, maintenance of 75-acre minimum patches of diseased trees for foraging, and limiting salvage logging after insect kills in spruce-fir forest.[450]

Olive-sided Flycatcher (*Contopus borealis*)

Olive-sided flycatchers prefer forest edges and natural or human-made openings in spruce-fir, mixed conifer, and ponderosa pine forest types. They nest high in coniferous trees and forage

[449] Latta et al., 1999
[450] Id.

primarily on flying insects. Management recommendations include maintenance or creation of openings, management for uneven-aged forest structure, and retention of tall snags or dead-topped trees during salvage operations.[451]

Cordilleran Flycatcher (*Empidonax occidentalis*)

Cordilleran flycatchers breed predominantly in pine, but also in spruce, fir, aspen forests. They prefer moist and shaded forest. This species is a facultative secondary cavity-nester that also uses rock crevices, tree roots, and forks in small branches. Numbers of birds have been found to be positively correlated with canopy cover, within stand variability of trees sizes (most abundant in stands with five to 20 percent of pine basal area comprised of one to five inch DBH stems), and snag density. Management recommendations target their preferred habitat, ponderosa pine forest. They include management for greater than or equal to two snags per acre, manage for greater than 383 ponderosa pine/acre with high variability in size classes, and avoid mechanical thinning of canopy and snags.[452]

Purple Martin (*Progne subis*)

In Arizona pine forests, purple martins prefer areas with high snag density adjacent to or in open areas. They are secondary cavity nesters and forage primarily on flying insects. Management recommendations include the creation and retention of large snags.[453]

Ferruginous Hawk (*Buteo regalis*)

Ferruginous hawks historically nested in open scrublands, woodlands, and grasslands in southeastern and northern Arizona. The current distribution of breeding birds in restricted to Plains and Great Basin Grasslands in northern and northeastern Arizona. Ferruginous hawks range more widely in winter and are found throughout the state, often in agricultural areas and other open habitats.[454] Ferruginous hawks forage regularly in montane grasslands in the Flagstaff vicinity and have been observed hunting prairie dogs in the upper portion Hart Prairie within the SUP area. Management recommendations include the reduction of chemical control of prairie dogs, particularly in suitable nesting habitat and treatment to control exotic species encroachment of grasslands.

GAME AND NON-GAME WILDLIFE

The analysis area is located within Game Management Unit (GMU) 7. Large game species managed by the Arizona Game and Fish Department are the pronghorn antelope, black bear, elk, mule deer, and wild turkey. Mountain lions are also known to occur in the analysis area. A number of smaller game animals and fur bearers also occur, including Abert and red squirrel, gray-collared chipmunk, mantled ground squirrel, Gunnison's prairie dog, coyote, and bobcat. Several species of bats have been documented in the Fort Valley area, west of the Snowbowl Road. The analysis area supports habitat for a number of neotropical migrant and resident breeding birds. Bird species observed in the SUP area include band-tailed pigeon, broad-tailed

[451] Latta et al., 1999
[452] Id.
[453] Id.
[454] Monson and Phillips, 1981; Glinski, 1998; Latta et al., 1999

hummingbird, northern flicker, hairy woodpecker, northern three-toed woodpecker, Steller's jay, Clark's nutcracker, common raven, mountain chickadee, red-breasted nuthatch, white-breasted nuthatch, pygmy nuthatch, house wren, golden-crowned kinglet, American robin, yellow-rumped warbler, chipping sparrow, vesper sparrow, dark-eyed junco, western tanager, and pine siskin.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF ENVIRONMENTAL CONSEQUENCES AND CONCLUSIONS

Major conclusions and determinations of this Wildlife analysis are summarized below. A more detailed analysis of the direct and indirect environmental consequences – from which this summary was derived – follows.

Alternative 1 – No Action

In conclusion, Alternative 1 would result in no changes to existing ski area operations or to forest management activities within the SUP area. As a result, there would be no effects to wildlife TES or MIS. Additionally, there would be no effects to migratory birds as a result of Alternative 1.

Alternative 2 – The Proposed Action

Alternative 2 would not adversely affect threatened or endangered species within the analysis area. Regarding sensitive species, this alternative may impact individuals of the Navajo Mountain Mexican vole and habitat for the northern goshawk but is not likely to result in a trend toward Federal listing or loss of viability.

The importance of trees to be removed to MIS is limited by their relatively small size and young age, and their location adjacent to roadways and cleared utility easements. Based on these factors, tree removal would not substantially alter habitat for the Abert squirrel, pygmy nuthatch, wild turkey, elk, hairy woodpecker, red squirrel, red-naped sapsucker, mule deer, or pronghorn antelope. The alternative would have no effect to the Forest-wide habitat or population trend for these MIS. Under Alternative 2, some species of migratory birds may be affected by tree removal, construction, and increased recreation use.

Overall, some game and non-game species would experience both positive and negative effects as a result of the Proposed Action. These potential effects would be primarily the result of additional moisture and nutrients from snowmaking, noise, and recreation activities within the SUP area, and forest fragmentation due to tree clearing for proposed developed ski terrain.

Alternative 3

Alternative 3 would not adversely affect threatened or endangered species within the analysis area. Regarding sensitive species, this alternative may impact individuals of the Navajo Mountain Mexican vole and habitat for the northern goshawk but is not likely to result in a trend toward Federal listing or loss of viability.

This alternative would not alter habitat for management indicator species along Snowbowl Road or the reclaimed water pipeline alignment and therefore would have no effect to the Forest-

habitat or population trend for these species. Habitat modifying activities within the SUP area would not affect habitat for management indicators species outside of the SUP area.

Effects of this alternative on the water pipit, Swainson's thrush, three-toed woodpecker, cordilleran flycatcher, purple martin, and ferruginous hawk would be the same as those described under Alternative 2 (Proposed Action). Effects on pine grosbeaks, golden-crowned kinglets, and olive-sided flycatchers would be similar to the Proposed Action, except that there would be no increase in arthropod prey base related to snowmaking.

Effects to game and non-game species as described above would be similar to those disclosed under Alternative 1, with the exception of the effects of recreational use of the summer trail and increased fragmentation or loss of forested habitat on birds and large carnivores, which would be the same as those described under the Proposed Action.

DETAILED ANALYSIS OF DIRECT AND INDIRECT EFFECTS

Terrestrial Species Habitat

***The Proposed Action may result in the alteration and/or removal of habitat for terrestrial wildlife species within the SUP* area.**

Indicator:

Disclosure/Quantification of Anticipated Effects to Threatened, Endangered, and Sensitive; Management Indicator Species, and Other Wildlife Species and Habitats Within the Analysis Area.

Alternative 1 – No Action

Threatened, Endangered, and Sensitive Species

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. The CNF would continue existing treatment of spruce-fir stands in the SUP infected by spruce bark beetles. This alternative would have no effect on any threatened, endangered, or sensitive species.

Additional disclosure of the effects of historic ski area activities on threatened, endangered, and sensitive species can be found in the Cumulative Effects analysis.

Management Indicator Species

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. Because there would be no habitat altering activities this alternative would have no effect on MIS Forest-wide habitat or population trends.

Additional disclosure of the effects of historic ski area activities on MIS species can be found in the Cumulative Effects analysis.

Migratory Birds

Under this alternative, there would be no changes in the analysis area. Habitat conditions for birds would generally remain the same, not withstanding natural processes. This alternative would have no effect on migratory birds.

Additional disclosure of the effects of historic ski area activities on migratory birds can be found in the Cumulative Effects analysis.

Game and Non-Game Wildlife

Under this alternative, there would be no changes in the analysis area. Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on game and non-game wildlife.

Additional disclosure of the effects of historic ski area activities on game and non-game wildlife can be found in the Cumulative Effects analysis.

Alternative 2 – The Proposed Action

Threatened, Endangered, and Sensitive Species

As further detailed within the Biological Assessment prepared for the project, the Proposed Action is not likely to adversely affect the threatened Mexican spotted owl or its habitat. As required by the Endangered Species Act, the USFWS has reviewed and concurred with this determination. There would be eleven trees removed along the Snowbowl Road, within the Snowbowl PAC. There will be no tree removal in restricted areas and all construction activities within ½-mile of active nest sites would be restricted to periods outside the breeding season, which extends from March 1 to August 31. Helicopter over flights would be restricted around PACs. Helicopter use and other construction noise within the SUP would not adversely affect PACs in the analysis area. These restrictions have been specifically detailed in the required mitigation measures listed in Chapter 2.

The Proposed Action would have "No Effect" on the threatened bald eagle or its habitat. Bald eagles are unlikely to be found in the SUP area. Construction activities along the proposed reclaimed water pipeline may result in eagles avoiding construction zones, although construction would predominantly take place outside the period when wintering eagles are present. Construction activities and removal of trees along the reclaimed water pipeline alignment would not affect any known winter or summer roosts and would not affect foraging or perching opportunities for bald eagles.

The Proposed Action would have "No Effect" on the endangered black-footed ferret or its habitat. This alternative would result in the temporary disturbance of approximately 17 acres and permanent disturbance of less than ½ acre of the active Gunnison's prairie dog colony within the SUP area. This disturbance is associated with the development of the snowplay area and associated facilities, relocation/realignment of the Aspen and Hart Prairie chairlifts, and the recontouring of the lower end of the *Hart Prairie* (trail #3). Prior surveys have found no black-footed ferrets in this area and the prairie dog town and associated complex are too small to provide potential habitat for this species.

The Proposed Action may impact individual Navajo Mountain Mexican voles (a Forest Service sensitive species), but is not likely to result in a trend toward federal listing or loss of viability of the species. Nine of the 13 locations where evidence of voles has been found would be temporarily disturbed by recontouring, rock/stump removal, or widening of existing ski trails. The number of individual voles potentially affected is not known. Recolonization of temporary disturbance areas would likely occur. Widening of existing ski trails and clearing of new trails would create more potential habitat for this species. Snowmaking would increase grass and forb density and cover on ski trails and could result in a local increase in the population of Navajo Mountain Mexican voles.

The Proposed Action may affect habitat for the northern goshawk, but is not likely to result in a trend toward federal listing or loss of viability. An estimated 54 pine trees would be removed in the Mars Hill PFA. The largest tree to be removed is approximately 18 inches DBH. All of these trees are adjacent to existing forest roads. Four of these trees would be removed from CNF lands; the remaining 50 would be removed from private land. Construction activities associated with installation of the reclaimed water pipeline would not affect nesting northern goshawks. Timing restrictions on construction activities within the Snowbowl PAC would largely prevent potential effects on nesting northern goshawks in the Viet Spring PFA. These restrictions would be extended to September 30 within ½-mile of any active nest site (i.e., no construction from March 1 to September 30) in the Viet Spring PFA to avoid impacts to nesting northern goshawks. Construction related traffic is not expected to affect northern goshawks nesting within this PFA. Northern goshawks using the Viet Spring PFA are likely habituated to traffic on Snowbowl Road. Timing restrictions on construction activities within ½-mile of any active nest site within the Mars Hill PFA (i.e., no construction from March 1 to September 30) would prevent disturbance to nesting northern goshawks.

As stated previously, there is no habitat in the analysis area for the Region 3 Forest Service sensitive peregrine falcon.

Management Indicator Species

The Proposed Action would result in the removal of approximately 156 trees (134 pine and 22 aspen trees) along approximately 14.8 miles of the Snowbowl Road and the reclaimed water pipeline alignment. All trees are immediately adjacent to roadways and previously cleared utility easements. Trees that would be removed are generally eight to 10 inches DBH; the largest tree removed would be about 18 inches DBH. Fifty-two of the 136 trees are located along Snowbowl Road. No snags or old-growth trees would be removed. Neither late seral stage aspen nor its associated snag component would be affected. Trees to be removed occur sporadically along Snowbowl Road and the remainder of the reclaimed water pipeline alignment. Therefore, their removal would not alter overall stand characteristics.

The importance of trees to be removed to management indicator species is limited by their relatively small size and young age, and their scattered locations adjacent to existing roadways and cleared utility easements. Based on these factors, tree removal would not substantially alter habitat for the Abert squirrel, pygmy nuthatch, wild turkey, elk, hairy woodpecker, red squirrel, red-naped sapsucker, or pronghorn antelope. Habitat impacts would be minor and would not alther overall stand structure; therefore there would be no impacts to Forest-wide habitat or population trends for these MIS.

This alternative would disturb some potential foraging habitat for mule deer. Tree removal along Snowbowl Road and the proposed reclaimed water pipeline alignment would include the removal of 22 smaller-sized aspen trees, some of which may provide browse for deer. Construction of the reclaimed water pipeline would result the temporary removal of forbs, shrubs, and other potential forage species along Snowbowl Road and the remainder of the water pipeline alignment. Some of the aspen trees to be removed are within aspen stands located adjacent to the Snowbowl Road and would have localized impact to stand structure. Despite the small, localized impact to habitat this alternative would not considerably alter or change the declining Forest-wide habitat and population trends for mule deer.

Habitat modifying activities within the SUP area (overstory spruce-fir removal to create new ski trails, thinning of stands to treat a spruce bark beetle infestation, and developed uses) would not alter habitat for management indicators species outside of the SUP area.

Migratory Birds

Effects of this alternative on migratory birds would occur primarily within the SUP area. Effects of tree removal along Snowbowl Road and the reclaimed water pipeline alignment on migratory birds would be negligible because these activities would involve a relatively small number of younger trees located at the edges of previously cleared areas, such as roadways and utility easements, and therefore provide limited resources for wildlife. Within the SUP area, proposed activities may affect these species directly through habitat removal or modification, or indirectly through changes in prey populations. Effects of noise, recreational activities, and habitat fragmentation on birds in general are discussed in the Game and Non-game Wildlife section below.

This alternative would have little effect on breeding habitat for the water pipit. Approximately ½-acre of alpine tundra would be disturbed to increase the landing area at the top at the Agassiz chairlift top terminal. This area consists of a steep and rocky talus slope that supports little vegetation. The potential suitability of this area for nesting pipits is already diminished by ongoing recreational activity associated with operation of the Scenic Sky Ride.

This alternative may affect the Swainson's thrush. This alternative would remove 76.3 acres of spruce-fir forest, representing potential habitat, within the SUP area for the construction of new ski trails and other improvements. Thinning of 47.4 acres of spruce-fir to address a localized spruce bark beetle outbreak would improve habitat conditions for the Swainson's thrush by creating a greater diversity of vegetation age classes and openings for the growth of grasses, forbs, shrubs, and tree saplings. Establishment and use of the summer hiking trail in this area would reduce habitat suitability for potentially breeding thrushes because of disturbance from human recreational activity.

The Proposed Action would have both negative and positive effects on habitat for pine grosbeaks and golden-crowned kinglets. Negative effects are related to the removal of overstory vegetation and disturbance from recreational use of the summer trail. Positive effects would be the creation of additional edge habitat, an increase in biomass of vegetation, and increased arthropod prey on cleared ski trails.

Thinning of 47.4 acres of spruce-fir forest within the Agassiz and Sunset pods would negatively affect the three-toed woodpecker by reducing preferred prey populations (spruce bark beetles) and by removing larger trees and snags that may serve as potential nesting habitat. Due to the pervasiveness of wildfire and bark beetle infestation on both a local and regional scale, activities under this alternative would not affect the overall population viability of this species.

The Proposed Action would improve habitat for olive-sided flycatcher by creating additional openings and enhancing arthropod prey populations due to snowmaking activities.

This alternative would have little effect on habitat for the cordilleran flycatcher and the purple martin. These species occur primarily in ponderosa pine forest. Effects on this vegetation type would be limited to tree removal along Snowbowl Road and the reclaimed water pipeline.

This alternative would have a negative effect on the ferruginous hawk through the disturbance of the prairie dog colony at the upper reach of the Hart Prairie within the SUP area. Proposed activities there would reduce prey availability for wintering or migrating hawks, but they would not affect breeding individuals. Since prairie dogs would likely recolonize the disturbed areas, effects on prey base for ferruginous hawks would be temporary in nature.

Game and Non-Game Wildlife

This alternative would have positive effects on some game and non-game wildlife species, and negative effects on others. Effects of tree removal along Snowbowl Road and the reclaimed water pipeline alignment would be negligible because these activities would involve a relatively small number of younger trees located at the edges of previously cleared areas, such as roadways and utility easements, and therefore provide limited resources for wildlife. This analysis therefore focuses on potential effects of proposed activities on wildlife in the SUP area and in the adjoining Kachina Peaks Wilderness. These include the potential effects of (1) additional moisture and nutrients from snowmaking on plants as a source of food for wildlife, (2) noise and recreational activities on wildlife use patterns, and (3) habitat removal and fragmentation on habitat suitability.

Increased Moisture and Nutrients

The effects of snowmaking and additional nitrogen loading on plants are discussed in detail under the Vegetation section of this chapter. In general, additional moisture and nutrients would favor early successional and weedy species which may reduce overall plant species diversity, and could result in limited tree mortality along the edges of ski trails. Based on patterns of surface and groundwater hydrology, these effects would be largely limited to the areas directly affected by snowmaking (i.e., the cleared ski trails). These areas currently support a predominantly non-native plant community consisting of commercially seeded grasses and forbs. Almost all of the seeded species are also early successional species, and their cover and biomass would therefore increase with added moisture and nutrients. Greater dominance of early successional plant species as a result of wastewater enrichment has been correlated with increased arthropod density and diversity in pine forest and short-grass prairie habitats. It is postulated that C3 plants (which include virtually all seed mix species) are more palatable or digestible for generalist

herbivores.[455] Increased biomass of plants on cleared ski trails would therefore directly benefit larger herbivores, such as elk and mule deer, and would directly or indirectly benefit granivorous and insectivorous birds through greater seed and invertebrate prey production, respectively. Reduced plant species diversity would reduce habitat quality for wildlife that specialize on particular native plant species.

Noise

Construction noise within the SUP area and along Snowbowl Road and the reclaimed water pipeline alignment may affect some wildlife species. Noise would result primarily from the operation of equipment for clearing, grading, and smoothing of ski trails and installation of the snowmaking water pipeline; construction of new lift lines and realignment of existing lift lines, including the use of a helicopter for setting lift towers; improvement of existing guest service and maintenance facilities and utilities; and construction of the reclaimed water pipeline. These activities would generally take place during late spring, summer, and early fall and would coincide with, or overlap, the breeding period for many wildlife species. Wildlife most likely affected would be those whose breeding habitat overlaps the analysis area (i.e., primarily birds and small mammals) or wildlife who use the area for foraging and/or resting (elk and mule deer). Over the long term, these effects would be temporary in nature and would be limited to the construction phase of the improvements. Over the short term, these types of effects may occur over a number of consecutive years, representing the implementation phase of the project.

Construction activities would likely result in some disruption of wildlife breeding and foraging activities in and around the work areas. Studies on both diurnal and nocturnal raptors have documented few responses to noise (including helicopters and blasting) and few adverse effects on nesting success beyond 400 m (¼-mile). Maximum noise levels at this distance would not exceed 65 dBA and would be well below threshold levels at which responses in raptors have been documented (±90 dBA or greater). Assuming that responses of raptors are representative, construction noise may interrupt breeding and foraging activities of birds and small mammals up to about ¼-mile from work areas. It would also preclude or reduce foraging, movement, and/or resting behavior of larger wildlife, such as deer and elk, in the area. At a maximum, this would affect the entire SUP area and up to a ¼-mile zone of influence in the adjacent Kachina Peaks Wilderness and adjacent Forest, private, and Arizona Game and Fish Lands along Snowbowl Road and the reclaimed water pipeline alignment. A number of species of birds and small mammals are likely more tolerant of noise than the larger raptor species. Wildlife in the analysis area have likely habituated to noise to some degree due to regular traffic on Snowbowl Road, year-round recreational and maintenance activities in the SUP, and recreational activity (hiking) along the Humphreys Trail. Since construction would occur in phases, only a portion of the analysis area would be affected in any one year. Also, construction activities would be limited in duration and would not extend over the entire breeding season for birds or small mammals. In most cases, adjacent undisturbed habitats would become suitable for wildlife after completion of construction activities. Since construction activities would be limited to daylight hours, movement and foraging activities of deer and elk would not be affected during the nighttime hours. In contrast to improvements within the SUP area, construction of the reclaimed water

[455] Hunt and Shure, 1980; Kirchner, 1977

pipeline from Flagstaff would likely take place over the course of one summer construction season.

Additional noise in the analysis area from operation of the snowmaking system (pumping facilities and snowmaking guns) and increased use of snowcats would have limited effects on wildlife. Within the SUP area, these activities would primarily take place during nighttime hours, and outside the breeding periods for most, if not all wildlife species, and would result in relatively low and sustained noise levels. Snowmaking and associated snowcat use would take place primarily during nighttime hours in winter. Noise output from snowmaking guns is estimated at 84 dBA at 15 m (30 feet) from the source. Noise from the pump stations would be inaudible at approximately 30 m (100 feet) from the source. Snowcat use occurring within the SUP area would not change substantially from the existing condition. These activities may continue to affect roosting birds or other wildlife that remain in the SUP year-round and which occur in the direct vicinity of the activities. However, due to the high metabolic demands at high elevations and cold temperatures, relatively few birds or other wildlife species likely remain in the SUP overnight during the winter period.

Recreation

Increased recreational activity may result in disturbance of some game and non-game wildlife. Proposed improvements would not increase the average number of skiers per day in the SUP area, but would introduce snowplay activity and potentially extend the period when recreationists are present during winter affecting the distribution of recreational use in the winter. Snowmaking under this alternative would extend the ski season in winter, which currently has a short or highly variable duration in some years. Extended and increased recreation use relative to current conditions would occur during the winter period, outside the breeding season for most, if not all, wildlife species. Day-time activities associated with skiing may interrupt foraging activities of some bird species, such as nuthatches and woodpeckers, and may result in increased stress levels and metabolic demands. These effects would be extended over a longer average period during the winter. They would affect birds foraging in the vicinity of the existing ski trails and the proposed 73.7 acres of new ski trails in the SUP area. Increased recreational activity in the SUP area may result in greater abundance of nest scavengers, such as crows, ravens, and Steller's jays (corvids) and higher rates of nest predation.[456]

The proposed summer hiking trail would affect wildlife by changing recreational use patterns within the SUP area. The proposed trail would provide a pedestrian route through the SUP area for Scenic Sky Ride users in summer. This trail would switchback through a stand of spruce-fir forest between the Agassiz Chairlift top terminal and the mid-station and would subsequently follow and existing unimproved access road to the base of the ski area. Use of this trail by hikers would result in some disturbance to wildlife. Repeated human intrusions in songbird territories can decrease singing, change nest defense behavior, increase predation, and result in local declines of songbirds.[457] Outdoor recreational activities such as hiking can result in energetic costs, impacts to behavior and fitness, and avoidance of otherwise suitable habitat. In open grassland habitat in Utah, mule deer generally took flight when hikers on established trails

[456] Marzluff, 1997
[457] Id.

approached within 100 m (±300 feet) in perpendicular distance, although these effects would be less in forested areas with substantially more cover.[458] Assuming a 100 m (±300 feet) zone of influence on both sides of the ±two mile pedestrian route (one mile of new trail, one mile existing unimproved road), recreational use of the summer trail would reduce the habitat suitability for wildlife by up to 15 acres within the SUP area.

Forest Fragmentation

Fragmentation of forested habitat within the SUP area may affect some wildlife species. Habitat loss coupled with fragmentation of remaining habitats is cited as the cause of declines in forest bird species through loss of breeding areas, detrimental edge effects such as increased nest predation and brood parasitism, and limitations on movement between habitat patches.[459] A number of studies have reported a direct correlation between habitat patch size and the density, diversity, and reproductive success of forest birds. A number of these studies were based on woodlots of various sizes within cleared agricultural fields in the eastern North America.[460] Results of studies from other areas and habitat types are more variable. A study found that predation rates were higher in forested landscapes compared with habitats fragmented by agriculture, presumably due to higher abundance of predatory red squirrels.[461] These researchers also found that corvids (jays, crows, ravens) increased only at very high levels of habitat fragmentation. Another review of 25 studies on the relationship between habitat patch size and population density for birds, mammals, and insects throughout the world. Based on their results, these researchers concluded that (1) generalist species are affected only by direct habitat loss, (2) interior species would be affected more by fragmentation than edge species, unless only small patches are removed from the landscape, and (3) resident interior species are most vulnerable, while migrant edge species are least vulnerable to the effects of fragmentation.[462]

This alternative would result in additional fragmentation of the remaining forested habitat within the SUP area. A total of 76.3 acres of overstory spruce-fir forest would be removed to create new ski trails. Most of this would be associated with development of the new Humphreys pod in the north central portion of the SUP area. This activity would open up a stand that currently has more or less continuous forested cover. This ski trail would be designed with a network of small forested islands to create a less continuous break in the landscape. Most of these patches are small in size and would potentially be subject to higher predation risk from corvids, reducing and potentially eliminating their suitability for nesting birds. This activity may also result in higher nest predation rates at the periphery of the cleared ski trail. Based on a 100 m (±300 feet) zone of influence, these edge effects may extend up to a distance of 75 m into the Kachina Peaks Wilderness at the north end of this proposed new ski trail. Although removal of overstory vegetation would increase the risk of predation by corvids, it would decrease predation rates by red squirrels.

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[458] Taylor and Knight, 2003
[459] Beslisle et al., 2001
[460] Wilcove, 1985; Weinberg and Roth, 1998; Burke and Nol, 2000; Doherty and Grubb, 2001
[461] Tewksbury et al., 1998
[462] Bender et al., 1998

Removal of overstory vegetation may potentially affect larger and more wide-ranging mammals, such as mountain lions and black bears. Clearing of new ski trails would further reduce hiding cover within the SUP area for large carnivores potentially traveling through the area. Although movement may be restricted, it is unlikely that movement of these animals through the SUP area would be precluded. Retention of small forested islands would mitigate the reduction of hiding cover along the proposed new Humphreys pod. Mountain lions and black bear are most likely to travel at night and are unlikely to use the SUP area regularly in winter months. Both species are known to travel through or near areas with various levels of human development.[463] Increased recreational use and upgraded guest service facilities within the SUP area may result in a greater frequency of encounters between humans and bears, particularly in drought years.[464]

Alternative 3

Threatened, Endangered, and Sensitive Species

As detailed discussion of the potential affects to threatened and endangered species is contained within the Biological Assessment prepared for the project.

This alternative is not likely to adversely affect the Mexican spotted owl or its habitat. Construction activities within the SUP area would not adversely affect Mexican spotted owls.

This alternative would have no effect on the bald eagle or its habitat.

This alternative would have no effect on the black-footed ferret or its habitat. Like the Proposed Action, this alternative would result in the temporary disturbance of approximately 17 acres of the active Gunnison's prairie dog colony within the SUP area. This disturbance would be due solely to recontouring of the lower end of the *Hart Prairie* (trail #3), and the relocation/realignment of the Aspen and Hart Prairie chairlifts. No black-footed ferrets have been found in this area and the prairie dog colony is too small to provide potential habitat for this species.

The effects of this alternative on the Navajo Mountain Mexican vole would be the same as described under the Proposed Action, except that existing grass and forb densities would not increase due to seasonal snowmaking.

The effects of this alternative on the northern goshawk would be the same as described under the No Action Alternative, except that there would be an increase in traffic on Snowbowl Road through the Viet Spring PFA due to construction activities in the SUP. Construction-related traffic along Snowbowl Road is not expected to impact nesting in this PFA.

Management Indicator Species

This alternative would not affect habitat for management indicator species because there would be no habitat altering activities outside of the SUP area along Snowbowl Road or the reclaimed water pipeline alignment. Habitat modifying activities within the SUP area would not affect

[463] Foster and Humphrey, 1995; Zack et al., 2003; Clevenger and Waltho, 2000
[464] Zack, et al., 2003; Arizona Game and Fish Department, 2003

habitat for management indicators species outside of the SUP area. Therefore, this alternative would have no effect on management indicator species' Forest-wide habitat or population trends.

Migratory Birds

Effects of this alternative on the water pipit, Swainson' thrush, three-toed woodpecker, cordilleran flycatcher, purple martin, and ferruginous hawk would be the same as those described under Alternative 2 (Proposed Action). Effects on pine grosbeaks, golden-crowned kinglets, and olive-sided flycatchers would be similar to the Proposed Action, except that there would be no increase in arthropod prey base related to snowmaking.

Game and Non-Game Wildlife

Under this alternative, there would be no removal of trees along Snowbowl Road or the reclaimed water pipeline alignment. There would be no increase in biomass of vegetation or arthropods related to additional moisture and nutrients from snowmaking. Overall construction noise would be less due to the elimination of the snowmaking system, its associated pipeline, and the snowplay facilities. There would be no additional noise in the SUP area from snowgun and pump station operation. Operation of snowcats and recreational use by skiers would likely occur over a shorter ski season, on average, resulting in fewer potential impacts on wildlife. The effects of recreational use of the summer trail and increased fragmentation or loss of forested habitat on birds and large carnivores would be the same as those described under the Proposed Action (Alternative 2).

Longer Duration Snowpack

Effects of a longer-duration snowpack, and water storage on wildlife within the SUP area.

Indicator:

Acreage of Proposed Snowmaking Coverage, Comparison of Natural Snowpack Duration With the Extended Snowpack Due to Snowmaking, and the Effects of Both Longer-Duration Snowpack and Water Storage (Impoundment) on Wildlife.

Alternative 1 – No Action

Under this alternative, there would be no snowmaking or associated water impoundment in the SUP area. Habitat conditions for wildlife, including threatened, endangered, and sensitive species; management indicator species; migratory birds; and game and non-game wildlife would remain in their current condition, not withstanding natural processes.

Alternative 2 – The Proposed Action

Proposed snowmaking under this alternative would cover approximately 205 acres within the SUP area. Snowmaking would generally extend the duration of snowpack in the SUP area. Snow grain (crystal) size of machine-produced snow is typically smaller than that of natural snow. This would result in denser snow that typically takes longer to melt than natural snow. Observational studies in Colorado have indicated that artificial snowpack persists about two

weeks longer than natural snowpack, although this is dependent on physical factors, such as aspect and slope.[465]

A 10-million gallon water impoundment reservoir would be constructed within the SUP area to provide storage for snowmaking operations. This impoundment would receive water from the City of Flagstaff, via the reclaimed water pipeline, through the end of February of each year. This reservoir would remain at least partially filled outside the ski season to protect the integrity of the impoundment lining and to provide an emergency water source. This impoundment would be surrounded by a fence that would exclude big game wildlife. Final fence specifications would be determined during final design of the impoundment.

Threatened, Endangered, and Sensitive Species

The Proposed Action would have no effect on any threatened or endangered wildlife species, but may affect some sensitive wildlife species. Bald eagles, black-footed ferrets, Mexican spotted owls, and peregrine falcons either do not occur or don't occur regularly in the SUP area and would therefore be unaffected by either the longer duration snowpack or the water impoundment. Northern goshawks have been observed foraging occasionally in the SUP area including the vicinity of the proposed water impoundment. Fencing of the impoundment would exclude larger wildlife, but the presence of surface water would attract birds. Northern goshawks occasionally foraging in the area may respond to the increased concentration of potential prey around the impoundment. Orange netting incorporated into the fencing would reduce, but not completely eliminate the potential for northern goshawk collisions with the fence. Extended snowpack duration would not affect the Navajo Mountain Mexican vole, other than potentially improving the forage base.

Management Indicator Species

The effects of the extended snowpack duration and the snowmaking water impoundment are limited to the SUP area. Because the SUP area is managed as a developed recreational site, impacts to MIS are not analyzed. However, effects on some of these species are addressed in the Game and Non-game Wildlife section below.

Migratory Birds

Extended snowpack duration and the snowmaking water impoundment would have no effect on the water pipit, Swainson's thrush, or the three-toed woodpecker. Pine grosbeaks, golden-crowned kinglets, olive-sided flycatchers, and cordilleran flycatchers may benefit from enhanced arthropod prey populations due to extended moisture availability. Purple martins may benefit from the water impoundment as an additional surface water source and an area of higher arthropod prey densities. These benefits may be offset by increased potential for collisions with the fence surrounding the impoundment. Extended moisture availability would enhance the growth of grasses and forbs in the upper portion of Hart Prairie, increasing forage availability for prairie dogs. This in turn may benefit ferruginous hawks foraging in this area.

[465] Williams, 2003

Game and Non-Game Wildlife

Greater moisture availability from snowmaking and an extended snowpack would generally enhance the growth of grasses and forbs on cleared ski trails within the SUP area. This would locally increase forage conditions for deer and elk and result in higher densities of these game species in the SUP area. The snowmaking water impoundment would have no effect on most game and non-game wildlife because access would be excluded by fencing. These species would continue to rely on natural surface water sources, in addition to waters (stock tanks) that have been placed specifically for wildlife in the SUP area. Some game and non-game birds would benefit from this additional surface water source offered by the snowmaking impoundment. Orange netting incorporated into the fencing would reduce, but not completely eliminate the potential for bird collisions with the fence.

Alternative 3

The effects of this alternative on threatened, endangered, and sensitive species; management indicator species; migratory birds; and game and non-game wildlife would be the same as those described under the Alternative 1 (No Action).

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of the cumulative effects analysis for wildlife extend from the initial development of Snowbowl as a winter recreational area into the foreseeable future during which recreation-related activities may affect wildlife.

Spatial Bounds

The physical extent of this cumulative effects analysis comprises mainly the Snowbowl SUP area, the proposed reclaimed water pipeline alignment between the City of Flagstaff and the SUP area, and adjacent public lands to the extent they would be potentially affected. These adjacent lands include a portion of the Kachina Peaks Wilderness, areas adjacent to the reclaimed water pipeline alignment, and areas downslope of the SUP area (primarily Hart Prairie). Other projects in the Peaks area that affect wildlife are also included in the cumulative effects analysis.

Past, Present, and Reasonably Foreseeable Future Actions

1. Kachina Peaks Wilderness Designation
2. White Vulcan Mine Settlement and Reclamation
3. San Francisco Mountain Mineral Withdrawal
4. Development and Maintenance of the SUP as a Recreational Area
5. Spruce Bark Beetle Control within the SUP
6. Fort Valley Restoration Project
7. Transwestern Lateral Pipeline Project
8. Peaks Segment of the Arizona Trail
9. Private Land Development
10. Miscellaneous/ongoing Recreational Uses

11. Power Line Maintenance
12. Various Aspen Regeneration and Exclosure Fences
13. Inner Basin Waterline Pipeline Maintenance
14. Snowbowl Road Paving

Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 – No Action

Threatened, Endangered, and Sensitive Species

Past development of the SUP area as a winter recreational area, associated maintenance activities, and measures implemented to control a spruce bark beetle outbreak affect primarily spruce-fir forest and subalpine grassland within the SUP area. These areas do not provide breeding habitat for the threatened Mexican spotted owl, the threatened bald eagle, the endangered black-footed ferret, or the sensitive peregrine falcon. The SUP area provides occasional foraging habitat for the sensitive northern goshawk. Since this species forages in both forested stands and along the edges of openings, initial development of the ski area and subsequent maintenance activities are unlikely to have had a substantially positive or negative effect on this species. Development of approximately 139 acres of skiing trails has increased the amount of potential habitat for the sensitive Navajo Mountain Mexican vole within the SUP area. Maintenance of existing ski trails may periodically impact some vole habitat and/or individuals.

Some of the past, present, and reasonably foreseeable future actions identified above have cumulative affected habitat for threatened, endangered, or sensitive species. Designation of the Kachina Peaks Wilderness provides conservation of potential habitat for the Mexican spotted owl, the northern goshawk, and the Navajo Mountain Mexican vole. Maintenance activities along the Transwestern Lateral Pipeline and the power line between the SUP area and Snowbowl Road may result in the occasional removal of hazard trees from within goshawk PFAs in the area. Proposed construction and use of the Peaks Segment of the Arizona Trail will result in recreational impacts to the Viet Springs goshawk PFA. A portion of the Snowbowl Road is located within the Snowbowl PAC. This roadway supports year-round traffic associated with winter sports, as well as other traffic related to the Scenic Sky Ride and other recreational events staged within the SUP area. Consistent presence and reproductive success suggest that traffic on Snowbowl Road has had little if any effect on Mexican spotted owls nesting in this PAC.

Management Indicator Species

Establishment of the Snowbowl SUP classified a total of 777 acres for recreational use, precluding the management of this area for indicator species. Establishment of the ski area in 1938 has likely had little effect on management indicator species beyond the SUP.

Other the past, present, and reasonably foreseeable future actions have affected management indicator species in the Peaks area. Closure and reclamation of the White Vulcan Mine and withdrawal of the Peaks from mineral extraction will benefit some management indicator species in the future. Designation of the Kachina Peaks Wilderness provided 18,963acres for management as Wilderness. As such, forest management activities are precluded and habitat

conditions are predominantly the result of natural events, such as fire, succession, insect pest outbreaks. The Fort Valley Restoration Project will restore 9,100 acres of ponderosa pine forest to pre-settlement conditions and will likely improve habitat conditions for species indicative of late seral ponderosa pine forest. Private lands in the Fort Valley and Baderville area, including portions of Lower Hart Prairie, are mostly zoned at one unit per two to 2.5 acres; however, some are zoned at one unit per five or ten acres for lands undergoing development for rural residential uses.[466] Increased human presence and development reduces the amount of habitat for elk and mule deer in the analysis area. Construction and maintenance of the Transwestern Lateral Pipeline resulted in the clearing of approximately four acres of ponderosa pine forest which probably improved foraging habitat for elk and mule deer.

Migratory Birds

Initial development of the Snowbowl ski area affected habitat for migratory birds within the SUP area. Clearing of ski runs and construction of associated facilities affected roughly 160 acres of predominantly spruce-fir forest and to a lesser degree subalpine grassland. Of this total, 21.4 acres were developed as roads, parking lots, and permanent structures which no longer serve as habitat for migratory birds. The remaining 138.6 acres was predominantly spruce-fir forest that was converted to open areas comprising the existing ski runs. This resulted in a corresponding loss of potential habitat for the Swainson's thrush. Potential habitat for pine grosbeaks and golden-crowned kinglets was negatively affected through the removal of overstory vegetation and positively affected by the creation of more edge habitat and more open areas for foraging. Potential habitat for olive-sided flycatchers likely increased through the creation of more openings. Construction of the Hart Prairie Lodge, lifts, and ski trails has likely reduced habitat quality for foraging ferruginous hawks. Removal of spruce-fir trees to control spruce bark beetles will reduce habitat quality for three-toed woodpeckers, which feed preferentially on these insects. Construction of the Agassiz Lift (to the original top terminal location) affected roughly two acres of habitat for the water pipit.

Designation of the Kachina Peaks Wilderness has conserved 18,705 acres of high elevation montane conifer forest and grassland. To some extent, this has benefited most or all of the migratory birds discussed above. Withdrawal of the Peaks from mineral extraction also provides conservation of these species or their potential habitats. The Fort Valley Restoration project will likely improve habitat conditions for the olive-sided flycatcher while private land development in Lower Hart Prairie is reducing foraging habitat for the ferruginous hawk.

Game and Non-game Wildlife

Initial development of the Snowbowl has affected game and non-game wildlife primarily through disturbance from recreational and other human activities and from fragmentation or disruption of continuous forest cover within the SUP area. The highest levels of human activity occur during the ski season; the presence of skiers primarily results in the disturbance of diurnally foraging birds and other wildlife outside the breeding season. Use of the SUP as a recreational area has likely increased the local abundance of potential nest scavengers, such as jays, crows, and ravens and other nuisance wildlife, such as bears. Summer recreational use is in large part related to the Scenic Sky Ride. This activity may cause disturbance to foraging or potentially breeding birds

[466] Coconino County Community Development, 2003

and other wildlife in the direct vicinity of the Agassiz Chairlift. Initial development of the ski area converted 138.6 acres of spruce-fir forest to ski trails, creating a mosaic of forested and open areas within the SUP area. This has resulted in direct habitat loss, limitations on movement between forest patches, and potential edge effects such as greater nest predation rates for some wildlife species.

Designation of the Kachina Peaks Wilderness, closure and reclamation of the White Vulcan Mine and withdrawal of the Peaks from mineral extraction will conserve habitat for game and non-game wildlife in the area. Removal of bark beetle infected trees opens up target stands of spruce-fir and affects wildlife through disturbance or direct habitat removal. Maintenance activities related to pipelines, power lines, and roads cause temporary disturbance to wildlife. Establishment of the Peaks segment of the Arizona Trail will contribute to recreational impacts on game and non-game wildlife. Areas adjacent to the Trail may become unsuitable or may be avoided by some species. Construction of a loop trail would likely reduce use of the area by wild turkey. Development of private lands in the Fort Valley/Baderville, Hart Prairie/White Horse Hill areas, and recreational use of the Peaks Segment of the Arizona Trail may increase the local abundance of scavengers, such as corvids, and may result in higher rates of nest predation in passerine birds. Greater human presence from recreational use of the Arizona Trail and from development of private lands in the Fort Valley/Baderville, Hart Prairie/White Horse Hill areas will further restrict, but not impede, movement of large carnivores through the analysis area. These activities would also result in a cumulative increase in the frequency of encounters between humans and bears in the analysis area.

Alternative 2 – The Proposed Action

Threatened, Endangered, and Sensitive Species

Cumulative effects of the Proposed Action on threatened, endangered, and sensitive species are the same as those described under Alternative 1, with the following exceptions.

Clearing of new ski trails under the Proposed Action would increase the area of potential habitat for the sensitive Navajo Mountain Mexican vole from approximately 138.6 to 233.1 acres. Snowmaking would increase grass and forb density and cover and may result in an increase in vole populations on both the existing and new ski trails. A correspondingly larger area would be subject to maintenance activities, which may temporarily disturb vole habitat and/or affect individuals. This alternative would result in the removal of 54 pine trees from the Mars Hill northern goshawk PFA.

Management Indicator Species

The Proposed Action would not change the boundaries or the total acreage associated with the Snowbowl SUP area. As such, it would not affect the total acreage managed as a recreational area and excluded from management for forest indicator species. Due to their location, number, and size, the removal of approximately 156 trees from along Snowbowl Road and the reclaimed water pipeline alignment would not affect most management indicator species. Associated ground disturbance and removal of approximately 22 smaller aspen trees may temporarily reduce potential foraging habitat for mule deer. Otherwise, cumulative effects are the same as those described under Alternative 1.

Migratory Birds

Cumulative effects of the Proposed Action on migratory birds are the same as those described under Alternative 1, with the following exceptions.

Cumulative effects under this alternative would relate to the removal, disturbance, or modification of a total of approximately 305.6 acres of montane conifer forest and grassland within the SUP. This consists of approximately 160 acres affected as a result of past ski area development and proposed improvements that would remove an additional 76.3 acres of spruce-fir forest, remove 2.7 acres and temporarily disturb 18.2 acres of subalpine grassland, and thin 48.4 acres of spruce-fir forest within the SUP area. Approximately 150 trees have already been removed from the SUP area and an additional 800 are planned to be removed for the control of spruce bark beetles. This alternative would result in a corresponding cumulative increase in the amount of potential habitat lost or modified for the Swainson's thrush, pine grosbeak, golden-crowned kinglet, ferruginous hawk, and three-toed woodpecker. This alternative would contribute an additional one-half-acre loss of potential habitat for the water pipit but would result in a cumulative increase in the amount of potential habitat for the olive-sided flycatcher.

Game and Non-Game Wildlife

Cumulative effects of the Proposed Action on game and non-game wildlife are the same as those described under Alternative 1, with the following exceptions.

This alternative would cumulatively increase the amount of open area dominated by forbs and grasses from roughly 138.6 acres to approximately 233.1 acres and would increase the productivity of the predominantly introduced plant species in these areas. This would further improve habitat conditions for elk, mule deer, other generalist herbivores, and edge species but would reduce habitat for specialist herbivores and forest interior species.

This alternative would result in a cumulative increase in the area subject to disturbance effects. Maintenance activities would be extended from approximately 138.6 to 233.1 acres and most of the existing and new trails would be subject to noise from snowmaking and grooming operations. Establishment and use of the proposed hiking trail would result in potential disturbance of an additional 15 acres during the summer period. This alternative would extend the ski season and would increase the total duration over which potential disturbance of wildlife occurs. This increased human presence would affect primarily diurnally foraging birds and other wildlife outside the breeding season. An extended ski season may cumulatively increase the local abundance of potential nest scavengers, such as jays, crows, and ravens and other nuisance wildlife, such as bears.

Removal of approximately 76.3 acres of spruce-fir forest would result in a cumulative decrease in continuous forest cover and an increase in the total amount of edge between open and forested areas. Creation of additional edge may cumulatively increase nest predation rates by corvids. The Proposed Action would result in greater patchiness and would further reduce cover for large carnivores.

Alternative 3

Threatened, Endangered, and Sensitive Species

Cumulative effects of this alternative on threatened, endangered, and sensitive species are the same as those described under Alternative 1, with the following exceptions.

Clearing of new ski trails under this alternative would increase the area of potential habitat for the sensitive Navajo Mountain Mexican vole from approximately 138.6 to 205 acres. Grass and forb density and cover would be dependent on natural precipitation. No trees would be removed from the Mars Hill northern goshawk PFA.

Management Indicator Species

Cumulative effects on management indicator species are the same as those described under Alternative 1, except that there would be no removal of trees along Snowbowl Road and the reclaimed water pipeline alignment under this alternative, and therefore no temporary impacts to mule deer foraging habitat.

Migratory Birds

Cumulative effects of this alternative on migratory birds are the same as those described under alternatives 1 and 2, with the following exceptions.

The cumulative effect of past ski area development and proposed additional development under this alternative would be the removal, disturbance, or modification of approximately 274.9 acres of montane conifer forest and grassland within the SUP area. This consists of 160 acres affected as a result of past ski area development and proposed improvements that would remove an additional 66.4 acres of spruce-fir forest, remove 0.1 acre of subalpine grassland, and thin 48.4 acres of spruce-fir forest within the SUP area. This alternative would result in a corresponding cumulative increase in the amount of potential habitat lost or modified for the Swainson's thrush, pine grosbeak, golden-crowned kinglet, ferruginous hawk, and three-toed woodpecker. Like the Proposed Action, Alternative 3 would contribute an additional one half-acre loss of potential habitat for the water pipit but would result in a cumulative increase in the amount of potential habitat for the olive-sided flycatcher.

Game and non-Game Wildlife

Cumulative effects of this alternative on game and non-game wildlife are the same as those described under Alternative 1, with the following exceptions.

This alternative would cumulatively increase the amount of open area dominated by forbs and grasses from approximately 138.6 acres to 205 acres and would expand the amount of foraging habitat for elk, mule deer, other generalist herbivores, and edge species. It would result in a corresponding reduction in the amount of habitat for specialist herbivores and forest interior species.

This alternative would result in a cumulative increase in the area subject to disturbance effects. Maintenance activities would be extended from approximately 138.6 to 205 acres and most of

the existing and new ski run would be subject to noise from nighttime snow grooming operations.

Removal of approximately 66.4 acres of spruce-fir forest would result in a cumulative decrease in continuous forest cover and an increase in the total amount of edge between open and forested areas. Creation of additional edge may cumulatively increase nest predation rates by corvids, would result in greater patchiness, and would further reduce cover for large carnivores.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There could be some irretrievable effects on small acreages from overstory removal of spruce-fir and/or conversion to additional ski runs. In alternatives that include the following actions there could be irreversible commitments of resources affecting small acreages from: the construction of additional parking, snowplay/tubing facility, the snowmaking reservoir, realignment of chairlifts and contouring new ski terrain.

3L. GEOTECHNICAL

In conjunction with this EIS, a geotechnical report was prepared by Myers Design Engineering, Inc. to analyze the feasibility and potential hazards of constructing a 10 million gallon, on-mountain snowmaking water impoundment. The following analysis is excerpted from the Geotechnical Report for the Arizona Snowbowl Facilities Improvement Proposed Snowmaking Pond Site,[467] which is contained in the project file.

Appendix A provides a conceptual design of the snowmaking water impoundment, which was necessary in order to complete a proper stability analysis and dam breach model. The reader is referred to Appendix A for specifics of the impoundment. A summary of the impound design follows.

The snowmaking water impoundment is proposed to be located just below (and to the south of) the ridgeline along the southern edge of the SUP area – near the top terminal of the existing Sunset Chairlift. The proposed impoundment is to be a geosynthetic lined pond with an earthen embankment. The conceptual design assumes a 15-foot wide embankment crest and a 15-foot wide access road around the perimeter of the pond for maintenance access. The impoundment would be constructed with 2:1 (horizontal to vertical) side slopes. Although the Proposed Action calls for a 10 million gallon capacity, maximum possible storage (to the embankment crest) would be approximately 12.6 million gallons (38.8 acre feet). This makes the structure a non-jurisdictional dam in the State of Arizona (less than 25-foot crest to toe embankment height and less then 50 acre feet of storage).

SCOPE OF THE ANALYSIS

Detailed field mapping of geologic hazards over the entire ski area was determined to be unnecessary in relation to the scope of this analysis. This hazard assessment is limited to the review of available published information, site-specific topographic maps, available aerial photography, and a field inspection of the proposed snowmaking water impoundment site.

EXISTING CONDITIONS

TOPOGRAPHY AND SOILS

The Snowbowl (and the proposed snowmaking water impoundment site, specifically) is located in the San Franciscan Volcanic Field of northern Arizona, north of Flagstaff, near Latitude 35° 19’ 49” North, Longitude 111° 42’ 30” West. The proposed snowmaking pond is proposed near the upper terminal of the existing Sunset Chairlift, at an elevation of approximately 9,990 feet. This area drains south and east into the Rio de Flag near US Highway 180. The area is in the south/central portion of the Colorado Plateau physiographic province.

Site topography is steep with slopes below the snowmaking pond site ranging from 15 to 50 percent. Bedrock at the site consists of extrusive igneous rock, specifically blocky lavas of medium gray to pinkish gray andesite containing phenocrists of plagioclase feldspar,

[467] Myers, 2003

horneblende, hypersthene, and augite of Quaternary age. Materials of similar mineralogic composition can also exist in the form of ashflow tuff, tuff breccias, and flow breccias. The formation present at the snowmaking impoundment site is designated "Younger andesite of Agassi Peak" (Qaay). The formation common to higher elevations is designated "Older andesite of San Francisco Mountain" (Qao). Outcrops are relatively uncommon except along the ridge tops at higher elevations. Other commonly observed materials include colluvium, alluvium, and avalanche/debris flow deposits.

A soil survey prepared by the CNF is available for the area. The predominant soil complex in the vicinity is described as having a severe erosion potential, slight cutbank stability potential, and low shrink/swell potential. Other soil units encountered along the drainage path between the proposed snowmaking water impoundment site to and along Rio De Flag are grouped according to "mountainous" and "valley" sections. Erosion hazard ranges from moderate to severe in the mountainous section, and from slight to severe in the valley floor section. Cutbank stability hazard varies from slight to moderate in the mountainous section, and slight to non-existent in the valley floor section. The severe erosion hazard, particularly in the uppermost portions of the identified flow path, indicates that flood flows are likely to carrying a high sediment load and have the potential to generate debris flows.

GEOLOGIC HAZARDS

Large landslides were not observed despite the steep terrain. However, combined avalanche and debris flow chutes are relatively common in the vicinity of the Snowbowl at higher elevations. The drainage path for any significant hydrologic event at the snowmaking water impoundment site (including a dam breach flood) is southwest off the face of Agassiz Peak, then southeast along the Rio De Flag toward the City of Flagstaff. The estimated flood discharge for the Rio De Flag at the city limits of Flagstaff is 340 cubic feet per second (cfs) for a return frequency of 25 years.

Other potential geologic hazards that were considered include: avalanche; rockfall; earthquake; subsidence; and expansive soils. There is a significant avalanche risk on all slopes between 26° and 45° (approximately 50 to 100 percent) which is further aggravated in areas of significant wind loading. However, the avalanche hazard is routinely monitored and mitigated during Snowbowl's safety operations. No significant rockfall hazard was observed anywhere within the immediate vicinity of the proposed snowmaking water impoundment area. Slopes are gentle to moderate with no exposed rock.

The total absence of carbonate rocks (limestone and dolomite) precludes the existence of any karst topography or associated sinkhole development and therefore also precludes the associated subsidence risk. Similarly, although extrusive volcanic rocks are present in the area, there is no evidence of shallow lava tubes that could create a subsidence hazard. No significant mining activity has ever existed at the site and therefore, there are no shafts or slopes that could present a subsidence risk. No groundwater pumping is carried out, and therefore subsidence associated with groundwater pumping is not an issue at the Snowbowl.

Mechanical weathering dominates over chemical weathering at this relatively high altitude. The residual and colluvial soil products that result from breaking down the andesitic rocks tend to be

fine-to-medium grained sands with little or no clay (i.e., non-plastic). Therefore, the soils are non-expansive (little shrink-swell activity).

SEISMICITY

This section of the analysis describes the potential impact of earthquakes at the Snowbowl by separately addressing two distinctly different aspects of seismicity:

- Seismic hazard
- Seismic risk

Seismic hazard addresses the nature of and likelihood of experiencing a seismic event at sometime in the future. However, the characterization of *seismic risk* requires more than just the establishment of a hazard and necessarily requires the consideration of the potential consequences of experiencing a seismic event.

Seismic Hazard

Seismic events or earthquakes have long been known to be associated strongly with tectonic movements of large masses of the earth's crust or plates. Earthquakes can and do occur virtually anywhere in the earth's crust, but tend to concentrate, both in space and time, near the boundaries of the major plates. They can be associated with magmatic movement and volcanism, with areas of crustal thinning or spreading centers (rift zones), or even from elastic crustal rebound and isostatic uplift following the removal of a great thickness of glacial ice. However, the largest earthquakes and the greatest frequency of earthquakes seem to be associated subduction zones where edge of one plate is sinking beneath the edge of an adjacent plate that is overriding it. Arizona (with the exception of the extreme southwest corner near Yuma) is not impacted by plate boundary, subduction zone tectonics. Most earthquakes are directly associated with the breaking or rupture of the crust along a fault line. The magnitude of the earthquake is a function of a number of factors including the type of rock present, the dip angle of the subduction zone, the depth of the rupture, the creep rate and magnitude of the stress drop during a rupture, the areal extent of the rupture, and so on.

The Snowbowl SUP lies in a Zone 2B seismic area in the Colorado Plateau – a region characterized by crustal uplift. A database was created of earthquake magnitude and the epicenter location of historic seismic events within a 100 km radius of the site extracted from the USGS seismic event catalog. In many areas of moderate to low seismicity, earthquakes can be considered to occur as independent, random events in space and time and can be modeled using probability models that assume a dispersed source area (such as the area of the circle defined by the arbitrary 100 km radius surrounding the site). However, in areas of high seismicity, earthquakes do not occur randomly, but are often clustered along active fault lines. For purposes of this analysis, it was assumed that the seismic source area contains the full population of historic events within a 100 km radius of the site.

The Flagstaff community has experienced several damaging earthquakes from seismogenic sources within northern Arizona. The region between Flagstaff and the Arizona-Utah border has

produced seven M_S[468] 5.0 historic earthquakes. The three largest occurred within a six-year period (1906-1912).

- January 25, 1906: M_S 6.2
- September 24, 1910: M_S 6.0
- August 18, 1912: M_S 6.2

Earthquakes are felt in Flagstaff about once per year. Part of the reason for this is that the Colorado Plateau transmits earthquake energy relatively efficiently. However, the primary reason is Flagstaff's location within the Northern Arizona Seismic Belt (NASB).[469] The most recent strongly felt earthquakes[470] stemmed from the 1993 Cataract Creek earthquake sequence of April and May. This sequence included both a m_b 4.9[471] foreshock and m_b 5.4 mainshock that were both widely felt in Flagstaff. More recently, earthquakes ranging up to M_L[472] 3.7 struck the Red Mountain and Lake Mary regions. These later events were only slightly felt in Flagstaff. In addition, earthquakes centered at the South Rim of the Grand Canyon ranging up to M_L 4.0 have occasionally been felt in Flagstaff.

Earthquakes no larger than magnitude seven would be expected in the seismic source area, and no larger than 6.5 in the vicinity of the site.

Design Earthquake

Analysis of the historic earthquake record as described above, and detailed in the Geotechnical Report prepared for this analysis, shows the following characteristics for the design earthquake (the event which should be used for the design of important facilities) for a facility design life of 100 years:

- Magnitude = 6.2
- Maximum On-Site Bedrock Acceleration (6.2 at 22 km) = 0.15g
- Annual Exceedance probability = 1.0 percent
- Probability of Occurrence During Design Life of 100 years = 63.21 percent
- Idealized Length of Fault Slip (Rupture Length) = 6.6 miles
- Probable Maximum Offset = .39 meters (1.3 feet)
- Expected Duration of Strong Ground Motion = 15 seconds

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[468] Surface Wave Magnitude. A relationship can be established between estimates of any of the various wave types that can be observed on a seismogram (P waves, S waves, and Rayleigh waves [also called surface waves]). M_s is estimated using the surface waves and is particularly useful for shallow focus earthquakes.

[469] The NASB is composed of a northwesterly trending belt of seismicity beginning southeast of Flagstaff, trending through the Grand Canyon, and apparently joining with a northward trending belt of seismicity at the Arizona-Utah border.

[470] MMI V-VI in Flagstaff.

[471] Body Wave Magnitude. This magnitude is estimated using the P wave amplitude.

[472] Local Magnitude (also known as the Richter Magnitude) is a procedure developed by Charles Richter in 1935 in California, specifically for the Wood-Anderson Seismograph instrument and was intended for use in characterizing California earthquakes (although it has seen much wider usage). It uses the difference in arrival time between the P wave (compression wave) and the S wave (shear wave) along with the maximum height (or amplitude) of the shear wave on the seismogram to determine the magnitude.

- Expected Duration of Acceleration greater than 5%g = 14 seconds
- Expected Duration of Acceleration greater than 10%g = 10 seconds

The above event could occur anywhere within the seismic source area defined by the 100 km radius around the site. However, the effects of earthquake shaking (acceleration and particle velocity) attenuate quickly with distance. Therefore, the worst-case conditions are likely to come from a nearby source, even if the magnitude of that event is less than the magnitude of the design event from within the entire seismic source area.

Maximum Credible Earthquake

The concept of Maximum Credible Earthquake (MCE) uses the characteristics of a specific fault system to set a practical limit on the magnitude of the event it can generate. It is based primarily on the length and character of the mapped fault rupture. The most likely source of large seismic events in the vicinity of the site is the neotectonic fault system located to the southeast of Flagstaff. This fault system has been assigned a MCE magnitude of 7.3.

Worst Case Event Characteristics are as follows:

- Maximum Credible Earthquake Magnitude = 7.3
- Maximum On-Site Bedrock Acceleration (7.3 at 22 km, 25 km rupture on Lake Mary fault system, Baush and Brumbaugh, 1997) = 0.27g
- Annual Exceedance probability = 0.17 percent
- Probability of Occurrence During Design Life of 100 years = 15.32 percent
- Idealized Length of Fault Slip (Rupture Length) = 40 miles
- Probable Maximum Offset = 1.3 meters (4.3 feet)
- Expected Duration of Strong Ground Motion = 28 seconds
- Expected Duration of Acceleration greater than 5%g = 29 seconds
- Expected Duration of Acceleration greater than 10%g = 14 seconds

Seismic Risk

Seismic risk must necessarily consider the potential consequences of the seismic hazard on facilities, equipment, and personnel associated with the project. The nature of the potential impacts varies depending on whether facilities are considered temporary, have a fixed life, or are considered permanent. Facilities can be impacted in a number of ways including surface ground rupture, strong shaking, liquefaction, and seismically induced instability.

All fixed structures at the site would be impacted by strong ground motion independent of their position at the site. For most facilities, the magnitude threshold at which some level of damage might be expected is about 5.0 with the severity of damage increasing with increasing magnitude. Probability of impact is simply the probability of the occurrence of the event.

Liquefaction, or the sudden loss of strength in the foundation soils supporting structures, typically begins at a magnitude threshold on the order of 6.0. However, the phenomenon requires not only strong ground motion, but also the presence of loose, saturated, non-cohesive soil. Although these conditions can exist locally where deeply weathered pockets in the bedrock have been filled with loose granular soil, the conditions are rare and isolated. The snowmaking

water impoundment site does rest above a pocket of residual and colluvial soil roughly eight to 10 feet thick above the volcanic bedrock. The colluvial soil in the upper one to 2.5+/- feet is relatively loose, however the density and cobble/boulder content increases with depth as the material transitions into a moderate to high-density residual soil with cobbles and boulders that becomes weathered volcanic bedrock at some depth greater than eight to 10 feet. The soils are normally dry and it is unlikely that they would fully saturate even during heavy snowmelt conditions. Based on the design 100 year return frequency earthquake (magnitude 6.2, barely above the threshold magnitude of 6.0), and an inspection of test pit excavations, it is believed that liquefaction risk at the snowmaking pond site is low.

Potential impacts from ground rupture during seismic events affect primarily permanent, fixed linear facilities such as roads, lifts, pipelines, and so on. Surface ground rupture has been documented during events as small as magnitude 3.6,[473] however, as a general rule, surface fault rupture requires events larger than magnitude 5.5. No known active faults exist on the site, and therefore the risk of impact from surface fault displacement is minimal.

Another potential consequence of a major seismic event is the occurrence of seismically induced instability. The most common seismically induced events include rockfalls, disrupted soil slides, and rockslides.

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT EFFECTS

Based on an analysis of the existing conditions within the Snowbowl SUP area, no geotechnical concerns were identified for any of the proposed project elements with the exception of the construction and on-going operation of the proposed snowmaking water storage impoundment. Because the snowmaking water impoundment is not a component of either Alternatives 1 or 3, this discussion of environmental consequences is limited to Alternative 2.

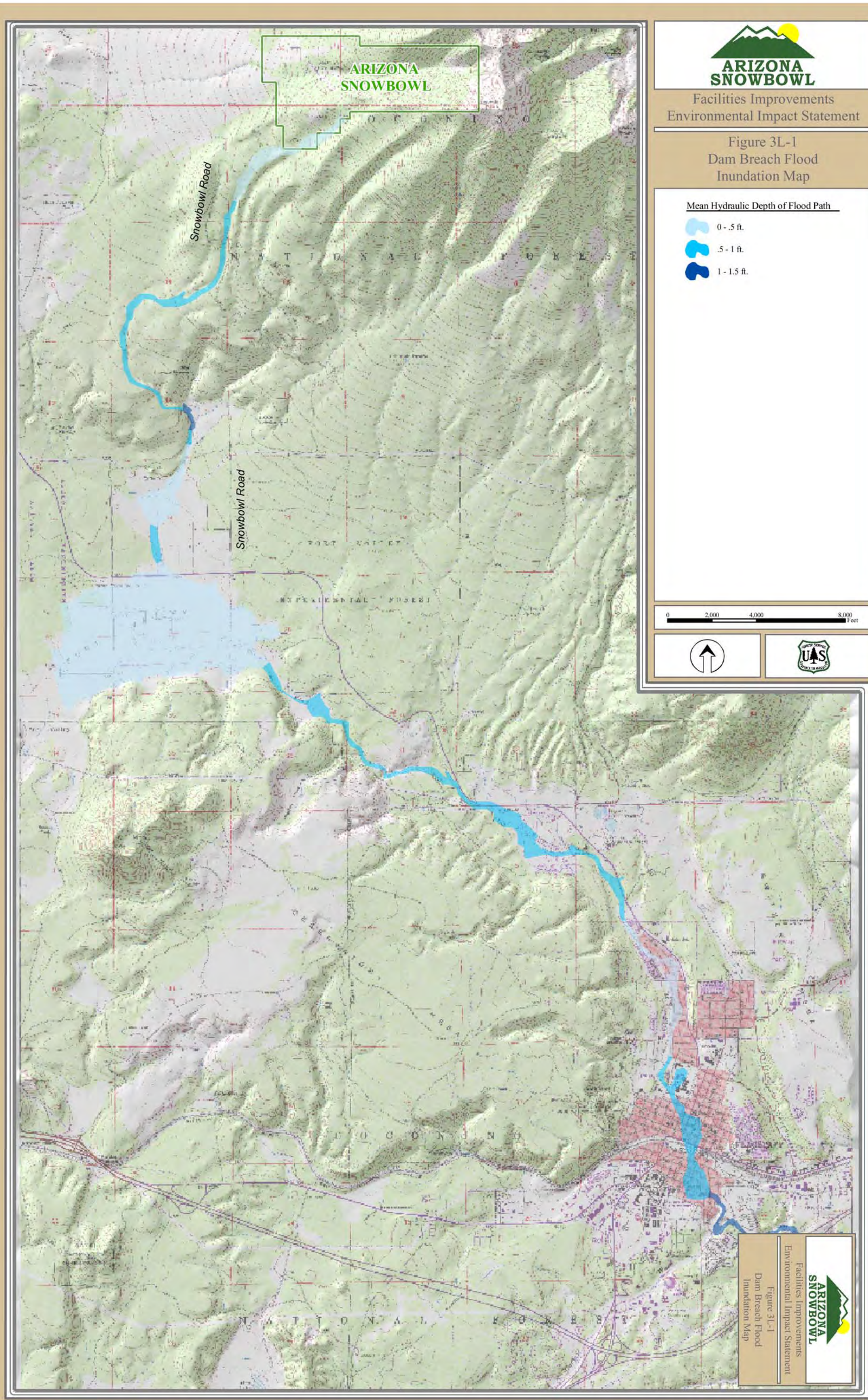
Geotechnical feasibility and hazards associated with construction of the proposed snowmaking water impoundment must be analyzed.

Indicator:

Dam Breach and Downstream Inundation Analysis

The character and potential impact of a dam breach flood was evaluated for the proposed snowmaking water impoundment using the unsteady flow modeling capabilities of the HEC-RAS program developed by the U.S. Army Corps of Engineers. HEC-RAS calculates the peak discharge through the breached dam and routes the flood wave downstream. The program uses an implicit finite difference procedure to solve the complete one-dimensional Saint-Venant equations of unsteady flow. Figure 3L-1 depicts the potential flow path.

[473] Imperial, California, 1966


ARIZONA SNOWBOWL
Snowbowl Road
Snowbowl Road
Mean Hydraulic Depth of Flood Path
0 - .5 ft.
.5 - 1 ft.
1 - 1.5 ft.
0
2,000
4,000
8,000
Feet
ARIZONA SNOWBOWL
Facilities Improvements
Environmental Impact Statement
Figure 3L-1
Dam Breach Flood
Inundation Map

In the event of a snowmaking water impoundment failure, the resulting flood would flow to the southwest, away from the developed terrain within the SUP area, and further south down unnamed drainages approximately five miles to the valley floor and the Rio De Flag. Most of the flow path is steep and often narrow and supercritical flow would dominate. The upper part of the channel is steep, producing high stream power and Froude numbers often above 2.0. Such conditions can result in severe erosion and scour. However, at the base of the mountain (approximately five miles below the impoundment location), floodwaters would spread out across a wide, flat floodplain area where most of the sediment would be deposited.

The HEC-RAS program requires the input of numerous parameters. However, some of the most important parameters are those that describe the ultimate shape of the breach in the embankment, and the time required for the breach to form. Due to the nature of the snowmaking water impoundment design (a geosynthetic lined pond excavated well below the embankment height into natural ground), only a partial breach would be expected with the portion of the reservoir well below natural ground not being released. Froelich equations of were used to obtain initial estimates of the average breach width and time to failure.[474] Additional equations that provide estimates of the peak discharge during breach were used to provide an independent check on the reasonableness of the breach parameters.[475] Given the sandy, cohesionless, and erodible nature of the embankment soils, it is expected that the elapsed time from the beginning of failure to the maximum breach development would be minutes (not hours). After some attempts at optimization, the following breach parameters were selected:

- Average breach width = 44 feet
- Max width at bottom of breach = 31 feet
- Breach side slopes = 0.77:1
- Maximum breach height = 17 feet
- Time required for breach development: 10.2 minutes

Two different failure mechanisms were considered: a sunny day piping failure (internal erosion), and an overtopping failure. The overtopping failure condition would be the result of operating error (the structure overfilled and overtopped) and not be the result of a hydrologic event (i.e., no inflow flood hydrograph is being routed along with the dam breach flood).

The dam breach flood would be discharged on the south side of the ridge that bounds the Snowbowl and would not be released onto an existing or proposed trail. The maximum discharge through the breach varies among the scenarios ranging from 1,380 cubic feet per second (cfs) for the piping failure mode to 1,165 cfs for the overtopping failure mode. In the mountainous section of the modeled flow path, flow depth can be as great as 1.7 feet (although the typical depth is roughly one foot). Velocities in the steep upper reaches can be as high as 23.5 feet per second (fps). However, most of the time, the flow velocity would range between five and 14 fps.

There are three structures shown along the flood path between the snowmaking water impoundment site and Fort Valley in the vicinity of Big Leroux Spring, the first at a distance of

[474] Froelich 1987, 1995

[475] Hagen, 1982; Fread, 1981

4.1 miles below the site and the other two at a distance of 4.3 miles. Two of the structures are outside the mapped flood limits and one is within it. At the site of the structure within the flood limits, the expected peak discharge is 830 cfs, the expected velocity is 5.1 ft/s and the expected mean depth 1.2 feet.

By the time the modeled flood wave reaches the valley floor near U.S. Highway 180 approximately 5.4 miles below the snowmaking impoundment site, there is no difference in the magnitude of the flood discharge under either scenario (between 414 cfs and 419 cfs). The expected peak discharge is 419 cfs, the expected velocity is 3.5 ft/s and the expected mean depth 0.6 feet. The model assumes an existing base flow of 180 cfs, therefore the dam breach flood produces a net increase of 239 cfs to this point. Once the flow reaches the alluvial valley floor, the depth falls to on the order of 0.6 feet just before reaching U.S. Highway 180.

A large, flat storage area exists immediately upstream of U.S. Highway 180 that would allow most of the coarse sediment load to drop out. Therefore, it is expected that existing hydraulic structures would not be plugged and would be functioning. Using existing estimates of peak flood discharges on the Rio De Flag from gaging station records, the 100-year return frequency flood in the area is estimated to be approximately 300 cfs. If the breach flood occurred while the channel is dry (the most likely scenario), then it would have approximately the same impact as a 50-year return frequency flood at the site, and the risk of overtopping the Highway would be low. If there were significant flow in the channel at the time of a breach, then it is possible that the Highway could be overtopped for a brief period of time (the period of time during which flows could exceed 300 cfs would be approximately 15 minutes). The depth of any overtopping flow on the Highway would likely be less than two inches with a velocity of less than 2.0 ft/s.

Downstream of Fort Valley the breach flood is substantially attenuated and would have impacts similar to 25-year return frequency flood or less (less than a 10-year return frequency flood in many cases further downstream). Once the flow enters the channel of the Rio De Flag, the modeled flow velocity declines from roughly 3.5 fps near the confluence to less than 0.3 fps near the first significant residential development (Fort Valley subdivision) at a downstream distance of 5.8 miles. The time required for the leading edge of the flood wave to reach U.S. Highway 180 after the start of a failure is approximately 28 minutes with the peak of the flood arriving approximately 10 minutes later (for a time to peak of 38 minutes).

Therefore, the model indicates that the flood wave attenuates substantially on its way down the mountain and dissipates almost entirely in the broad floodplain of Fort Valley. For purposes of computational stability, the model assumes an existing, minimum flow in the channel of 180 cfs (approximately the equivalent of a 25-year return frequency flood on the Rio de Flag above Flagstaff). The cumulative discharge leaving Fort Valley would be less than 210 cfs (i.e., a net contribution from the dam breach flood of 30 cfs or less). Downstream from Fort Valley, it is anticipated that existing hydraulic structures (bridges and culverts) on the Rio De Flag would accommodate the passing breach flood without impact through the Flagstaff area.

Indicator:

Hazard Classification

There is no simple, quantifiable method for the assignment of a hazard classification to a reservoir. Classification is a matter of judgment. Most systems consider two main factors:

- The potential for loss of human life
- The potential for property damage

The approach to hazard classification also varies with the administering entity (usually a state or federal agency). For example, the State of Arizona has the following guidance with respect to hazard classification:

Hazard Potential Classification – State of Arizona

1. The Department shall base hazard potential classification on an evaluation of the probable present and future incremental adverse consequences that would result from the release of water or stored contents due to failure or improper operation of the dam or appurtenances, regardless of the condition of the dam. The evaluation shall include land use zoning and development projected for the affected area over the 10 year period following classification of the dam. The Department considers all of the following factors in hazard potential classification: probable loss of human life, economic and lifeline losses, and intangible losses identified and evaluated by a public resource management or protection agency.

    a. The Department bases the probable incremental loss of human life determination primarily on the number of permanent structures for human habitation that would be impacted in the event of failure or improper operation of a dam. The Department considers loss of human life unlikely if:

        i. Persons are only temporarily in the potential inundation area
        ii. There are no residences or overnight campsites
        iii. The owner has control of access to the potential inundation area and provides an emergency action plan with a process for warning in the event of a dam failure or improper operation of a dam.

    b. The Department bases the probable economic, lifeline, and intangible loss determinations on the property losses, interruptions of services, and intangible losses that would be likely to result from failure or improper operation of a dam.

2. The four hazard potential classification levels are very low, low, significant, and high, listed in order of increasing probable adverse incremental consequences. The Director shall classify intangible losses by considering the common or unique nature of features or habitats and temporary or permanent nature of changes.

    a. Very Low Hazard Potential. Failure or improper operation of a dam would be unlikely to result in loss of human life and would produce no lifeline losses and very low economic and intangible losses. Losses would be limited to the 100 year

floodplain or property owned or controlled by the dam owner under long-term lease. The Department considers loss of life unlikely because there are no residences or overnight camp sites.

b. Low Hazard Potential. Failure or improper operation of a dam would be unlikely to result in loss of human life, but would produce low economic and intangible losses, and result in no disruption of life-line services that require more than cosmetic repair. Property losses would be limited to rural or agricultural property, including equipment, and isolated buildings.

c. Significant Hazard Potential. Failure or improper operation of a dam would be unlikely to result in loss of human life but may cause significant or high economic loss, intangible damage requiring major mitigation, and disruption or impact on lifeline facilities. Property losses would occur in a predominantly rural or agricultural area with a transient population but significant infrastructure.

d. High Hazard Potential. Failure or improper operation of a dam would be likely to cause loss of human life because of residential, commercial, or industrial development. Intangible losses may be major and potentially impossible to mitigate, critical lifeline services may be significantly disrupted, and property losses may be extensive."

Forest Service Manual 7500, Chapter 7510

Classify dams according to hazard potential based on the loss of human life or property damage that could occur if the structure failed.

1. Low Hazard. Dams built in undeveloped areas where failure would result in minor environmental or economic loss, damage would be limited to undeveloped or agricultural lands, and significant improvements are not planned in the foreseeable future. Loss of human life would be unlikely.

2. Moderate Hazard. Dams built in areas where failure would result in serious environmental damage or appreciable economic loss with damage to improvement, such as commercial and industrial structures, public utilities and transportation systems. No urban development and no more than a small number of habitable structures are involved. Loss of human life would be unlikely.

3. High Hazard. Dams built in areas where failure would likely result in loss of human life or excessive economic loss. Generally this would involve urban or community development with more than a small number of habitable structures."

Hazard classifications are based solely on downstream conditions and not on the design of the structure, operating procedures, or the condition of the dam. For structures assigned a low or moderate/significant hazard classification, periodic review of the hazard classification is appropriate to account for potentially changing downstream conditions. A review frequency on the order of five years is typical.

Hazard classifications affect design criteria (primarily spillway design), and the need for and nature of an Emergency Action Plan. An Emergency Action Plan defines appropriate response scenarios for all potential modes of failure and includes specific notification plans (updated at least every two years with current phone numbers), and evacuation plans. All responsible operating staff must be familiar with the Emergency Action Plan.

Given the long site distance on this section of U.S. Highway 180 and the low depths and velocities, an overtopping event of the Highway would not be life threatening. The subdivision within Fort Valley post-dates the USGS topography, and the structure base elevations are not known. However, the breach flood at the subdivision location would be less than the 100-year flood and would not be expected to impact any existing structures. However, a considerable volume of shallow water would be stored in open areas within Fort Valley during the passage of a breach flood. It is anticipated that existing hydraulic structures (bridges and culverts) on the Rio De Flag in the Flagstaff area would accommodate the passing breach flood without impact.

Based on the conditions described above in the Dam Breach and Downstream Inundation Analysis, the structure would classify as a low hazard dam using the State of Arizona criteria, and a moderate hazard dam using the Forest Service criteria. Therefore, it is recommended that the final structure be designed using design criteria associated with a moderate hazard dam.

Indicator:

Failure Risk

It is extremely important to understand the distinction between *hazard* and *risk*. A *hazard* is a condition, either natural or human-made, that poses a *potential* danger to life and/or property. Hazards exist everywhere, all around us. The existence of a hazard says absolutely nothing about the likelihood of being impacted by the hazard. *Risk* is the probability of occurrence of the event that would cause the impact. Stated another way, the hazard associated with a potential dam breach flood is exactly the same whether the dam embankment is a state-of-the-art structure in good condition or a poorly designed, sloppily constructed structure in poor condition. However, the risk or the probability that the embankment might fail, leading to the occurrence of a dam breach flood, would be dramatically different for those two extremes.

The principle determinant of the risk of experiencing a dam breach flood is the structural stability of the dam embankment. Potential failure modes were evaluated to assess failure risk along with the identification of mitigation measures that could reduce failure risk.

Potential dam embankment failure modes considered include the following:

- Overtopping of the embankment crest due to an extreme hydrologic event
- Overtopping of the embankment crest due to operator error
- Piping development in the downstream toe of the embankment or in the foundation
- Static failure of the embankment
- Embankment failure due to excessive displacement during an earthquake
- Liquefaction of the embankment foundation
- Excessive settlement

Overtopping of the Embankment Crest Due to an Extreme Hydrologic Event or to Operator Error

For a moderate hazard rating, the required uncontrolled spillway design criteria is the Probable Maximum Flood (PMF). Estimation of the Probable Maximum Precipitation (PMP) and the associated PMF is beyond the scope of this study. However, based on the very limited size of the contributing basin above the proposed snowmaking pond, the design PMF is likely to be very small. The level of anticipated discharge should be easily carried through a modest sized emergency spillway placed in one of the dam abutments. The dam abutments contain an abundance of boulders and weathered volcanic rock at or very near the surface. Therefore the erosion potential in the floor of the spillway channel would be minimal. The uncontrolled emergency spillway should be checked routinely and frequently as part of normal operations for potential blockage by snow, ice, or debris and cleared if significant blockage is found.

Operator error could result in overfilling the reservoir if pumps were inadvertently left running unattended. However, using an automatic cutoff switch that would shut down pumps when the water surface in the pond reached its maximum storage level could mitigate this risk (this feature has been specified as required mitigation as detailed in Chapter 2). A pressure sensing transducer on the bottom of the pond should be used in lieu of a float device at the surface of the pond to prevent interference by ice. Even if automated systems were to experience a total mechanical failure, the uncontrolled emergency spillway would still prevent overtopping.

Due to the very low probability of occurrence of the sequence of events that might lead to an overtopping failure and the degree of redundancy possible in mitigation design, there is a very low risk of failure by overtopping.

Piping Development in the Downstream Toe of the Embankment or In the Foundation

Piping involves the transport of solid particles from within an embankment or foundation soil in response to high seepage pressures or seepage velocities. The risk is greatest where certain fine-grained soil types are present and in high head dams (high embankments impounding water to great depth) that can produce high exit gradients (rapidly changing upward pressure gradients in the toe area of the dam). Fine sands and silts that are poorly graded (nearly all the same grain size) are very susceptible to piping. A particularly dangerous soil group is called “dispersive clay.” These very fine-grained soils (less than 2.0 microns) disaggregate in the presence of water and become extremely mobile. None of these high-risk soils are present at the proposed snowmaking water impoundment site. The soils observed on site consist of fine to medium grained, *well*-graded sands with gravel, cobbles, and boulders. “Well graded” refers to a wide variety of different particle sizes that impart good filtering characteristics (large particles hold back the medium sized particles which hold back the small particles and so on) creating a soil with good drainage characteristics and very limited particle mobility. These soils have a low piping potential.

The design maximum embankment height is on the order of 24 feet making the structure a small, low head structure. The impoundment area will be lined with a geo-synthetic liner to create a “bathtub” configuration that, during normal operations, would prevent any release of water to the soil and rock below the reservoir. However, any liners may leak at some point in their life

through defects in the liner or more often in the seams that that join sheets of liner. The most common defect is a small pinhole leak producing orifice flow through the liner and into the porous soil beneath. Such leaks, even if they were numerous, would not result in saturation of the foundation and embankment, but would perch and flow harmlessly beneath the structure and out on the bedrock/soil interface. A large leak (a major slice or tear in the liner or a long rip in a seam) could release enough water to saturate the foundation and embankment. Due to the shallow depth to rock, a portion of the back of the reservoir is likely to expose rock or even excavate a short distance into weathered rock. If this process were to expose any open, high continuity (long) joints, then it would be possible for water to directly enter these joints and be delivered with little head loss to the area immediately beneath the toe of the dam producing strong upward flow and high exit gradients leading to a piping risk even in the well graded sands.

This risk can be mitigated in a number of ways. A composite liner system consisting of HDPE liner above a minimum six inch thick bedding of compacted clay would restrict the flow volume sufficiently to prevent saturation of the foundation and embankment soils and create enough head loss to reduce high exit gradients in the toe area of the dam. However, there is no local source of clay soil and the importation of clay liner/bedding material would be very expensive. Another approach would be to grout any open fractures exposed during excavation prior to covering with the local sand bedding and the HDPE liner. The process of filling open fractures from the surface is sometimes referred to as “dental” grouting or “slush” grouting. The plugging of these fractures would either prevent the entry of water into the fractures or at least create enough head loss to reduce exit pressures at the embankment site. A third option would be injection grouting beneath the embankment foundation. Again, the plugging of fractures in the foundation below the embankment would create enough head loss to reduce exit pressures beneath the downstream toe of the embankment.

In summary piping does represent a risk to the stability of the structure, but the piping risk can be mitigated to a low risk by taking appropriate measures during final design and construction.

Static Failure of the Embankment

Slope stability failure in the embankment can cause a loss of crest height and an associated risk of overtopping. The risk of instability is increased in the presence of saturated soil conditions and high pore pressure. Under normal operating conditions the embankment and foundation would be expected to be dry. Even in the presence of small to moderate leakage through the liner, the embankment would be expected to remain dry. Slope stability models were developed and analyzed for the downstream embankment of the snowmaking water impoundment. Rapid drawdown conditions were not analyzed for the upstream embankment slopes because the embankment soils are expected to be relatively free draining and incapable of preserving excess pore pressure following a reduction in impoundment water levels, and under normal operating conditions, there is no connection between impoundment water levels and pore water pressures in the embankment soils. Using an embankment slope of 2:1, the factor of safety (FOS) under the normal dry condition is 2.75, and under a moderate leakage condition 2.71 indicating a very low risk of instability.[476] Under worst-case conditions of major leakage through the liner, the

[476] For static failures, most structures are designed to a minimum FOS of 1.5. An FOS exceeding 1.5, therefore, has a low likelihood of failure.

embankment soils would saturate and establish a steady state seepage profile. The FOS under this condition is 2.13 indicating a low risk of instability.

For the proposed embankment slope of 2:1, the risk of static instability is low.

Embankment Failure Due to Excessive Displacement During an Earthquake

Strong ground motion during an earthquake can cause displacements in the embankment that in turn can cause a loss of crest height and an associated risk of overtopping. The potential for unacceptable displacements during an earthquake is checked in a hierarchy of analyses beginning with a pseudostatic limit equilibrium analysis. If the pseudostatic analysis indicates a factor of safety equaling or exceeding 1.15,[477] then there is no need for any additional analysis. For the condition of no leakage the FOS is 2.32, and for small to moderate leakage through the liner 2.28, indicating a low risk of excessive displacement and no need for further analysis. The combined conditions of major leakage with the development of a steady state seepage profile, and the occurrence of a major earthquake would produce a FOS of 1.79, again exceeding normal design criteria. In addition, the probability of a large leak going undetected and unmitigated coinciding with the timing of a large earthquake is extremely low (i.e., it is not a reasonable worst case design condition for this structure).

The risk of excessive displacement during an earthquake is low.

Liquefaction of the Embankment Foundation

Liquefaction is a phenomenon that causes loss of shear strength during the strong ground motion accompanying an earthquake. Liquefaction requires two conditions:

1. Loose cohesionless soils
2. Saturated conditions

Test pits revealed loose, cohesionless soils in the upper 2.0+/- feet of the soil profile, however these soils would not be saturated for the condition of no leakage or even small to moderate leakage through the liner and therefore not subject to liquefaction. The combined conditions of major leakage with the development of a steady state seepage profile, and the occurrence of a major earthquake would have an extremely low probability for the same reasons described in the earlier section on excessive displacement. Test pits indicate that the cohesionless soils densify with depth transitioning into dense residual soils and weathered rock at a depth of less than 10 feet. However, the lower portion of the soil profile could be saturated with only a small to moderate level of leakage through the liner. Based on observations in the test pits, these deeper soils are too dense to be liquefiable. However, it would be prudent to check the relative density of the entire soil profile and quantify the liquefaction potential of the deeper soils through a site-specific drilling program at the time of final design. If a liquefaction risk is identified at the time of final design, it can be easily mitigated. Loose soil can simply be removed and replaced with compacted, densified soil, or deep layers can be stabilized with grout.

[477] For seismic-induced failures, most structures are designed to a minimum FOS of 1.15. An FOS exceeding 1.15, therefore, has a low likelihood of failure during a seismic event.

In summary, the liquefaction risk is believed to be low, but needs to be verified by site-specific investigation at the time of final design.

Excessive Settlement

Excessive settlement can lead to a loss of crest height and an associated risk of overtopping. Large settlements are typically associated with low-density clay soils. The soils in the foundation area are low cohesion silty sand and gravel becoming progressively denser with depth and terminating against boulders and weathered rock at depths of 10 feet or less. Settlement movements in such soils are small, elastic in nature, and immediate. Therefore, little or no settlement movement would be expected after completion of construction.

The risk of excessive settlement is very low.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of the cumulative effects analysis for geotechnical issues extends from the point at which the water impoundment would be constructed until it is no longer necessary.

Spatial Bounds

The physical extent of this cumulative effects analysis is confined to the flood inundation path, as identified in Figure 3L-1.

Past, Present, and Reasonably Foreseeable Future Actions

No past, present or reasonably foreseeable future activities have been identified which could cumulatively affect geotechnical resources. Appendix C includes the full list of past, present and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternatives 1, 2 and 3

Because no past, present or reasonably foreseeable future activities have been identified that could cumulatively geotechnical resources, no further cumulative effects analysis is warranted.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

No irreversible or irretrievable commitments of resources were identified in association with this geotechnical analysis.

3M. AIR QUALITY

INTRODUCTION

Neither public nor agency scoping identified potential effects to air quality as a key issue within this analysis. The two action alternatives include the same level of selective tree removal but each has a varying degree of ground disturbance due to the inclusion of snowmaking under Alternative 2.

SCOPE OF THE ANALYSIS

The air quality analysis for this analysis focuses on the Snowbowl SUP area (NFS lands), the adjacent base area, and a proximate Class I airshed.[478]

FEDERAL AND STATE AIR QUALITY REGULATIONS

FEDERAL

The Clean Air Act (CAA) was enacted in 1955, but it contained few requirements for reducing air pollutant emissions. It was amended numerous times from 1963 through 1990 to address reductions in vehicular and stationary source emissions and to establish national air pollution concentration limits. It also established several programs, including: the National Ambient Air Quality Standards (NAAQS), which limited air concentrations to protect public health and welfare; the New Source Performance Standards, which set emission standards for major sources; and the State Implementation Plan (SIP) procedures, which were designed to bring areas that exceeded NAAQS levels (non-attainment areas) to within the standards. Table 3M-1 lists the state and Federal Ambient Air Quality Standards.

Table 3M-1
State and Federal Ambient Air Quality Standards

Pollutant	Averaging Period	Primary Standard	Secondary Standard
Carbon Monoxide (ppm)	1 hour 8 hour	35 9	-- --
Nitrogen Dioxide (NO2) (ppm)	Annual	0.05	0.05
Particulate Matter (PM10) (micrograms/m3)	24 hour Annual	150 50	150 50
Ozone (ppm)	1 hour	0.12	0.12
Sulfur Dioxide (SO2) (ppm)	3 hour 24 hour Annual	-- 365 (0.14) 80 (0.03)	1300 (0.5) -- --
Lead (Pb) (micrograms/m3)	Calendar Quarter	1.5	1.5

Source: ADEQ 2003

[478] The nearest Class I airshed is Sycamore Canyon Wilderness. The Kachina Peaks Wilderness is not classified as a Class I airshed, though it is treated as if it were.

In its amended form, the CAA designates two separate air quality areas receiving differing levels of protection. Class I areas generally include National Parks, Congressionally designated Wildernesses that are in excess of 5,000 acres and which were created prior to 1977,[479] National Monuments, National Seashores, and other areas of special national or regional value. Class I designation warrants the highest level of protection afforded to an area. Class II designation typically applies to all non-Class I areas.

Class I and II areas are either designated as attainment, non-attainment, or unclassifiable areas. Unclassifiable designations apply where pollution is not anticipated to exceed national standards and where insufficient information is available to either substantiate or reject this assumption. Unclassified areas generally have little, if any, industrial development and comparatively sparse populations. The low likelihood of air quality problems makes these areas a lower priority for expensive monitoring programs.

In addition to the NAAQS discussed above, the EPA has created regulations to protect and enhance air quality. The Prevention of Significant Deterioration (PSD) regulations are intended to help maintain good air quality in areas that attain the national standards and to provide special protections for national parks, Congressionally wildernesses, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historical value.[480] These regulations stipulate that new sources must not cause a decline in ambient air quality and must use best available control technology to limit emissions.

PSD permits are required for "major emitting facilities" which emit, or have the potential to emit, 100 tons or more per year of any air pollutant.[481] EPA regulations specifically list the sources that are considered "major emitting facilities" – this list does not include ski areas.[482] However, the regulations note that the term "major emitting facilities" also includes "any other source with the potential to emit two hundred and fifty tons per year or more of any air pollutant."[483] A PSD permit is not required for Snowbowl because the ski area does not have the potential to emit over 250 tons of any regulated air pollutant.

In an effort to eliminate or minimize the severity and number of violations of the NAAQS and to achieve expeditious attainment of these standards, the EPA promulgated the Conformity Rule in 1993. Conformity regulations apply to Federal actions and environmental analyses in non-attainment areas completed after March 15, 1994. The conformity regulations do not apply to Snowbowl area because it is classified as an area in attainment for all criteria pollutants.

VISIBILITY

Visibility is the maximum distance that an object can be perceived against the background sky; it also includes the clarity with which the form and texture of objects can be seen. Visibility impairment in Arizona is most often related to fine particulates in the atmosphere; these particulates either scatter or absorb light, obscuring vision. The most common anthropogenic

[479] The Kachina Peaks Wilderness was designated by Congress in 1984.
[480] 42 USC 7470-7479, 1997
[481] 42 USC 7475(a) and 7479(1), 1997
[482] 42 USC 7479(1), 1997
[483] Id.

sources for these particulates are vehicular emissions, fugitive dust from unpaved roads, and wildfires. Topographic features, wind patterns, and humidity are all related to effects on visibility.

Prevention of visibility impairment to Class I areas is required by the EPA's CAA implementing regulations.[484] The Forest Service has also created visibility standards called Limits of Acceptable Change to determine sensitive receptors within the Wilderness and how much air pollution is acceptable. As previously stated, the Kachina Peaks Wilderness is not technically classified as a Class I airshed, though it is treated as if it were. The Kachina Peaks Wilderness is the only protected airshed proximate to the Snowbowl area which has relevance to this analysis.

STATE

The EPA retains oversight authority for air quality but has delegated enforcement of the CAA to the states. In Arizona, the Air Quality Division of the Arizona Department of Environmental Quality (ADEQ) acts as the lead agency. The state is required to develop and administer air pollution prevention and control programs; state standards must be either the same as, or more stringent than, Federal CAA standards. Table 3M-1 lists the State and Federal Ambient Air Quality Standards.

EXISTING CONDITIONS

CLIMATE AND METEOROLOGY

Snowbowl has a climate monitoring station at the Hart Prairie Lodge, which is at 9,300 feet in elevation. This station shows average total snowfall over a period of 22 years (1981/82 season through 2002/03 season) to be 232.5 inches per year, with a maximum of 460 inches during the 1992/93 season and a minimum of 76 inches during the 1983/84 season.

The average daily temperature for the past three winter operating seasons (November through March of 2000/01, 2001/02, and 2002/03) has been 27.6, 29.9, and 30.1 degrees Fahrenheit, respectively. The average low temperatures for the same time periods were 24.7, 22.2, and 23.1 degrees Fahrenheit, respectively. With moisture in the air, Snowbowl has sufficient temperatures to produce and maintain snow on the mountain throughout the winter operating season.

Due to its desert locale, humidity is low and diurnal temperature fluctuations are high at Snowbowl. Prevailing winds are generally from the northwest, and the region receives the majority of its winter precipitation from Pacific storms. Average winter wind speed, (based on 12 winter months of data) measured at the Hart Prairie Lodge, is 3.4 mph, with gusts up to 43 mph.

CLIMATE CHANGE

An increasing body of evidence supports the collective majority view within the scientific community that the average global climate of the earth is warming, and that this trend is giving rise to a variety of "ripple-through" changes in the inter-connected climate system.[485] The IPCC

[484] 40 CFR 51.300-51.307, 1999
[485] IPCC, 2001.

(Intergovernmental Panel on Climate Change) concludes that "… concentrations of atmospheric greenhouse gases … have continued to increase as a result of human activities… [and] …emissions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that are expected to affect the climate."[486] The issue of global warming is an area of significant concern to the ski industry and to ski area operators throughout North America.[487]

The potential implications of climate change for the Arizona Snowbowl may include:

- Shorter winters
- Warmer winter temperatures
- Increased incidence of winter snowpack melt and sublimation loss
- Earlier spring snowmelt
- An increase in the elevation at which seasonal snowpack can be maintained

REGIONAL CLIMATE CHANGE IN THE SOUTHWEST

Many of the predictions regarding the range of possible effects of global warming rely upon general circulation models (GCMs). However, there are limitations to the abilities of GCMs to predict regional climate trends, due to the complex interactions of orography and topography, combined with the relative coarseness of the computational grid used in global-scale models.[488] Within a GCM, each grid area, or cell, represents a single temperature and precipitation state-value within the model, yet a grid area may represent tens of square miles of area on the earth's surface.[489]

Region-specific climate scenarios are commonly developed by "nesting" a finer-scale model, which is more sensitive to regional variations in topography and climatology, within a global-scale GCM.[490] For application to the Southwestern United States, researchers at NCAR (National Center for Atmospheric Research), have developed and applied a model called RegCM (Regional Climate Model).[491] The regional model estimates a temperature increase of approximately seven degrees Fahrenheit in the Southwest United States by the year 2060, which is similar to the predictions of two different GCMs.[492] In contrast with GCM predictions, which generally indicate regional winter precipitation *increases* for the Southwest, the regional model indicates a *decrease* in winter precipitation of approximately 1.2 inches by the year 2060, with correspondingly less high-elevation snowfall accumulation, and less springtime and early summer re-charge or runoff.[493]

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[486] Id.
[487] National Ski Areas Association 2004a.
[488] Merideth 2001.
[489] Id.
[490] Id.
[491] Id.
[492] Doherty and Mearns, 1999; Giorgi et al. 1998.
[493] Merideth 2001.

EL NIÑO – SOUTHERN OSCILLATION

Superimposed on the anthropogenic climate change signal are natural cycles or oscillations that tend to cause variability in regional climate. The El Niño cycle is a quasi-periodic warming of surface waters in the central and eastern equatorial Pacific Ocean, recurring every two-to-seven years, with each event's duration lasting anywhere from six-to-eighteen months.[494] The corresponding episodic cooling of central and eastern equatorial Pacific waters, also occurring every two-to-seven years, is referred to as La Niña.[495] These oceanic events are paired with the Southern Oscillation, which is a broad change in atmospheric circulation patterns across the southern Pacific Ocean. Together, the irregular cycle of this coupled ocean-atmospheric heat circulation system is referred to as the El Niño – Southern Oscillation (ENSO).[496] A variety of studies have revealed a relationship between ENSO and climate variability in the Southwest.[497] Although winter precipitation patterns can range from wet to dry for any given El Niño event, in general, El Niño winters are associated with higher than average winter precipitation.[498] Indeed, the greatest winter precipitation amounts observed within the available instrumental climate record have occurred during El Niño years.[499] Meanwhile, La Niña years are usually associated with drier winters in Arizona.[500]

PACIFIC – DECADAL OSCILLATION

In Arizona's semi-arid climate, winter precipitation is highly variable from year-to-year. However, within the long-term climatic record, there are phases of generally lower than average and higher than average precipitation spanning time frames that last several decades.[501] Within the instrumental climate record extending from approximately 1895 to the present, there have been three distinct multi-decadal trends observed in Arizona precipitation:[502]

- 1925 – 1946: Wet
- 1947 – 1976: Dry
- 1977 – 1998: Wet

At the decadal time frame, this observed variation in precipitation has been linked by climate researchers to an occurrence known as the Pacific Decadal Oscillation (PDO).[503] Although the PDO is similar to ENSO in that it describes an oscillation in Pacific sea-surface temperatures (SSTs), it is misleading to describe the phenomenon as a multi-decadal version of ENSO. In contrast to ENSO, the SST oscillations of the PDO are strongest in the northern Pacific Ocean,

[494] McPhee, et al 2004.
[495] Id.
[496] Id.
[497] Id.
[498] Id.
[499] Id.
[500] Id.
[501] Id.
[502] Id.
[503] Mantua et al. 1997, Mantua and Hare 2002.

while ENSO events tend to be concentrated in the equatorial zones of the Pacific.[504] The PDO appears to be linked to a somewhat regular pattern of high and low air pressure systems over the northern Pacific Ocean, which correlate to SSTs in that region.[505]

In general, the warm phase of the PDO correlates with trends of wetter winters in Arizona, while the cool phase correlates with multi-decadal periods of drier than average conditions.[506] Because the causal atmospheric and oceanic processes of the PDO are not well understood, using PDO indices to forecast long-term climatic shifts is subject to some uncertainty.[507] Nonetheless, many researchers believe that the PDO circulation pattern shifted to a cool phase in the late 1990's, indicating that winter precipitation may exhibit below average trends in the Southwest for the next several decades.[508] However, it may be some time before researchers develop a level of certainty whether or how such a PDO shift might have occurred.[509]

ONGOING OPERATIONS

Snowbowl maintains one air quality permit through the state of Arizona; permit number 1000934 is a class 2 permit for a Detroit V92 diesel engine with turbo that provides auxiliary power for the Agassiz Lift at Snowbowl. Auxiliary power is for backup in the event of an electric power outage only. As a result this engine operates less than 25 hours per year on average. This is also the case for the auxiliary power sources at all other lifts at Snowbowl; which each run less than 25 hours per year.

Emergency generators used to provide backup power to lifts could produce occasional, short-term emissions. Some fugitive dust may result from the operation of ski area vehicles on the mountain road network during the summer for ski area maintenance; however, this is minor because of the limited extent of road use. These potential sources are not considered to substantially contribute to air quality related values and are therefore not discussed further in this analysis.

Most day-to-day pollutant sources in the Snowbowl area are assumed to result from mobile sources rather than stationary point sources. Potential mobile sources of air pollution include automobiles, trucks, buses, snowmobiles, slope grooming equipment, and emergency power generators. Of these, only automobiles are thought to contribute to substantial pollutant emissions. Automobile emissions, like other mobile sources, can occur over a broad geographic area. The effects of automobile emissions are likewise dispersed over an equally large area, and dispersal is highly dependent on topographic and climatic conditions.

[504] NOAA-NWS 2004.
[505] Id.
[506] McPhee, et al 2004.
[507] Id.
[508] Id.
[509] Id.

SUMMARY

Air quality in the project area meets both Arizona air quality regulations and Federal CAA standards, and Snowbowl is currently in attainment with the state and Federal regulations for all six criteria pollutants.

ENVIRONMENTAL CONSEQUENCES

Snowplay activities at Snowbowl could increase vehicular traffic and may negatively impact air quality in the region.

Indicator:

Compliance with Local, State, and Federal Regulations Regarding Air Quality

Air quality effects of greatest concern as related to implementation of the Proposed Action are fugitive dust during construction, vehicular emissions as a result of skier and snowplay visitation, and smoke emissions from burning slash.

DIRECT AND INDIRECT EFFECTS

Alternative 1 – No Action

Under the No Action alternative, no new construction of trails or lifts would occur nor would the installation of snowmaking infrastructure occur. The area would maintain its permit for the auxiliary diesel engine and would likely continue to emit for short durations over the course of the winter, as disclosed above. No change in fugitive dust from traffic on dirt roads would be anticipated because no additional up-mountain maintenance traffic would be expected. Neither snowmobile nor slope grooming equipment use would increase because no additional terrain would be serviced.

With the selection of Alternative 1, there would be no increase in visitation. There would also be no change in current trends to air quality in and around Snowbowl. The area would remain in attainment for all six criteria pollutants and the visibility of the Kachina Peaks Wilderness would remain unimpaired.

Alternative 2 – The Proposed Action

Under the Proposed Action, the CCC of the Snowbowl would increase from 1,880 to 2,825 guests-at-one-time. However, because the ski area is already servicing in excess of 3,400 guests on peak days, this would not constitute and increase in daily visitation. The proposed snowtubing facility would be developed to accommodate 600 tubers-at-one-time. The snowplay guests would be supported by the construction of a 400 space parking lot. The snowtubing facility is anticipated to receive average daily use of approximately 420 guests; with peak day visitation approaching 1,680 visitors.[510] Assuming average vehicle occupancy of three persons per car this would equate to 143 and 560 additional vehicles on average and peak days, respectively. Although the development of the proposed snowplay facility would result in a net

[510] Refer to the Recreation section for additional detail pertaining to the proposed snowplay facility and estimated useage.

increase in total vehicles at Snowbowl, it is implicit that a large portion of these vehicles are currently traveling the Snowbowl Road and to the ski area seeking snowplay opportunities.

Under existing conditions, average annual skier visitation is approximately 98,000 guests. At 2.5 people per vehicle, this equates to approximately 39,200 vehicles at Snowbowl each year. In ten years, at full build-out of the Proposed Action, visitation would increase to approximately 215,000 skiers and 42,000 snowplayers. Using a factor of 2.5 skiers per vehicle and three snowplayers per vehicle, this would equate to approximately 100,000 vehicles at Snowbowl each year.

As detailed in the Recreation section of this chapter, parking has recently been prohibited along the Snowbowl Road approaching the ski area. As a result, dispersed snowplay activities are effectively prohibited as well. On peak days during the 2002/03 ski season, as many as 300 to 500 vehicles per day arrived at the ski area in search of snowplay opportunities and were turned away due to lack of parking or overselling of tickets. As a result, it appears that many of the additional vehicles anticipated to result from the operation of the snowplay facility are accounted for in traffic numbers and ADEQ air quality monitoring. These snowplay seekers would not necessarily constitute a net increase in average daily traffic or result in substantial additional vehicular emissions in the area.

Other effects to air quality under Alternative 2 would be an increase in particulate matter during construction as fugitive dust escapes specific project construction areas (including construction of the reclaimed water pipeline) and enters the atmosphere. Overall, Alternative 2 proposes approximately 245.4 acres of temporary and permanent ground disturbances. However, ground disturbing activities would be implemented over the course of several summers with total areas disturbed at a given time being relatively confined.

The temporary effects to air quality as a result of construction activities would be minimized by precipitation and/or the required watering of disturbance areas during construction. Additionally, areas of proposed disturbance would be reseeded and replanted promptly after the disturbance occurs to reduce the duration and extent of soil exposure. Refer to the mitigation measures listed in Table 2-2 for more information on these requirements.

Selection and implementation of proposed project elements in Alternative 2 would entail the removal of approximately 76.3 acres of permanent overstory vegetation. In areas where access is difficult, trees would be lopped and scattered. In more accessible areas of vegetation removal, merchantable timber volumes would be assessed prior to project implementation. It would then be removed and sold (or given to the tribes) as required by the Forest Service. Prescribed burning of the remaining slash would involve hand or machine piling to insure the slash is burned in distinct piles rather than broadcast burning. Snowbowl would obtain all necessary burn permits from the Forest Service and ADEQ prior to any burning to ensure compliance with all local, state, and Federal regulations. Prescribed burning of slash would result in short-term, temporary increases to $PM_{2.5}$, PM_{10}[511] in the vicinity of Snowbowl. Because winds are primarily from the northwest, smoke from the prescribed burning may affect visibility in the southeastern

[511] Particulate matter less than 2.5 or 10 microns (respectively) in diameter.

portion of the Kachina Peaks Wilderness; however, the effects would be short-term and temporary.

As a result of implementation of Alternative 2, Snowbowl would remain in attainment for all six criteria pollutants. It would also maintain the integrity of the visibility in the nearby Kachina Peaks Wilderness. Snowbowl would maintain compliance with all local, state, and Federal air quality regulations.

Alternative 3

Under Alternative 3, the CCC of the Snowbowl would increase from 1,880 to 2,825 guests-at-one-time. However, because the ski area is already servicing in excess of 3,400 guests on peak days, this would not constitute and increase in daily visitation. The proposed snowtubing facility would not be developed. As stated previously, parking has recently been prohibited along the Snowbowl Road approaching the ski area; as a result, dispersed snowplay is also prohibited. Many vehicles have approached Snowbowl seeking snowplay opportunities and have returned home without finding access to these activities. As a result of Alternative 3, this level of dispersed snowplay traffic would likely continue and would likely not result in an increase in average daily traffic or result in additional vehicular emissions in the area.

Because Alternative 3 does not include the installation of any snowmaking infrastructure, the overall amount of temporary and permanent ground disturbance within the SUP area is reduced to approximately 131.4 acres. As stated previously, the temporary effects to air quality as a result of construction would be minimized by precipitation and/or watering of disturbance areas during construction. Additionally, areas proposed for disturbance would be reseeded and replanted promptly after the disturbance occurs to reduce the duration and extent of soil exposure. Refer to the mitigation measures listed in Table 2-2 for more information on these requirements.

Selection and implementation of proposed project elements in Alternative 3 would entail the removal of approximately 64.4 acres of permanent overstory vegetation. As disclosed under Alternative 2, in areas with difficult access, trees would be lopped and scattered. In more accessible areas, merchantable timber would assessed prior to project implementation. It would then be removed and sold (or given to the tribes) as required by the Forest Service. Prescribed burning of the remaining slash would involve hand or machine piling to insure the slash is burned in distinct piles rather than broadcast burning. Snowbowl would obtain all necessary burn permits from the Forest Service and ADEQ prior to any burning to ensure compliance with all local, state, and Federal regulations. As stated previously, prescribed burning of slash would result in short-term, temporary increases to $PM_{2.5}$, PM_{10} in the vicinity of Snowbowl. Because winds are primarily from the northwest, smoke from the prescribed burning may affect visibility in the southeastern portion of the Kachina Peaks Wilderness; however, the effects would be short-term and temporary.

As a result of implementation of Alternative 3, Snowbowl would remain in attainment for all six criteria pollutants with a net reduction of direct and indirect effects as compared to those disclosed under the Proposed Action. It would also maintain the integrity of the visibility in the nearby Kachina Peaks Wilderness. Snowbowl would maintain compliance with all local, state, and Federal air quality regulations.

CUMULATIVE EFFECTS

Scope of Analysis

Temporal Bounds

The temporal bounds of the cumulative effects analysis for air resources extends from the initial development of the Snowbowl in 1938 into the foreseeable future for which this and other projects can be expected to continue in and around the Snowbowl SUP area.

Spatial Bounds

The physical extent of this cumulative effects analysis comprises the Snowbowl SUP area, the surrounding Kachina Peaks Wilderness, approximately 600 acres in the lower Hart Prairie area, and 9,100 acres in the lower south and west slopes of the Peaks.

Past, Present, and Reasonably Foreseeable projects relevant to a discussion of Cumulative Effects

No past activities having potential to cumulatively affect air quality resources were identified for this analysis. Present and reasonably foreseeable projects with potential to cumulatively affect air quality include:

1. Bebbs Willow Restoration Project
2. Fort Valley Restoration Project

Appendix C includes the full list of past, present, and reasonably foreseeable future actions analyzed in this document, as well as background information on each of them.

Alternative 1 – No Action

The past, present, and reasonably foreseeable actions identified above will not dramatically affect the air quality of the Peaks region. Activities in the vicinity of the project area that are likely to contribute to airborne particulates and visibility impairment in the analysis area include wildfires and other prescribed burn operations conducted in the area. Construction and prescribed burns are anticipated to be short-term and relatively small in scope. The tree thinning/prescribed burning projects listed above will consist of 9,700 acres of such activity, and remaining amounts of timber not removed and sold as required by the Forest Service will be transferred by hand and/or machine into distinct piles to be burned. Prescribed burning of slash will result in short-term, temporary increases to $PM_{2.5}$, PM_{10} in the vicinity of lower Hart Prairie and the lower south and west slopes of the Peaks.

Alternative 2 – The Proposed Action

The Proposed Action would result in 76.3 acres of permanent overstory vegetation removal within the Snowbowl SUP area, and remaining amounts of timber not removed and sold as required by the Forest Service will be transferred by hand and/or into distinct piles to be burned. The 76.3 acres of vegetation removal combined with the 9,700 acres of present and reasonably foreseeable projects within the vicinity would possibly result in the general treatment of

approximately 9,776 acres of Forest. The prescribed burning of slash would have the same effect as stated in Alternative 1.

Alternative 3

Alternative 3 would result in 64.4 acres of permanent overstory vegetation removal within the Snowbowl SUP area. The 64.4 acres of vegetation removal combined with the 9,700 acres of present and reasonably foreseeable projects within the vicinity would possibly result in the general treatment of approximately 9,764 acres of Forest. The prescribed burning of slash would have the same effect as stated for alternatives 1 and 2.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Temporary, reversible reductions in air quality would be experienced in the area as a result of construction activities. Although these impacts are irretrievable, they would only be anticipated to occur for a short duration.

3N. ENVIRONMENTAL JUSTICE

EXECUTIVE ORDER 12898

In 1994, President Clinton issued Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"[512] to ensure such populations are not subject to disproportionately[513] high levels of environmental risk. EO 12898 provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." EO 12898 makes it clear that its provisions apply fully to programs involving Native Americans. *EO 12898 does not carry the force of law*.[514]

In the memorandum to heads of departments and agencies that accompanied EO 12898,[515] President Clinton specifically recognized the importance of the procedures under NEPA for identifying and addressing environmental justice concerns. The memorandum particularly emphasizes the importance of NEPA's public participation process, directing that "each Federal agency shall provide opportunities for community input in the NEPA process." Agencies are further directed to "identify potential effects and mitigation measures in consultation with affected communities, and improve the accessibility of meetings, crucial documents, and notices."

While the Council on Environmental Quality (CEQ) has oversight of the Federal government's compliance with EO 12898 and NEPA, EO 12898 established a Federal Interagency Working Group chaired by the Environmental Protection Agency (EPA) and comprised of 11 Federal departments and agencies, as well as several White House Offices. EPA's Office of Environmental Justice, while overseeing the integration of environmental justice into EPA's policies, programs and activities, serves as the lead on the Federal Interagency Working Group to incorporate environmental justice into all Federal agencies.[516]

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[512] 59 Federal Register 7629, 1994

[513] *Disproportionately* is a generic term used to define the adverse effects of environmental actions that burden minority and/or low income populations at a higher rate than the general public.

[514] This is stated in Section 6-609 of EO 12898 *Judicial Review*, and echoed in the USDA's Departmental Regulation 5600-2 – Environmental Justice, as well as in the Council on Environmental Quality's Environmental Justice Guidance Under the National Environmental Policy Act.

> *This order is intended only to improve the internal management of the executive branch and is not intended to , nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, it agencies, it officers, or any person. This order shall not be construed to create any right to judicial review involving the compliance or noncompliance of the United States, its agencies, its officers, or any other person with this order.*

[515] Memorandum form the President to the Heads of Departments and Agencies. Comprehensive Presidential Documents No. 279 (February 11, 1994)

[516] Environmental Protection Agency, 2004

COUNCIL ON ENVIRONMENTAL QUALITY ENVIRONMENTAL JUSTICE GUIDANCE

As mentioned, the CEQ has oversight of the Federal government's compliance with EO 12898 and NEPA. The CEQ, in consultation with the EPA and other affected agencies, has developed guidance - Environmental Justice Guidance Under the National Environmental Policy Act (CEQ EJ Guidance)[517] - to further assist Federal agencies with their NEPA procedures so that environmental justice concerns are effectively identified and addressed. EO 12898 requires the development of agency-specific environmental justice strategies[518] and to the extent practicable and permitted by law, agencies may supplement CEQ guidance with more specific procedures tailored to particular programs or activities of an individual department, agency, or office. To that end, the United States Department of Agriculture (USDA) issued Departmental Regulation #5600-2[519] to provide direction to its agencies (of which the Forest Service is one) for integrating environmental justice considerations into USDA programs and activities in compliance with EO 12898. Departmental Regulation #5600-2 is discussed in more detail later in this analysis.

The CEQ EJ Guidance reflects a general consensus based on Federal agencies' experience and understanding of the issues presented. The guidance is meant to be applied with flexibility, and its terms may be considered a point of departure rather than conclusive direction in applying the terms of EO 12898.[520] As indicated by the CEQ EJ Guidance, environmental justice issues may arise at any phase within the NEPA process and agencies should consider these issues at each step of the process, as appropriate. Environmental justice encompasses a broad range of impacts covered by NEPA, including impacts on the natural or physical environment and interrelated social, cultural and economic effects. In preparing an EIS or an EA, agencies must consider both impacts on the natural and physical environment and related social, cultural and economic impacts. Environmental justice concerns may arise from impacts on the natural and physical environment, such as human health or ecological impacts on minority populations, low-income populations, and Indian tribes, or from related social or economic impacts.[521]

Agencies should recognize that the question of whether agency action raises environmental justice issues is highly sensitive to the history or circumstances of a particular community or population, the particular type of environmental or human health impact, and the nature of the proposed action itself. However, *there is no standard formula for identifying or addressing environmental justice issues.*[522] CEQ identifies six principles that provide general guidance, which are discussed later in this analysis.

EO 12898 does not change the prevailing legal thresholds and statutory interpretations under NEPA and existing case law. Under NEPA, the identification of a disproportionately high and adverse *human health* or *environmental* effect on a low-income population, minority population, or Indian Tribe does not preclude a proposed agency action from going forward, nor does it

[517] Council on Environmental Quality, 1997
[518] Executive Order No. 12898, Section 1-101
[519] USDA 1997
[520] Council on Environmental Quality, 1997. page 5
[521] Council on Environmental Quality, 1997. page 8
[522] Council on Environmental Quality, 1997. page 8

necessarily compel a conclusion that a Proposed Action is environmentally unsatisfactory. Rather, the identification of such an effect should heighten agency attention to alternatives (including alternative sites), mitigation strategies, monitoring needs, and preferences expressed by the affected community or population.[523] *Human health* and *environmental* effects, as defined by the EO 12898, are defined here.

HUMAN HEALTH EFFECTS

1. Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and
2. Whether the risk or rate of hazard of exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and
3. Whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

ENVIRONMENTAL EFFECTS

1. Whether this is or will be an impact on the natural or physical environment that significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and
2. Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority populations, low-income populations, or Native Americans that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group.
3. Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

In addition, neither EO 12898 nor CEQ guidance prescribes any specific format for examining environmental justice, such as designating a specific chapter or section in a NEPA document. Agencies are encouraged to integrate analyses of environmental justice concerns in an appropriate manner so as to be clear, concise, and comprehensible within the general format suggested in 40 CFR §1502.10.[524]

[523] Council on Environmental Quality, 1997. page 10
[524] Id.

U.S. DEPARTMENT OF AGRICULTURE ENVIRONMENTAL JUSTICE REGULATIONS

As noted previously, USDA Departmental Regulation #5600-2 provides direction to its agencies for integrating environmental justice considerations into USDA programs and activities in compliance with EO 12898. All existing and future USDA programs and activities are subject to this regulation. The USDA goals in implementing EO 12898 are as follows:[525]

1. To incorporate environmental justice considerations into USDA programs and activities and to address environmental justice across mission areas.
2. To identify, prevent, and/or mitigate, to the greatest extent practicable, disproportionately high and adverse human health or environmental effects of USDA programs and activities on minority and low-income populations.
3. To provide, to the greatest extent practicable, the opportunity for minority and low-income populations to participate in planning, analysis, and decision-making that affects their health or environment, including identification of program needs and designs.

According to this departmental regulation, an environmental justice issue arises where conduct or action may involve a disproportionately high and adverse environmental or human health effect on an identifiable low-income or minority population. The determination of whether a particular program or activity raises an environmental justice issue depends on an evaluation of the totality of the circumstances.

In determining whether there are disproportionately high and adverse environmental or human health effects, including social and economic effects, on an identifiable low-income or minority population, agencies should consider, as appropriate, such effects as: bodily impairment, infirmity, illness or death; air, noise and water pollution and soil contamination; destruction or disruption of man-made or natural resources; destruction or diminution of aesthetic values; destruction or disruption of community cohesion or a community's economic vitality, destruction or disruption of availability of public and private facilities and services; displacement of persons, businesses, farms, or nonprofit organizations; isolation, exclusion, or separation of minority or low-income individuals within a given community or from the broader community; and the denial, reduction in, or significant delay in the receipt of, benefits of USDA programs or activities. In determining if an effect on a minority and/or low-income population is disproportionately high or adverse, agencies should consider whether the adverse effect is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non-low-income population.[526]

[525] USDA, 1997. page 3
[526] USDA, 1997

CULTURAL AND DEMOGRAPHIC INFORMATION RELATED TO THE ARIZONA SNOWBOWL

In an effort to reduce repetitive discussions and to minimize bulk without impeding agency and public review of the analysis,[527] the reader is referred to Section 3A – Heritage and Cultural Resources, as well as Section 3E – Social and Economic Resources (particularly, the "Population" subheading and Table 3E-2). "Existing Conditions" in Section 3A provides detailed information on the numerous tribes, and their backgrounds, who presently and have historically lived in the Flagstaff region.

The racial distribution of Arizona, Coconino County, and Flagstaff is summarized in Table 3E-2. As evidenced, the population of Coconino County has a substantially higher percentage of American Indians than either the State or the City of Flagstaff. American Indians comprised almost 27 percent of the overall County's population in both 1990 and 2000.

DETERMINATION OF ENVIRONMENTAL JUSTICE ISSUES

In reaching a conclusion as to whether an environmental justice issue(s) exist as directly related Alternatives 1, 2, or 3, the Forest Service made the following critical assumption: EO 12898 was created in response, and intended to apply, to *quantifiable* environmental hazards (e.g., a chemical, biological, physical or radiological agent, situation or source) with the potential for deleterious effects on human health and/or the physical environment. *However*, it is clear that Environmental Justice has been further interpreted to apply to a broad range of physical, social, cultural, and economic effects that are addressed through the NEPA process, as evidenced by CEQ: [528]

> "*Environmental justice encompasses a broad range of impacts covered by NEPA, including impacts on the natural or physical environment and interrelated social, cultural and economic effects. In preparing an EIS or an EA, agencies must consider both impacts on the natural and physical environment and related social, cultural and economic impacts. Environmental justice concerns may arise from impacts on the natural and physical environment, such as human health or ecological impacts on minority populations, low-income populations, and Indian tribes, or from related social or economic impacts.*"

Tribal "culture" is defined by a complex interaction of many components, including spirituality, tradition, and the natural environment. The concepts of *spirituality* and *culture* are repeatedly used throughout Cultural Section 3A of this FEIS. These terms are used both interchangeably and independently, depending on the context being conveyed. While the terms "culture" and "social impacts" are found in the EO 12898, CEQ EJ Guidance and USDA Departmental Regulation #5600-2, the reader will note that the concept of "spirituality" is not specifically mentioned. The published DEIS relied upon a strict interpretation of the intent of EO 12898, interpreting that it was created in response to, and intended to apply, to *quantifiable*

[527] As per 40 CFR §1502.20 and 21
[528] Council on Environmental Quality, 1997. page 8

environmental hazards with the potential for deleterious effects on human health and/or the physical environment. The DEIS did not specifically recognize the interrelatedness of *culture, society,* and *spirituality* within the confines of the Heritage and Cultural Resources analysis, nor did it recognize these within the Environmental Justice analyses. The Environmental Justice analysis in the FEIS acknowledges that the San Francisco Peaks are of traditional cultural and spiritual significance to a number of Native American Tribes, and that the spiritual connections that many Native Americans have with the Peaks cannot be separated from their cultural identities, traditions, or societies. For the purposes of this analysis, "culture" is used to encompass the complex interaction of tribal traditions, spirituality, beliefs, and societies.

It is likely not possible for non-Native Americans to fully comprehend or appreciate the complex natures of the multiple tribes who hold the Peaks sacred, although the Cultural Section of the FEIS attempts to characterize this to the extent possible. While no standard formula exists for identifying or addressing environmental justice issues,[529] this Environmental Justice analysis relies on information presented in the Cultural Section, and intentionally errs on the side of full disclosure by making a determination that each of the alternatives carries with it some level of disproportionately high and adverse *environmental* effects to Native Americans who hold the Peaks sacred.[530] It is important to note that the FEIS discloses no adverse effects (as defined by NEPA) to *human health* stemming from selection of any of the alternatives. Therefore, there exists no risk or rate of hazard of exposure by a minority population, low-income population, or Indian tribe to an environmental hazard that exceeds or is likely to exceed the risk or rate to the general population or other appropriate comparison group. With that being said, this environmental justice analysis identifies no disproportionate effects to human health regarding the tribes pertaining to Alternative 1, 2, or 3. Also, it is noted that none of the alternatives discriminates among, or precludes, members of the public who wish to recreate at the Snowbowl – all members of the public (tribal and non-tribal) may use the NFS lands within the SUP area for developed winter recreation in the same manner.

In determining whether disproportionately high and adverse human health or environmental effects could result to Native American communities in relation to the Arizona Snowbowl Facilities Improvements EIS, multiple factors were taken into consideration. This environmental justice analysis heavily tiers to information presented in the Section 3A - Heritage and Cultural Resources – of the FEIS to provide context for the complex issues that surround the sacred nature of the Peaks and historic and future projects on them. EO 12898 and accompanying guidance provided in both USDA Department Regulation #5600-2 and the CEQ EJ Guidance served as the basis for this analysis. In addition, particular emphasis was placed on the following six principles for identifying and addressing environmental justice issues offered by CEQ.[531]

[529] Council on Environmental Quality, 1997. page 8

[530] This determination is consistent with the analysis presented in Section 3A, as well as guidance offered by CEQ and USDA Departmental Regulation #5600-2.

[531] Italicized text included after each of the six principals applies to alternatives 1 through 3.

1. **Consider the composition of the affected area to determine whether minority populations, low-income populations, or Indian tribes are present in the area affected by the proposed action.**

   Demographic data is presented in the Social and Economic Resources analysis presented in Section 3E, with additional information presented in the Heritage and Cultural Resources analysis in Section 3A. The composition of the affected area was considered to determine whether minority populations, low-income populations, or American Indian tribes are present in the area affected by the alternatives. As indicated, the population of Coconino County has a substantially higher percentage of American Indians than either the State or the City of Flagstaff.

2. **Consider relevant public health data and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards[532] in the affected population and historical patterns of exposure to environmental hazards.**

   The anticipated environmental impacts of all three alternatives are discussed throughout Chapter 3 of this FEIS, with particular emphasis on Section 3H – Watershed Resources. The reclaimed water produced at the Rio de Flag Water Reclamation Plant meets all pertinent state and federal water quality standards for the proposed use. The proposed use of reclaimed water for snowmaking represents a low risk of adverse environmental impact to wildlife and/or humans. Given the lack of existing research on the potential effects of endocrine disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs) on vegetation, there is insufficient information to judge the possible effects of these compounds upon plant life, although due to the hydrogeologic characteristics of the site (which result in rapid infiltration with little run-off), these effects would largely be limited to the ski trails that are already dominated by introduced grasses and forbs and the areas immediately adjacent to them.

3. **Recognize the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action. These factors should include the physical sensitivity of the community or population to particular impacts; the effect of any disruption on the community structure associated with the proposed action; and the nature and degree of impact on the physical and social structure of the community.**

   The San Francisco Peaks are sacred to at least 13 formally recognized tribes that are still actively using the Peaks in cultural, historic, and religious contexts. A central underlying concept to all tribes for whom the Peaks are especially important is the recognition that the San Francisco Peaks are a source of water in the form of rain, springs, and snow. It is believed that the Peaks were put there for the people and it is therefore the peoples' duty to protect them for the benefit of the world. Native American religions often emphasize the natural world in its entirety; every part of nature contains sacred knowledge, and the relationship of humans to every creature and place is one of kinship. The entire earth is sacred; it is seen as the source of life. Some parts of the natural world, such as the San Francisco Peaks, are accorded special reverence. These special places may be where

[532] CEQ defines "environmental hazard" as a chemical, biological, physical or radiological agent, situation or source that has the potential for deleterious effects to the environment and/or human health. (See Council on Environmental Quality, 1997. page 30)

spiritual beings or forces originated, or where they reside, or where individuals or spiritual leaders communicate with them. Thus, the relationship between native people and the land is central and indispensable to their religion, culture, and way of life.

This reinforces that, in many cases, tribal members and the general public hold opposing views on the traditional versus modern cultural significance of the San Francisco Peaks. These differences trigger disagreement over how the future of the Peaks should be managed by the Forest Service. Therefore, due to the critical roles that the Peaks play in the tribes' distinct cultural identities, Alternatives 1, 2, and 3 carry with them the potential for greater, although varying, levels of impacts to Native Americans than to the general population. It is this concept that led the Forest Service to a determination that there is a potential for disproportionately high levels of environmental risk to the tribes.

4. **Develop effective public participation strategies.**

   NEPA requires adequate opportunities for public participation.[533] Extensive tribal scoping and consultation efforts are indicated in Chapter 1. However, it was not considered practical or reasonable to hold meetings in all tribal communities. The Forest Service attempted to accommodate requests from tribes for on-site meetings. Numerous contacts were made with tribal governments, traditional practitioners and the general tribal public and include: over 200 phone calls and emails, 33 meetings (26 of which were held on reservation lands), and nearly 250 letters.

5. **Assure meaningful community representation in the process.**

   See #4 above.

6. **Seek tribal representation in the process in a manner that is consistent with the government-to-government relationship between the United States and tribal governments, the federal government's trust responsibility to federally-recognized tribes, and any treaty rights.**

   Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments," requires federal agencies to consider federal trust responsibilities and tribal rights and to provide meaningful opportunities for tribal participation in the policy-making process. The trust responsibility is unambiguous in that the welfare of American Indians and their land and its resources are entrusted to the United States. For the Forest Service, trust responsibilities are defined by executive orders, laws, and treaties that are directly related to NFS lands. There are no treaties tied to the San Francisco Peaks.

Alternative 1 – No Action

The tribes have always objected to the Snowbowl's presence, due to their belief that any disturbance of the Peaks is sacrilegious. The historic use of the Peaks for developed skiing (as well as other recreational activities), dating back to 1938, has likely had a negative impact on traditional cultural values. Per CEQ EJ Guidance for addressing environmental issues (#3, above) this analysis recognizes the interrelated cultural and social factors that may amplify the

[533] 40 CFR 1503

natural and physical environmental effects of Alternative 1. Therefore, the existing condition represents a disproportionately high and adverse environmental effect to tribes.

The basis for the determination in Alternative 1 is rooted in the fact that the San Francisco Peaks have received historic visitation and have been used for developed recreation as a direct result of the Snowbowl's existence. Visitation to the Peaks, and use of them for recreational purposes, is in conflict with the tribes' sacred relationship with the mountain.

Under Alternative 1, the spiritual values of the Peaks, identified in Section 3A, would continue as they are today. The presence of the ski area, and other recreational infrastructure, on the Peaks would continue in the existing configuration. In reaching this determination, the Forest Service recognizes that the Peaks retain much of their traditional religious, cultural, natural, and social values which make them significant to the Native Americans of the region.[534] However, historic ground and vegetation disturbances which have occurred within the SUP area may have visually and physically impacted the Peaks. Alternative 1 represents a continuation of effects to the Peaks' spiritual character and potentially the ability for tribes to perform rituals and spiritual practices and the effectiveness of those practices.

Alternative 1 represents the baseline condition for which all resources, alternatives, and this Environmental Justice analysis, are compared. Among the three alternatives analyzed in this EIS, Alternative 1 represents the least impact from an Environmental Justice perspective.

Alternative 2 – The Proposed Action

Among Alternatives 1 through 3, the Proposed Action would represent the highest degree of potential disproportionate adverse impact to Native American cultures. The obvious difference between the Proposed Action and Alternatives 1 or 3 is the initiation of the use of reclaimed water within the SUP area for the production of snow, additional ground and vegetation disturbance associated with new infrastructure, lifts and facilities, and increased visitation throughout the winter. Although the reclaimed water proposed for use in snowmaking fully meets both EPA and ADEQ water quality standards, the tribes have expressed concern that trace levels of unregulated residual constituents within reclaimed water could negatively impact the spiritual purity of the Peaks.

For example, the Hopi have expressed concern that plants that are used in ceremonies would be affected spiritually in two ways: 1) the increased water would impact the natural growth of plants, and 2) runoff from the Peaks to areas where they collect plants would not be pure, natural rainwater - thus affecting the spiritual purity of the plants. An additional concern is that reclaimed water, once passed through hospitals or mortuaries, could carry the spirits of disease, illness, and the dead with it. Those spirits, as part of the water draining from the Peaks, would then infiltrate plants, thus affecting their ritual purity.

Relevant public health data concerning the existing and proposed use of reclaimed water in Flagstaff was researched and is detailed in Section 3H. There has been no identified potential risk for multiple or cumulative exposure to human health or environmental hazards on American Indian tribes as a result of use of reclaimed water in the SUP area. Furthermore, there are no

[534] Pilles, 2003

historical patterns of exposure to environmental hazards. Reclaimed water has served a crucial role in meeting public irrigation needs in the City of Flagstaff since 1992, with no demonstrated adverse public health effects.

Thus, there has been no conclusive evidence presented to date that suggests that the presence of reclaimed water in the environment carries with it the potential for quantifiable and adverse effects to human health and/or the environment. However, it is not possible within the confines of this analysis to determine if the reclaimed water proposed for use in the snowmaking system is indeed spiritually pure. Therefore, this FEIS has chosen to acknowledge that use of reclaimed water within the SUP area has potential to represent disproportionately high and adverse environmental impact, with the potential for both cultural and social effects.

Direct, indirect, cumulative, irreversible, and irretrievable impacts to heritage and cultural resources are acknowledged in Section 3A, as attributable to historic and proposed ground disturbance, snowmaking, use of reclaimed water, etc. From a cultural/spiritual perspective, direct, indirect, and cumulative impacts to the San Francisco Peaks are unable to be completely mitigated. Through the Section 106 process, an MOA has been assembled (contained in Appendix D), identifying mitigation measures that attempt to address tribal concerns. All thirteen affected tribes were given the opportunity to have input in the MOA process. As of release of the FEIS, only the Yavapai-Prescott, Fort McDowell Yavapai Nation, Yavapai-Apache Nation and Hualapai have signed the MOA.

While no significant environmental effects (measured in risks and rates or hazard of exposure) on American Indians have been identified that would appreciably exceed or are likely to appreciably exceed those on the general population, cultural and social impacts have been identified in association with the Proposed Action that would not occur in the general population.

Alternative 3

Alternative 3 represents a disproportionately high and adverse environmental impact to Native Americans that falls somewhere between the No Action Alternative (1) and the Proposed Action (2). Alternative 3 has additional ground and vegetation disturbance amounts over Alternative 1, but more important is the potential for increased annual visitation under Alternative 3, However, annual visitation would not be as high as under the Proposed Action (2) and Alternative 3 does not include the use of reclaimed water. Though the ground and vegetation disturbance levels both remain of a great concern to tribes, it is at a lower level of concern than the use of reclaimed water.

CHAPTER 4

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CHAPTER 5

AGENCIES, ORGANIZATIONS, TRIBAL GOVERNMENTS, AND PERSONS RECEIVING COPIES OF THE FEIS

Coconino National Forest
Peaks Ranger District

5. AGENCIES, ORGANIZATIONS, TRIBAL GOVERNMENTS, AND PERSONS RECEIVING COPIES OF THE FEIS

FEDERAL GOVERNMENT

Advisory Council on Historic Preservation
Federal Highways Administration
US Army Corps of Engineers
USDA National Agricultural Library
USDA Office of Civil Rights
USDI Office of Environmental Policy and Compliance
US Environmental Protection Agency
US Fish and Wildlife Service
US House of Representatives (Arizona's 1st, 3rd, 5th, and 6th districts)

TRIBAL GOVERNMENTS

Acoma
Fort McDowell Mohave Apache
Havasupai
Hopi
Hualapai
Navajo
San Carlos Apache
San Juan Southern Paiute
Tonto Apache
White Mountain Apache
Yavapai-Apache
Yavapai-Prescott
Zuni

STATE GOVERNMENT

Arizona Department of Commerce
Arizona Department of Environmental Quality
Arizona Department of Transportation
Arizona Department of Water Resources
Arizona Fish and Game Department
Arizona House of Representatives
Arizona Office of Tourism

Arizona State Senate
State Historic Preservation Officer

LOCAL GOVERNMENT

City of Flagstaff
City of Williams
Coconino County
Coconino County Community Development
Flagstaff Tourism Commission

LOCAL MEDIA

Arizona Daily Sun

ORGANIZATIONS

Arizona Conservation Alliance
Arizona Ski Museum
Black Mesa Water Coalition
Center for Biological Diversity
Community Services
Dark Skies Group, Keep Sedona Beautiful
Dine' Medicineman's Association
Flagstaff Activist Network
Flagstaff Chamber of Commerce
Flagstaff Tourism Commission
Fort Valley Fire District Board
Gap-Bodaway Chapter
Grand Canyon Trust
Grand Canyon Wild Lands Council
Greater Flagstaff Economic Council
Icomindios Switzerland
Lowell Observatory
Maricopa Audubon Society
National Congress of American Indians
Native Americans for Community Action, Inc.
Natural Resources Conservation Service
Navajo Nation - Pinon Chapter
Page Chamber of Commerce
Pan African Forum
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CHAPTER 6
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CHAPTER 7
GLOSSARY OF TERMS

Coconino National Forest
Peaks Ranger District

7. GLOSSARY OF TERMS

303(d) - The section of the 1972 Clean Water Act that requires states, territories, and authorized tribes to develop lists of impaired waters – those that do not meet water quality standards that states, territories, and authorized tribes have set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters.

Abiotic - The non-living material components of the environment such as air, rocks, soil particles, inorganic compounds, coal, peat, and plant litter.

Accelerated erosion or **accelerated sediment production** - Erosion at a greater rate than natural, usually associated with human activities that either reduce vegetative cover or increase surface runoff.

Acre-foot - The amount of water necessary to cover one acre to a depth of one foot; equals 43,560 cubic feet or 325,851 gallons.

Action alternatives - Any alternative that includes upgrading and/or expansion of existing winter and summer recreational development within the area.

Affected environment - The physical, biological, social, and economic environment that would or may be changed by actions proposed and the relationship of people to that environment.

Age Class - An age grouping of trees according to an interval of years, usually 20. A single age class would have trees that are within 20 years of the same age, such as 1-20 years or 21-40 years.

Airshed - A geographical area that, because of topography, meteorology, and climate, shares the same air. The Clean Air Act establishes three air quality classes (I, II, and III), each with defined air quality standards.

> **Class I airsheds** are areas designated for the most stringent degree for protection from future degradation of air quality.
> **Class II airsheds** are areas where a moderate amount of development could occur.
> **Class III airsheds** are areas where significant development could occur as long as National Ambient Air Quality Standards are not exceeded.

Alpine tundra - A vegetation type that occurs above treeline characterized by extreme environmental conditions, including high winds, cold temperatures, and often seasonally dry moisture regimes.

Alternative - One of several conceptual development plans described and evaluated in the EIS.

Anthropogenic - relating to or resulting from the influence humans have on the natural world.

Army Corps of Engineers (COE) -The federal agency charged with enforcing the Clean Water Act by regulation of dredge and fill activities in wetlands.

Archaeological Site - A geographic locale that contains material remains of prehistoric and/or historic human activity. Also referred to as a cultural or heritage resource site.

Artifact - A simple object (such as a tool or ornament) showing early human workmanship or modifications.

Assessment area - The geographical area and/or physical, biological, and social environments which are analyzed for specific resources in the EIS.

Aspect - The direction a slope faces. A hillside facing east has an east aspect.

Backcountry - An undeveloped area where dispersed, off-road recreation such as hiking and trail bike riding may occur. Generally describes semi-private motorized and semi-primitive non-motorized recreation opportunities.

Background - A landscape viewing area visible to a viewer from approximately three to five miles to infinity. Also, in economics, naturally occurring; uninduced.

Bark Beetles - A group of beetles that can kill live trees by boring galleries and girdling the inner bark.

Basal Area - The cross-sectional area of the trunk of a tree or stand of trees at breast height (4.5 feet).

Baseline condition - The existing dynamic conditions prior to development, against which potential effects are judged.

Best Management Practices (BMPs) - A practice or a combination of practices that are determined by a State or a designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling non-point source pollutants at levels compatible with water quality goals. (R3 Soil and Water Conservation Practices Handbook (R3 supplement to FSH 2509.22).

Big game - Those species defined by law which are managed as a sport hunting resource, such as mule deer, turkey, elk, bear, and mountain lion.

Biodiversity - The variety of biotic communities, species, and genes and their interaction with ecological processes and functions, within ecosystems and across landscapes. The number of species present is the basic unit of measurement. More complex measurements also exist.

Biological Evaluation -An evaluation conducted to determine whether a proposed action is likely to affect any species which are listed as sensitive (USFS), candidate (USFS), or other special designations.

Biological Oxygen Demand - a measure of the pollution present in water, obtained by measuring the amount of oxygen absorbed from the water by the microorganisms present in it.

Browse - Leaf and twig growth of shrubs, woody vines and trees available for animal consumption; act of consuming browse.

Buffer - A land area that is designated to block or absorb unwanted impacts to the area beyond the buffer. Buffer strips along a trail could block views that are undesirable. Buffers along streams can greatly reduce any changes or impacts to stream water quality, temperature, or channel stability.

Candidate species - Those plant and animal species that, in the opinion of the U.S. Fish and Wildlife Service, may become threatened or endangered. Not protected under the Endangered Species Act.

Canopy - The more-or-less continuous cover of leaves, needles and/or branches collectively formed by the crowns of adjacent trees in a stand or forest.

Capability - The potential of an area of land to produce resources, supply goods and services, and allow resource uses under an assumed set of management practices and at a given level of management intensity. Capability depends upon current conditions and site conditions such as climate, slope, landform, soils, and geology, as well as the application of management practices such as silviculture or protection from fire, insects, and disease.

Carrying Capacity - The number of organisms of a given species and quality that can survive in, (and not cause deterioration of), an ecosystem through the least favorable environmental conditions that occur within a stated interval of time.

Cavity - A hole in a tree often used by wildlife, especially birds, for nesting and reproduction.

Clean Water Act - An act that was enacted by the U.S. Congress in 1977 to maintain and restore the chemical, physical, and biological integrity of the waters of the United States. This act was formerly known as the Federal Water Pollution Control Act (33 U.S.C. 1344).

Coarse Woody Debris (CWD) - Snags, fallen trees, and decaying logs and large limbs distributed across the forest floor that are larger than three inches in diameter.

Comfortable carrying capacity (CCC) - Comfortable Carrying Capacity (CCC) is a planning tool used to determine the optimum level of utilization that facilitates a pleasant recreational experience. This is a planning figure only and does not represent a regulatory cap on visitation. CCC is used to ensure that different aspects of a resort's facilities are designed to work in harmony, that capacities are equivalent across facilities, and sufficient to meet anticipated demand. CCC is based on factors such as vertical transport and trail capacities.

Compaction - A physical change in soils properties that that results when pore spaces are reduced in size and soil becomes more dense. Compaction generally occurs when a load is applied to the soil, such as when heavy equipment makes several passes that compress the soil.

Connectivity - The degree to which similar but separated vegetation components of a landscape are connected.

Consumptive use - Use of a resource that reduces the supply.

Cooperating agency - A federal agency, other than a lead agency, which has jurisdiction by law or special expertise with respect to any environmental impact associated with the proposed action or one of the alternatives. A state or local agency or an Indian tribe may be a cooperating agency with agreement from the lead agency.

Corridor - A linear strip of land identified for the present or future location of transportation or utility rights-of-way within its boundaries. Also, a contiguous strip of habitat suitable to facilitate animal dispersal or migration.

Council on Environmental Quality (CEQ) - An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Cover - Vegetation used by wildlife for protection from predators and weather conditions, or in which to reproduce.

Critical habitat - A formal designation pursuant to the Endangered Species Act which may be applied to a particular habitat that is essential to the life cycle of a given species, and if lost, would adversely affect that species. Critical habitat can have a less formal meaning when used outside the context of the Endangered Species Act.

Cultural resource - Cultural resources are the tangible and intangible aspects of cultural systems, living and dead, that are valued by a given culture or contain information about the culture. Cultural resources include, but are not limited to sites, structures, buildings, districts, and objects associated with or representative of people, cultures, and human activities and events.

Cumulative effect - The effect on the environment which results from the incremental impact of the action when added to other past, present and reasonable foreseeable future actions regardless of what agency or person undertakes such other actions. Each increment from each project may not be noticeable but cumulative effects may be noticeable when all increments are considered together.

Demand - The quantity of goods or services called for, given a price of other combinations of factors.

Desired condition - In a project analysis document, the forest-wide desired future condition as applied to a specific project area and modified to fit the site-specific conditions of that area.

Developed recreation site - An area with characteristics that enable to accommodate, or be used for intense recreation. Such sites are often enhanced to augment the recreational value. Improvements range from those designed to provide great comfort and convenience to the user to rudimentary improvements in isolated areas.

Direct effect - An effect which occurs as a result of an action associated with implementing the proposal or one of the alternatives, including construction, operation, and maintenance.

Dispersed recreation - Recreation that occurs outside of a developed recreation site and includes such activities as scenic driving, hunting, backpacking, and recreation activities in primitive environments.

Distance zone - One of three categories used in the visual management system to divide a view into near and far components. The three categories are (1) foreground, (2) middle ground, and (3) background. See individual entries.

District Ranger -The official responsible for administering the National Forest System lands on a Ranger District.

Diversity - The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Ecosystem - The system formed by the interaction of a group of organisms and their environment, for example, marsh, watershed, or lake.

Edge - The interface between landscape elements of different composition and structure, for example between an old clearcut and a closed-canopy forest.

Effects - Results expected to be achieved from implementation of the alternatives relative to physical, biological, economic, and social factors. Effects can be direct, indirect, or cumulative and may be either beneficial or detrimental.

Endangered species -An official designation for any species of plant or animal that is in danger of extinction throughout all or a significant portion of its range. An endangered species must be designated in the Federal Register by the appropriate Federal Agency Secretary.

Environmental analysis - An analysis of alternative actions and their predictable short and long-term environmental effects, which include physical, biological, economic, social and environmental design factors and their interactions.

Environmental Impact Statement (EIS) - A disclosure document required by the National Environmental Policy Act (NEPA) that documents the anticipated environmental effects of a proposed action that may significantly effect the quality of the human environment.

Environmental Protection Agency (EPA) - The federal agency charged with lead enforcement of multiple environmental laws, including review of Environmental Impact Statements.

Erosion - The detachment and movement of soil from the land surface by wind, water, ice, or gravity.

Erosion control - Materials, structure, and techniques designed to reduce erosion. Erosion control may include rapid revegetation, avoiding steep or highly erosive sites, and installation of cross-slope drainage structures.

Erosion hazard - Soil ratings to predict the erosion hazard or potential to be eroded.

Evapotranspiration - the water removed from our soils by soil evaporation (a direct pathway for water to move from soil to the atmosphere as water vapor) and plant transpiration (evaporation of water from leaf and plant surfaces).

Fill - Earth or rock moved during road construction and used to build up portions of the roadway.

Fill slope - The sloping earth surface on the downhill side of a road resulting from roadway excavation.

Finding of No Significant Impact (FONSI) - A document that is prepared if the agency finds, in an environmental assessment, that the proposed action will not significantly affect the human environment. It must set forth the reasons for such a decision.

Forage - All browse and non-woody plants used for grazing or harvested for feeding livestock or game animals.

Forb - Any non-grass-like plant having little or no woody material on it. A palatable, broadleaved, flowering herb whose stem, above ground, does not become woody and persistent.

Foreground - The landscape area visible to an observer from the immediate area to .5 miles.

Forest Plan -A comprehensive management plan prepared under the National Forest Management Act of 1976 that provides standards and guidelines for management activities specific to each National Forest. The CNF Forest Plan was approved in 1987.

Forest Service -The agency of the United States Department of Agriculture responsible for managing National Forests and Grasslands.

Forest Supervisor -The official responsible for administering the National Forest System lands in a Forest Service administrative unit who reports to the Regional Forester.

Fragmentation - The splitting or isolating of patches of similar habitat. Habitat can be fragmented by natural events or development activities.

Fuel - Any substance or composite mixture susceptible to ignition and combustion.

Game species - Any species of wildlife or fish for which seasons and bag limits have been prescribed and which are normally harvested by hunters, trappers, and fisherman under State or Federal laws, codes, and regulations.

GIS - geographic information system, a computer mapping system composed of hardware and software

GPS - Global Positioning System, a satellite-based surveying system

Gradient - The vertical distance divided by the horizontal distance, usually measured as percent. Gradient is used to describe streams and ski slopes.

Groundwater - Subsurface water in the part of the ground that is wholly saturated.

Habitat - The sum of environmental conditions of a specific place that is occupied by an organism, a population, or a community.

Habitat type - A classification of the vegetation resource based on dominant growth forms. The forested areas are more specifically classified by the dominant tree species.

Hydrologic cycle - Also called the water cycle, this is the process of water evaporating, condensing, falling to the ground as precipitation, and returning to the ocean as runoff.

Impacts - See effects

IMPLAN - An economic impact assessment modeling system.

Indicator species - An animal species used to represent a group of species that utilize the same habitat. For monitoring purposes, the well being of the indicator species is assumed to reflect the general health of the community.

Indirect impact - Secondary consequences to the environment resulting from a direct impact. An example of an indirect impact is the deposition of sediment in a wetland resulting from surface disturbance in the upland.

Instream flow - The volume of surface water in a stream system passing a given point at a given time.

Interdisciplinary Team (ID Team) - A group of individuals each representing specialty resource areas assembled to solve a problem or perform a task through frequent interaction so that different disciplines can combine to provide new solutions.

Irretrievable commitments - losses of production or use for a period of time. An example is suited timber land being used for a skid trail. Timber growth on the land is irretrievable lost while the land is a skid trail, but the timber resource is not irreversibly lost because the land could grow trees again in the near future.

Irreversible commitments - Permanent or essentially permanent resource uses or losses that cannot be reversed, except in the extreme long term. Examples include minerals that have been extracted or soil productivity that has been lost.

Issue - A public or agency concern about a specific action or area that is addressed in the NEPA process.

Landscape – A heterogeneous land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout.

Lop and scatter - When branches are cut from fallen trees and scattered over the area rather than piled for burning. This allows the slash to lie close to the ground to reduce the fire hazard and accelerate decomposition.

Management area - An area of land with similar management goals and a common management prescription, as described in the Forest Plan.

Management direction - A Forest Plan statement of multiple-use and other goals and objectives, the associated management prescriptions, and standards and guidelines for attaining them.

Management emphasis - Long-term management direction for a specific area or type of land.

Management indicator species (MIS) - A representative group of species that are dependant of a specific habitat type. The health of an indicator species is used to gauge function of the habitat on which it depends.

Management practice - A specific activity, measure, course of action, or treatment.

Mass wasting - The movement of unstable soils and geologic formations, which can be exacerbated through construction on sites prone to movement.

Master Development Plan (MDP) - A document that is required as a condition of the ski area term special use permit, designed to guide resort planning and development and avoid piecemeal decision making.

Merchantable (timber) - Meeting standards for minimum size and soundness.

Middle ground - The landscape area visible to a viewer from .5 miles to about three to five miles.

Mitigation - Actions taken to avoid, minimize, reduce, eliminate, or rectify the adverse environmental impacts associated with the implementation of an alternative or a portion thereof.

Modification - See visual quality objectives.

Monitoring - The process of collecting information to evaluate if objectives and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned.

National Ambient Air Quality Standards (NAAQS) - Established under the Clean Air Act of 1963, there are primary standards, designed to protect public health, and secondary standards, designed to protect public welfare from known or anticipated air pollutants.

National Environmental Policy Act (NEPA) - A law enacted by Congress in 1969 that requires federal agencies to analyze the environmental effects of all major federal activities that may have a significant impact on the quality of the human environment.

National Forest Management Act (NFMA) - A law passed in 1976 as an amendment to the Forest and Rangeland Renewable Resources Planning Act that requires the preparation of regulations to guide that development.

National Forest System (NFS) lands - National Forests, National Grasslands, and other related lands for which the Forest Service is assigned administrative responsibility.

National Historic Preservation Act (NHPA) - An act that was enacted by the U.S. Congress in 1966 to protect historic sites and artifacts (16 U.S.C. 470). Section 106 of the Act requires consultation with members and representatives of Indian tribes.

National Register of Historic Places - A listing maintained by the National Park Service of areas which have been designated as historically significant. The register includes places of local and state significance, as well as those of value to the nation in general.

No action alternative - The management direction, activities, outputs, and effects that are likely to exist in the future if the current trends and management would continue unchanged. Under NEPA, it means following the current approved Forest Plan management direction and guidance.

Noxious weed - A designated plant species that causes negative ecological and economic impacts to both agricultural and NFS lands.

Objective - A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals.

Obliteration - The treatment of a disturbed area with the objective of returning productivity and hydrologic function to as near to natural conditions as possible.

Off-piste - Skiable terrain that is not associate with the formal trail network, typically including gladed, open-bowl, chute, and other advance dot expert terrain types

Old growth - A stand that is past full maturity and showing signs of decadence; the last stage in forest succession. Although the tree age, size, height, or density will vary by timber type, trees are usually 21" or larger dbh and 150 years or older.

Overstory - The canopy or uppermost layer of the forest.

Partial retention - See visual quality objectives.

Particulates - Small particles suspended in the air and generally considered pollutants.

Permit area - See Special Use Permit Area.

pH - A numeric value used to represent the acidity or alkalinity of an aqueous solution. The Ph scale ranges from 0 (acidic) to 14.0 (basic); 7.0 is a neutral solution.

Pharmaceuticals and personal care products (PPCPs) - PPCPs comprise a very broad, diverse collection of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, fragrances, cosmetics, sun-screen agents, diagnostic agents, nutraceuticals, biopharmaceuticals, and many others. This broad collection of substances refers, in general, to any product consumed by individuals for personal health or cosmetic reasons.

Pile and burn - Natural or activity fuels that are piled by hand or with equipment and then burned. Fuels are piled in openings where fire spread can be controlled and heat will do minimal damage to surrounding trees.

Pod - The area comprising a lift and associated trails.

Preferred alternative - The alternative selected from the range of alternatives which is favored by the lead agency.

Prehistoric - The period prior to a written record, and may include emigrant exploration, trappers, miners, etc., but generally refers to the previous Native American (aboriginal) occupants of the area, who kept no written records.

Prescribed burning - The intentional application of fire to wildland fuels under predetermined conditions. This allows the fire to be confined to a specific area while producing the amount of heat and fuel consumption required to achieve planned objectives. These objectives are usually fuel reduction, site preparation for regeneration, or wildlife habitat management.

Project area - The area encompassed by the development proposal including base area and the permit area.

Proponent - The individual or business who is proposing the development. In this case, the proponent is Arizona Snowbowl Resort Limited Partnership, Inc.

Proposed action - A proposal made by the Forest Service to authorize, recommend, or implement an action to meet a specific purpose and need.

Recreational Opportunity Spectrum (ROS) - A means of classifying and managing recreation opportunities based upon physical setting, social setting, and managerial setting. The six different ROS classes briefly described are as follows:

a. Primitive (P) - An area three miles or more from roads and trails with motorized use; generally 5,000 acres or more in an essentially unmodified natural environment.
b. Semi-Primitive Non-motorized (SPNM) - An area 1/2 mile from roads and trails with motorized use; generally 2,500 to 5,000 acres with only subtle modifications to an otherwise natural setting.
c. Semi-Primitive Motorized (SPM) - Same as semi-primitive non-motorized but with motorized use; generally 2,500 to 5,000 acres with only subtle modifications to an otherwise natural setting.
d. Roaded Natural (RN) - An area 1/2 mile or less from roads; resource modifications range from evident to strongly dominant.
e. Rural (R) - The setting is substantially modified with structures or other cultural modifications.
f. Urban (U) - The setting is strongly dominated by structures, highways and streets.

Record of Decision (ROD) - A document prepared within 30 days after the final EIS is issued which states the agency's decision and why one alternative was favored over another, what factors entered into the agency's decision, and whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why not.

Rational Method - The stormflow estimation method that uses a runoff coefficient, uniform rainfall intensity and drainage area to estimate peak stormflow from a small watershed.

Recreation visitor day (RVD) - Twelve hours of recreation use in any combination of persons and hours (i.e. one person for 12 hours, three persons for four hours, etc.).

Revegetation - The re-establishment and development of self-sustaining plant cover. On disturbed sites, this normally requires human assistance such as seedbed preparation, reseeding, and mulching.

Revegetation potential - The ability or capacity of a site to be revegetated after a disturbance, which often depends on the quantity and quality of topsoil remaining in place

Roadless area - A National Forest area which satisfies the following criteria -a) larger than 5,000 acres or, if smaller than 5,000 acres, contiguous to a designated wilderness or primitive area, b) contains no roads and, c) has been inventoried by the Forest Service for possible inclusion in the Wilderness Preservation System.

Scenery Management System (SMS) - A system designed for the inventory and analysis of the aesthetic values of NFS lands. The SMS evolved from and replaces the VMS defined in Agricultural Handbook #462. The SMS provides for improved integration of aesthetics with other biological, physical and social/cultural resources in the planning process.

Scoping process - A process that determines the issues, concerns, and opportunities which should be considered in analyzing the impacts of a proposal by receiving input from the public and affected agencies. The depths of analysis for these issues identified are determined during scoping.

Section 7 consultation - Consultation required by the Endangered Species Act with the appropriate jurisdictional agency for a listed species.

Sediment - Solid material, both organic and mineral, that has been transported from its site of origin by air, water, or ice.

Sensitive species - Species which have appeared in the Federal Register as proposed additions to the endangered or threatened species list; those which are on an official State list or are recognized by the Regional Forester to need special management in order to prevent them from becoming endangered or threatened.

Seral - The unique characteristics of a biotic community that is a developmental, transitory stage in an orderly ecological succession involving changes in species, structure, and community processes with time.

Significant impact - A somewhat subjective judgement based on the context and intensity of the impact. Generally, a significant impact is one that exceeds a standard, guideline, law, or regulation.

Silviculture - The care and tending of stands of trees to meet specific objectives.

Silvicultural prescription - The method selected to manage a forest stand. Silvicultural prescriptions are broken into several broad types, including even-aged and uneven-aged.

Sites - Any place of past human activity.

Skiers-at-one time (SAOT) - A term used to measure recreation capacity which means the number of skiers that can use a facility at one time. See also Comfortable Carrying Capacity.

Skier visit - Skier visitor day. One visitor day equals one lift ticket sold.

Skidding - Dragging logs from the stump to a collective point.

Snag - A standing dead tree.

Soil - A dynamic natural body on the surface of the earth, in which plants grow, composed of mineral and organic materials and living forms.

Soil productivity - The capacity of a soil for producing plant biomass under a specific system of management. It is expressed in terms of volume or weight/unit area/year.

Special Use Permit (SUP) - A legal document, similar to a lease, issued by the U.S. Forest Service. These permits are issued to private individuals or corporations to conduct commercial operations on National Forest System lands. They specify the terms and conditions under which the permitted activity may be conducted.

Stand - A community of trees or other vegetation, which is sufficiently uniform in composition, constitution, age, spatial arrangement, or condition to be distinguishable from adjacent communities and to thus, form a management entity.

Study area - The geographical area that was analyzed to predict the possible effect that may be associated with proposed alternatives. This area varies depending on the resource, but often coincides with the special use permit boundary.

Sublimation - The changing from a solid to a gaseous state or from a gaseous to a solid state without becoming a liquid.

Subwatershed -A subdivision within a watershed.

Succession -The replacement in time of one plant community with another.

Threatened species - Any species which is likely to become an endangered species within the foreseeable future and which has been designated in the Federal Register as a threatened species.

Understory - Low-growing vegetation (herbaceous, brush or reproduction) growing under a stand of trees. Also, that portion of trees in a forest stand below the overstory.

U. S. Fish and Wildlife Service (USFWS) - The agency of the Department of the Interior responsible for managing wildlife, including non-ocean going species protected by the Endangered Species Act.

Viability - The ability of a wildlife or plant population to maintain sufficient size so that it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a specific population for a specified period.

Visual Management System (VMS) - As defined in Agricultural Handbook #462, provides a method for setting measurable objectives for the management of the visual resource. It provides standards for inventorying the visual resource and documenting changes in the landscape.

Visual quality - Describes the degree of variety in the landscape, created by the basic vegetative patterns, landform, and water forms. Landscapes with the greatest variety or diversity have the greatest potential for high scenic value or visual quality.

Visual Quality Objective (VQO) - A set of measurable maximum levels of future alteration of a characteristic landscape. These levels are as follows:

1. Preservation (P) - Ecological change only here.
2. Retention (R) - Human activities are not evident to the casual Forest visitor.
3. Partial Retention (PR) - Human activity may be evident but must remain subordinate to the characteristic landscape.
4. Modification (M) - Human activity may dominate the characteristic landscape, but must, at the same time, follow naturally established form, line, color, and texture. It should appear as a natural occurrence when viewed in the foreground or middle ground.
5. Maximum Modification (MM) - Human activity may dominate the characteristic landscape but should appear as a natural occurrence when viewed as background.
6. Enhancement (E) - A short-term management alternative which is done with the express purpose of increasing positive visual variety where little variety now exists.

Visual resource - The composite of basic terrain, geologic features, water features, vegetative patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for visitors.

Water quality - Refers to the chemical, physical, or biological characteristics that describe the conditions, of a river, stream, or lake.

Water Rights - The legal right to use water.

Watershed - The entire area that contributes water to a drainage system or stream.

Wilderness - Under the 1964 Wilderness Act, wilderness is undeveloped federal land retaining its primeval character and influence without permanent improvements of human habitation. It is protected and managed so to preserve its natural conditions.

Winter Range - That part of the home range of a species where 90 percent of the individuals are located during the winter at least five out of ten winters.

WRENSS - The Environmental Protection Agency's Handbook *An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources* (WRENSS).

WRNSHYD - The PC computerized version of Chapter III – Hydrology of the WRENSS Handbook.

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APPENDICES

A: Conceptual Snowmaking Water Impoundment Design

B: Proposed Forest Plan Amendment

C: Cumulative Effects Table

D: Memorandum of Agreement Between the USDA Forest Service, Advisory Council on Historic Preservation, and the Arizona State Historic Preservation Officer

Coconino National Forest
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APPENDIX A – CONCEPTUAL SNOWMAKING WATER IMPOUNDMENT DESIGN

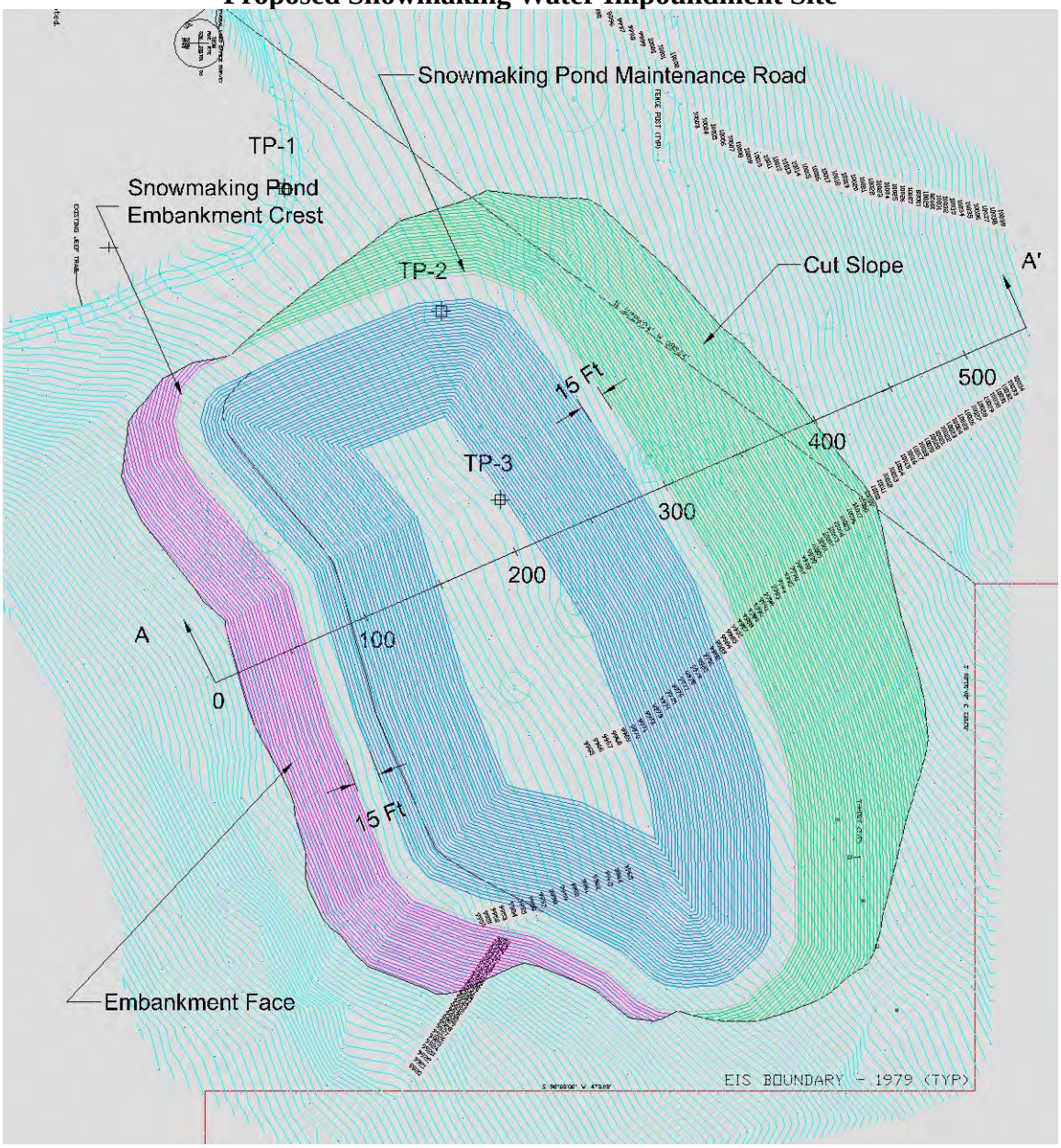
In order to complete a proper stability analysis and dam breach model, it is necessary to prepare a conceptual design layout of the snowmaking water impoundment facility.

DESIGN LAYOUT

The snowmaking water impoundment is proposed to be located just below (and to the south of) the ridgeline along the southern edge of the SUP area – near the top terminal of the existing Sunset Chairlift. The proposed impoundment is to be a geosynthetic lined pond with an earthen embankment. Figure A-1 shows the approximate layout of the pond and embankment. The conceptual design assumes a 15-foot wide embankment crest and a 15-foot wide access road around the perimeter of the pond for maintenance access. The crest elevation is 9,957 feet above AMSL. The impoundment floor is at 9,922 feet above AMSL, with 2:1 (horizontal to vertical) side slopes. The downstream face of the embankment is also at 2:1.

Approximate dimensions of the snowmaking impoundment are 1.9 acres in surface area with a maximum depth (floor to crest of the embankment) of 35 feet.

Figure A-1
Proposed Snowmaking Water Impoundment Site

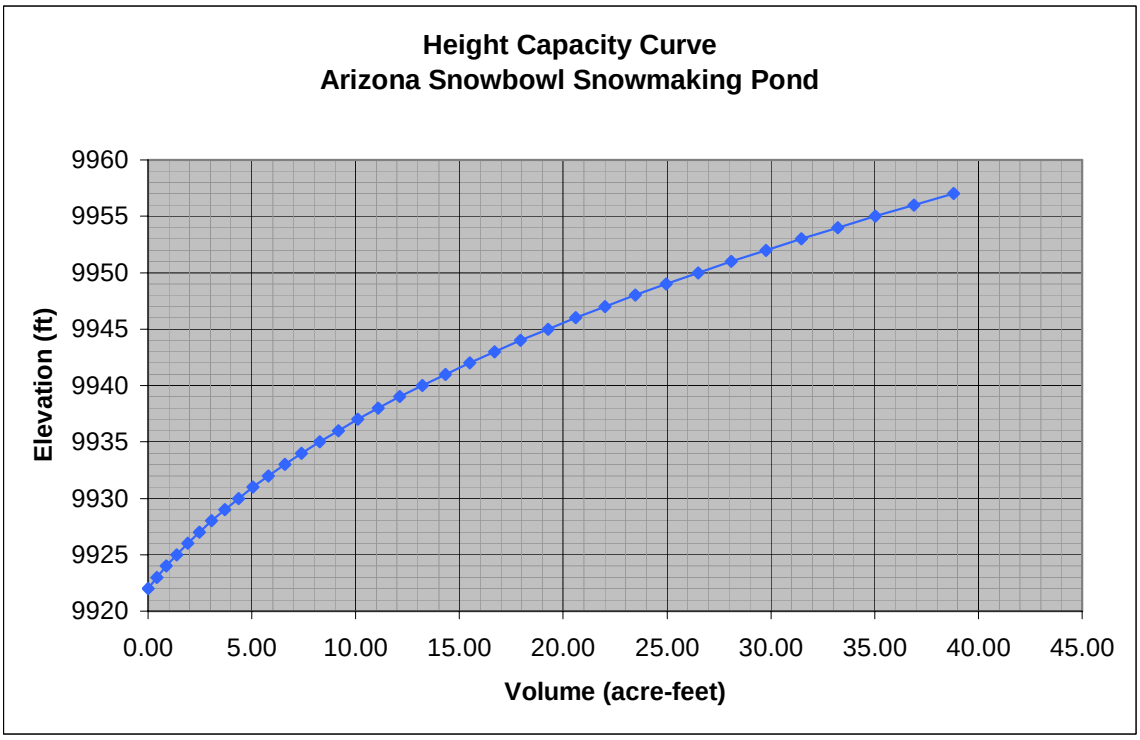


The embankment height from crest to toe is 24.5 feet. Maximum possible storage (to the embankment crest) is 38.8 acre feet. This makes the structure a non-jurisdictional dam in the State of Arizona. (less than 25-foot crest to toe embankment height and less then 50 acre feet of storage). Although the structure would not have to be permitted as a jurisdictional dam, the State of Arizona would still have a notification requirement.

It is assumed that the embankment would be a simple, homogeneous embankment and that all materials used in the embankment construction would be generated on site from excavation in

the proposed impoundment area. Based on the layout shown in Figure A-1, and the assumptions described above, the pond excavation would generate approximately 120,880 bank cubic yards (CY) of debris. Assuming a 15 percent shrinkage factor during compaction, the embankment would require approximately 12,300 CY of debris for construction. This produces an excess of cut on the order of 108,580 CY that would need to be disposed of in grading operations elsewhere – either on- or off-site. Soils encountered in the test pit excavations contained cobbles and boulders ranging from five percent to 20 percent of the excavated volume. Cobbles eight inches and larger must be excluded from any fill material used in dam embankment construction due to compaction restrictions and the overall percentage of cobbles (particles over three inches in diameter) must be such that cobbles are not allowed to nest (group together). Therefore, some processing of fill material should be anticipated during construction. Due to the large imbalance in cut to fill volumes, it is not anticipated that any difficulty would be encountered in creating a sufficient volume of fill material meeting gradation specifications for compaction. Due to the depth of excavation required to achieve storage of 10,000,000 gallons of water, it should be anticipated that excavation would encounter zones of large boulders, weathered bedrock requiring ripping for removal, and, in the deepest portions of the pond, hard, unweathered bedrock that could require blasting for removal.

Figure A-2
Snowmaking Pond Height Capacity Curves



The recommended liner would be a 60 mil High Density Polyethylene (HDPE). Since the impoundment would store only clear water with no undesirable constituents, there are no environmental consequences to leakage (with respect to water quality). Therefore, a composite liner system (HDPE overlying a compacted clay bedding layer) would not be necessary and the local sand could be used as bedding for the HDPE liner. Any bedrock, boulders, or cobbles

exposed during the pond excavation should be removed and/or covered with not less than six inches of sand with not more than 30 percent by weight gravel sizes and a maximum particle size not greater than ¾-inch. It is not necessary to protect HDPE from ultraviolet light, although covering the plastic may further extend its useful life.

Exposed plastic on a 2:1 slope presents a problem for wildlife. The water in the impoundment would almost certainly attract local wildlife that would attempt to drink at the edge. The plastic is very slippery and animals can easily slip into the pond. Once they are in the water it is almost impossible for them to climb back out of the impoundment and drowning is likely. This hazard can be mitigated by fencing wildlife out (although the smaller animals are difficult to exclude in this way). An alternative to fencing is to cover the plastic with soil. However the interface friction between HDPE and soil is commonly in the range of 14° to 18° and soil will not stay on the surface of a 2:1 slope (26.5°) or even at a 3:1 slope (18.4°). An expandable geocell grid filled with the local sand and gravel would keep the soil in place and provide a surface conducive to both wildlife and operating personnel. The geocell surface would also provide a buffer against the greatest post-construction puncture risk which is ice loading.

This storage facility will require an Operation & Maintenance inspection by a qualified Forest Service engineer on an annual basis. Timing of said inspection shall be such to allow correction of discovered safety deficiencies prior to the immediately following season of operation. Inspection criteria shall be according to current safety criteria and engineering state-of-art judgment, and manual FSM 7500 direction. In addition, there shall be completed within three calendar days after any event of any unusual event; such as an earthquake of Richter magnitude 5.0 or greater within a twenty-mile radius of the event epicenter, in the event of an overtopping event, or at the discretion of the Forest Service. The Forest Service shall be notified by the facility owner/operator in the event of any unusual facility operational behavior or physical characteristic.

SITE INVESTIGATION

Three test pits were excavated at the site of the proposed snowmaking water impoundment using a small backhoe. The location of each test pit (TP1, TP2 and TP3) is shown on Figure A-1. The test pits permitted inspection of the near surface soil profile and the sampling of the on-site soils for laboratory testing.

The observed soil profiles would be described as follows:

TEST PIT #1

- 0 to two feet - Loose to medium dense, fine to medium grained well graded to silty sand (SM), brown, colluvial soil with root mass (scattered roots to three feet) and three to eight inches of poor topsoil.
- Two to 10 feet – Medium dense to dense, fine to medium grained well graded to silty sand (SM), brown, colluvial soil with occasional cobbles and boulders (less than five percent).
- Refusal hard silty fine sand, gray (weathered rock) at 10 feet.

TEST PIT #2

- 0 to 1.2 feet - Loose to medium dense, fine to medium grained well graded to silty sand (SM), brown, colluvial soil with root mass (scattered roots to three feet) and eight to 12 inches of topsoil.
- 1.2 to 10 feet – Medium dense to dense, fine to medium grained well graded to silty sand with gravel (GC/GM), brown, colluvial soil with cobbles and boulders (15% +/-). Cobbles and boulders range from three inches to 18 inches in diameter, six inches diameter typical. Increasing clay content with depth.
- Refusal on boulders and weathered rock at 10 feet.

TEST PIT #3

- 0 to 2.5 feet - Loose to medium dense, fine to medium grained well graded to silty sand (SM), brown, colluvial soil with root mass (scattered roots to three feet) and eight to 12 inches of topsoil.
- 2.5 to eight feet – Medium dense to dense, fine to medium grained well graded to silty sand with gravel (GM), brown, colluvial soil with cobbles and boulders (20 percent +). Cobbles and boulders range from three inches to 36 inches in diameter, 12 inches diameter typical. Nested boulders at four to five feet.
- Refusal on boulders and weathered rock at eight feet.

Bulk samples of the colluvial soil were obtained from each test pit and submitted for particle size analysis/plasticity testing. All samples were found to be non-plastic (no significant clay content) with the exception of TP2 which contained measurable amounts of a low plasticity clay (Liquid Limit (LL) of 23 and Plasticity Index (PI) of 6). Particle size analyses include two samples from test pits excavated at an alternate site located to the southwest and at significantly lower elevation (the glade site). Soils at this alternate site were similar but somewhat finer grained.

SITE HYDROLOGY

Detailed design of spillways and other hydraulic control structures is beyond the scope of this study. The proposed snowmaking water impoundment site is located near the ridgeline and has only a very small contributing area upslope. A 15-foot wide roadway required for construction and maintenance is proposed to completely surround the impoundment. A small diversion ditch along the outside edge of this road would intercept and completely remove any flow from the very small basin upstream of the impoundment. Therefore, there is not anticipated to be a significant contribution of runoff to the impoundment from upslope areas. A small emergency spillway structure should be included in the southeastern abutment of the embankment to protect the structure against overtopping from operator errors or equipment failures during impoundment filling and from direct precipitation within impoundment limits during extreme events.

SLOPE STABILITY

Slope stability models were developed and analyzed for the downstream embankment of the snowmaking water impoundment site. While site-specific laboratory testing of the on-site soils for shear strength parameters has not been performed, for this conceptual level design effort, conservative assumptions have been made for the shear strength parameters. The following shear strength characteristics have been assigned:

- For the native non-plastic sands above the weathered bedrock surface, a friction angle of 28° and cohesion of 500 pounds per square foot (psf).
- For the compacted sands in the pond embankment, a friction angle of 30° and cohesion of 800 psf.
- For zones containing nested boulders and weathered bedrock, a friction angle of 45° and cohesion of 500 psf.
- For the bedrock materials, no specific shear strength was assigned, however, failure surfaces were constrained from penetrating the bedrock surface.

Analyses were performed using a computer assisted limit equilibrium model called SLOPE/W. The slope stability analysis that was performed indicates that the required stability criteria are met by all of the conditions analyzed.

The stability results for the observed range of conditions on site (a slope range of five to 50 percent, 20 to 40 percent typical) indicate that the Snowbowl's trails are very stable, even at the upper slope range of 50 percent. High artesian pressures would be required to induce instability in the soil layer, even at a grade of 50 percent. The presence of an abundance of woody vegetation tends to increase the stability of near surface, shallow slopes due to the reinforcing effect of root structure.

APPENDIX B – PROPOSED FOREST PLAN AMENDMENT

FOREST SERVICE DIRECTION FOR AMENDING FOREST PLANS

Forest Service requirements for amending forest plans are included in agency regulations and policies. These require that proposed activities be consistent with forest plans and that proposed activities which may be in conflict with the Forest Plan either be denied, modified (so as to be consistent), or that the Forest Plan be amended. Regulations at 36 CFR 219.10(f) direct the Forest Service to consider whether a proposed amendment to a forest plan would be considered a significant change.

The Forest Service is authorized to implement amendments to forest plans in response to changing needs and opportunities, information identified during project analysis, or the results of monitoring and evaluation. The process to consider Forest Plan amendments, review them for significance, document results, and reach a decision is contained in Forest Service Manual (FSM) 1922 and Forest Service Handbook (FSH) 1909.12, Chapter 5. An assessment of a proposed amendment's significance in the context of the larger Forest Plan is a crucial part to the process. It is important to note that the definition of significance for amending a forest plan (36 CFR 219.10(f) and FSH 1922.5) is not the same significance as defined by NEPA. Under NEPA, significance is determined by whether a proposal is considered to be a "major federal action significantly affecting the quality of the human environment,"[1] or whether the relative severity of the environmental impacts would be significant based on their context and intensity.[2]

In contrast, the National Forest Management Act (NFMA) requires that proposed Forest Plan amendments be evaluated for whether they would constitute a significant change in the long-term goods, outputs, and services projected for an entire National Forest. Amendments that are not significant may be adopted following disclosure and notification in an environmental document, such as an EA, EIS, or a supplement to one of these documents.

The criteria to analyze the significance of a Forest Plan amendment are summarized below.[3] Each of the four criteria for determining significance of the proposed amendment is responded to directly later.

1. Timing. When the change in the Forest Plan would take place relative to the planning period and scheduled revisions of the plan.

2. Location and size. Location and size of the area affected compared to the size for the overall planning area.

[1] 40 CFR 1502.3
[2] 40 CFR 1508.27
[3] USDA-FS, 1992, Forest Service Handbook 1909.12

3. Goals, Objectives, and Outputs. How, or to what degree, the amendment would affect the long-term relationship between levels of goods and services projected by the Forest Plan.

4. Management Prescription. Whether the change would apply only to a specific situation, or to future situations across the planning area.

PROPOSED AMENDMENT TO THE CNF FOREST PLAN

In order to respond to changing needs and opportunities on the Forest since the Forest Plan was adopted in 1987, a minor, non-significant Forest Plan amendment has been incorporated into the Proposed Action. This Forest Plan amendment is for Management Area 15 – Developed Recreation Sites. As indicated in Management Area 15, current management emphasis for Developed Recreation Sites states that: "Facility development at the Snow Bowl ski area is guided by the Final Environmental Impact Statement of 1979."[4]

The original management emphasis in the Forest Plan failed to allow for changed circumstances that may required and initiate a new environmental analysis of the ski area operations; therefore, the Final Environmental Statement of 1979 did not provide for unforeseen future guest and operational amenities such as snowmaking and developed snowplay at the Snowbowl. This management direction needs to be more inclusive and reference the Snowbowl's Master Development Plan as developed from approved NEPA decisions. This amendment applies to all of the alternatives analyzed in detail in this FEIS.

In order to allow current and potential future proposals at the Snowbowl to be in compliance with Forest Plan direction, the Alternatives 1, 2 and 3 include replacing the following management emphasis on page 188 of the Forest Plan:

> *"Facility development at the Snow Bowl ski area is guided by the Final Environmental Impact Statement of 1979."*

With the following statement:

> *"Facility development at the Snow Bowl ski area is guided by the* ***Ski Area Master Development Plan as based on approved NEPA analysis."***

As per FSH 1909.12, the four criteria for determining significance of the proposed amendment are responded to directly.

1. Timing. When the change in the Forest Plan would take place relative to the planning period and scheduled revisions of the Plan.

[4] USDA Forest Service, 1987, pg. 188

The CNF is currently in the very initial steps of undertaking a formal Forest Plan revision process. A Notice of Intent to prepare and Environmental Impact Statement (NOI) is not scheduled to be submitted to the Federal Register until 2006, with a *potential* Record of Decision (ROD) in 2009. Therefore, because the completion of the Forest Plan revision process is not imminent, this non-significant Forest Plan amendment is being proposed at an appropriate time.

2. Location and size. Location and size of the area affected compared to the size for the overall planning area.

   The CNF includes approximately 1,821,495 contiguous acres in north central Arizona. This proposed Forest Plan amendment would pertain to NFS lands within Snowbowl's existing 777-acre SUP area only, representing approximately 0.04 percent of the Forest.

3. Goals, Objectives, and Outputs. How, or to what degree, the amendment would affect the long-term relationship between levels of goods and services projected by the Forest Plan.

   This amendment intends to improve the long-term relationship between levels of goods and services projected by the Forest Plan. As per the Forest Plan and the SUP, Snowbowl's permit area is managed for developed recreation. This proposed Forest Plan amendment is consistent with the developed recreation theme, and is not anticipated to negatively impact the long-term relationship between levels of good and services in any way.

4. Management Prescription. Whether the change would apply only to a specific situation or to future situations across the planning area.

   The proposed Forest Plan amendment is specific to the Snowbowl SUP area within Management Area 15. This amendment would not apply to the entire Management Area or any other current or future situations on the CNF.

Subsequent to issuance of the Final EIS and ROD, Snowbowl will be required to prepare and submit an updated Approved Master Development Plan document which corresponds to the final approved alternative. The Approved Master Development Plan will guide the future development of the Snowbowl.

APPENDIX C – CUMULATIVE EFFECTS TABLES

Tables C-1 and C-2 provide information on past, present and reasonably foreseeable future activities that were used in the cumulative effects analyses provided in Chapter 3.

Table C-1
Cumulative Effects Matrix
Past, Present and Reasonably Foreseeable Future Projects

Project	Location	Description	Status	Potentially Affected Resource	Units of measure
Kachina Peaks Wilderness	Peaks	Designation of Wilderness Area will result in diminished land use activities such as logging, mining, and road-building.	Designated 1985	▪ Cultural ▪ Recreation ▪ Visual ▪ Wildlife	18,705 acres
White Vulcan Mine Settlement and Reclamation	Eastern slope of Peaks	Reclamation and closure of the White Vulcan Mine. This project is located on the opposite side of San Francisco Mountain from the Snowbowl operations.	Ongoing, to be completed by 2010.	▪ Cultural ▪ Visuals ▪ Wildlife ▪ Watershed	130 acres
San Francisco Mountain Mineral Withdrawal	All of Peaks except Wilderness	The Peaks and surrounding area was withdrawn from availability for mineral entry in 2000. The designated area of special protection totals approximately 74,381 acres. This will limit potential ground disturbing activities associated with mining operations. This action precludes individuals and entities from staking a mineral claim in preface to planned extraction activities within the withdrawn area.	Completed 2000	▪ Cultural ▪ Visuals ▪ Recreation ▪ Wildlife ▪ Soils ▪ Watershed ▪ Economics	75 acres
Snowbowl Road Parking Restriction	Snowbowl Road	Parking along the Snowbowl Road in the winter is restricted and enforced, snow play at Snowbowl and along road closed.	Ongoing	▪ Cultural ▪ Recreation ▪ Traffic ▪ Social	12 miles

Table C-1
Cumulative Effects Matrix
Past, Present and Reasonably Foreseeable Future Projects

Project	Location	Description	Status	Potentially Affected Resource	Units of measure
Peaks Nomination to National Register	Peaks Withdrawal area	The Forest Service is in the process of completing a National Register nomination for the Peaks as a Traditional Cultural Property (TCP). The area to be designated as a TCP would be inclusive of the Arizona Snowbowl SUP and would encompass 74,380.5 acres of NFS lands.	2004 nomination process will be complete	▪ Cultural	74,381 acres
Peaks Segment of the Arizona Trail	Western slopes of Peaks	Designate and construct a non-motorized trail from Sandy Seep to Kelly Tank (Peaks Segment). The segment is approximately 31.0 miles, traveling north between Hart Prairie and the Kachina Peaks Wilderness to Kelly Tank. Includes the additional trailhead at the Snowbowl parking area and a 0.4-mile connector trail that includes a short interpretive trail loop at the trailhead.	Pending DN/FONSI as of December 2003	▪ Cultural ▪ Recreation ▪ Wildlife	Approximately 31 miles
Bebbs Willow Restoration Project	Lower Hart Prairie	Using prescribed burning, tree thinning, soils and water rehabilitation to restore Bebbs willow-wet meadow community. The objective is to improve the hydrologic function in the 170-acre Fern Mountain Botanical Area by increasing groundwater availability in the shallow perched aquifer and springs that support the riparian habitat.	NEPA decision 2001 Implementation ongoing	▪ Vegetation ▪ Cultural ▪ Watershed ▪ Soils ▪ Air quality	600 Acres
Fort Valley Restoration Project	Lower south and west slopes of Peaks	Involves restoration of forest lands in and around the urban Flagstaff interface by using tree thinning, prescribed burning, and road and trail management techniques. The effects of the proposed Fort Valley Ecosystem Restoration are limited to the local area and the techniques of tree thinning, prescribed burning, and road and trail management proposed for Fort Valley Ecosystem and has been determined to not have significant environmental impacts.	NEPA decision 2000, implementation ongoing	▪ Fire ▪ Vegetation ▪ Wildlife ▪ Visual ▪ Air quality	9,100 Acres

Table C-1
Cumulative Effects Matrix
Past, Present and Reasonably Foreseeable Future Projects

Project	Location	Description	Status	Potentially Affected Resource	Units of measure
Transwestern Lateral Pipeline Project	West Flagstaff to Snowbowl Road	Constructed in 1992, this pipeline project brought natural gas service to the eastern portion of Fort Valley. There is on-going operation, maintenance, and construction activities for the 6 inch natural gas pipeline, which extends through Forest Service land for a distance of six miles within a 50 foot right-of-way.	Construction 1992	▪ Vegetation ▪ Soils ▪ Watershed ▪ Wildlife ▪ Economics	6 miles 50' ROW
Snowbowl Wireless Telephone Communications Site	Snowbowl SUP area at Maintenance Shop	Installation of a 125-foot tall cellular tower near Snowbowl's maintenance shop was approved via a Decision Notice in August 2000. However, it has not been constructed. It is assumed that this facility will be eventually constructed independent of any actions taken by the ski area.	NEPA complete in 2000, facilities have not been built. Construction expected in 2004	▪ Visuals ▪ Cultural ▪ Economics	0.2 Acre VQO
Inner Basin Water Pipeline Development and Maintenance	Inner Basin/east side of Peaks to Schultz Pass	*Existing* pipeline under permit to City of Flagstaff. Annual repair and maintenance including pipeline replacement activities.	Ongoing/Maintenance only	▪ Cultural ▪ Wildlife ▪ Soils ▪ Watershed	20 Miles 30' ROW
Private Land Development	Lower Hart Prairie	Residential and summer home development exists on private lands in Hart Prairie, downhill from the Snowbowl facility. These homes are primarily used during the summer months, as no winter road access exists. Currently, there are approximately 13 summer homes developed in the lower Hart Prairie area. Additionally there are approximately four parcels of land which could potentially be developed as home sites. Development is presently limited and likely to remain low density due to Coconino County zoning restrictions and availability of land and water supplies.	Ongoing	▪ Cultural ▪ Recreation ▪ Visuals ▪ Wildlife ▪ Soils ▪ Watershed ▪ Vegetation ▪ Noise ▪ Water quality ▪ Traffic ▪ Economics	Acres

Table C-1
Cumulative Effects Matrix
Past, Present and Reasonably Foreseeable Future Projects

Project	Location	Description	Status	Potentially Affected Resource	Units of measure
Miscellaneous/ongoing Recreational Uses	Peaks Area	Ongoing recreational use of the area including weddings, reunions, recreation events, hiking, bicycling, OHV use, vehicle travel on misc, horseback riding, cross-country skiing, dirt roads, camping, hunting. The USFS has developed best management practices to mitigate current and future recreational land uses.	Ongoing	▪ Recreation ▪ Cultural ▪ Visuals ▪ Wildlife ▪ Soils ▪ Watershed ▪ Vegetation ▪ Noise ▪ Traffic ▪ Economics ▪ Social ▪ Noise	PAOT
Power line Maintenance	Power line from Snowbowl Road to permit area	Ongoing maintenance activities including clearing of hazard trees.	Ongoing	▪ Wildlife ▪ Cultural ▪ Noise ▪ Vegetation	5 miles 50' ROW
Inner Basin Well Field	Inner Basin of the Peaks	Operation of the Inner Basin well field as part of Flagstaff's potable water system. This lies outside of the proposed areas of snowmaking and associated snowmelt runoff from Snowbowl operations.	Ongoing since turn of the century	▪ Watershed ▪ Cultural	Acre feet
Snowbowl Road Paving	Snowbowl Road	Reconstruction and paving of the road.	Construction competed in 1988	▪ Cultural ▪ Recreation, ▪ Visual ▪ Wildlife ▪ Traffic ▪ Noise	12 miles
Various Aspen Regeneration and exclosure fences	Peaks area	Fencing of aspen areas to promote regeneration.	Ongoing	▪ Vegetation ▪ Wildlife ▪ Visual	400 Acres

Table C-1
Cumulative Effects Matrix
Past, Present and Reasonably Foreseeable Future Projects

Project	Location	Description	Status	Potentially Affected Resource	Units of measure
Use of city reclaimed water	Flagstaff area	Use of reclaimed water for irrigation. Reclaimed water for the Snowbowl would not be available for other reuse. City of Flagstaff Utilities Department records (2003) indicate there are only limited demands for reclaimed water during the winter months when diversion to Snowbowl would occur.	Ongoing	▪ Watershed ▪ Water Quality	Acre feet of water used
City Water Well Fields	Flagstaff area aquifers	Operation and continued development of the City of Flagstaff domestic water supply.	Ongoing	▪ Watershed	Acre feet
Miscellaneous improvement projects along Highway 180	Highway 180 between Flagstaff and Snowbowl	Miscellaneous improvements increasing visibility, safety and speed limits.	1990 to 2000	▪ Traffic	N/A
Grand Canyon Traffic	Highway 180 between Flagstaff and the Grand Canyon	Seasonal (i.e., spring, summer and fall) traffic levels on Highway 180 attributable to attendance at the Grand Canyon.	Ongoing	▪ Traffic	ADT/AADT
Miscellaneous facilities and trail construction within Snowbowl's SUP area	Snowbowl SUP area	Construction of lifts, trails, buildings and parking areas between 1938 and present.	1938 to present	▪ Cultural ▪ Recreation ▪ Visuals ▪ Traffic ▪ Noise ▪ Vegetation ▪ Wildlife ▪ Soils	
Summer events held at Snowbowl	Snowbowl SUP area	Occasional events (weddings, concerts and festivals) held at Snowbowl throughout the summer	Ongoing	▪ Recreation	N/A
Continued growth of the Phoenix metropolitan area	Regional	N/A	N/A	▪ All	N/A

Table C-1
Cumulative Effects Matrix
Past, Present and Reasonably Foreseeable Future Projects

Project	Location	Description	Status	Potentially Affected Resource	Units of measure
Improvements to Highway 180 in 1994	five miles of Highway 180 from Cheshire to Snowbowl	Clearing, wider shoulders and a turn-lane to specifically accommodate Snowbowl-related traffic and safety issues between Snowbowl Road and Flagstaff.	Complete	▪ Traffic	N/A
Historic traffic on Highway 180 related to dispersed snowplay and the Nordic Center	Greater Flagstaff area	Highway 180 from Flagstaff, north of Snowbowl Road	Continuing	▪ Traffic ▪ Recreation	N/A
Patented mining claims	east slopes of the Peaks	Mines are experiencing erosion problems	Historic and present	▪ Cultural ▪ Soils ▪ Wildlife ▪ Visuals	unknown

Table C-2
Development History Within the Snowbowl SUP Area: 1982-1999

Year	Project	
1982	1979 EIS appeal process completed & Preferred Alternative approved for development master plan that included:	▪ 206 acres of ski trails ▪ Comfortable Carrying Capacity (CCC) of 2825 ▪ Parking of 8.1 acres ▪ Base Lodge Capacity 1/3 of CCC or 940 seats ▪ Approval for total of five chair lifts and one Poma
1982	Hart Prairie Chairlift constructed.	
1982	Fairfield Communities purchases Snowbowl.	
1983	Construction of: Hart Prairie Lodge (14,000 sq. ft.), Sunset Chairlift and three ski trails totaling 26 acres.	
1986	Agassiz Chairlift replaced with new CTEC triple.	
1987	CNF Forest Plan approved; adopts Selected Alternative in 1979 EIS as management emphasis for Snowbowl.	
1988	Widening of Snowbowl Road and paving begins.	
1988	*Black Jack* (trail #17) constructed.	
1989	Snowbowl is listed for sale and continues to operate.	
1992	Fairfield Snowbowl sold to Arizona Snowbowl Limited Partnership. 40-year Special Use Permit issued.	
1993	Improvements to Hart Prairie lodge approved.	
1993	Categorical Exclusion signed for widening *Logjam* (trail #25).	
1994	Categorical Exclusion issued for miscellaneous improvements including: installing portable handle tow, replacing Hart Prairie Chairlift, new addition to Hart Prairie Lodge, new offices, and utility upgrades.	
1994	Completion of *Logjam* widening.	
1994	Master Concept Plan submitted, based on 1979 EIS.	
1995	Completion of Hart Prairie Lodge addition; ticket offices, retail store, drop off, ADA ramps, deck, and rental shop expansion.	
1997	(June) Construction of *Lava* (trail #41a) and *Volcano* (trail #43c) via Categorical Exclusion. Approval also includes hiking trail from *Spur Catwalk* (trail #27) to *Midway* (trail #24) and the widening of *Spur Catwalk*, which were not completed.	
1997	(October) Scoping letter sent to public notifying Snowbowl's intention to implement projects approved in 1979 EIS. Previously-approved projects to be analyzed under an EA.	
1997	(November) EA open house at Snowbowl.	
1997	(December) Second EA open house at City Hall, due to public outcry on proposal.	
1998	(February) Question of TCP arises and review of bulletin 38 by USFS, discussion on NHPA, SHPO, eligibility questions.	
1998	(February) Work on EA suspended.	

APPENDIX D

MEMORANDUM OF AGREEMENT BETWEEN THE USDA FOREST SERVICE, ADVISORY COUNCIL ON HISTORIC PRESERVATION, AND THE ARIZONA STATE HISTORIC PRESERVATION OFFICER

MEMORANDUM OF AGREEMENT

between the

UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE

Coconino National Forest

and the

ADVISORY COUNCIL ON HISTORIC PRESERVATION

and the

ARIZONA STATE HISTORIC PRESERVATION OFFICER

REGARDING THE ARIZONA SNOWBOWL SKI AREA PROPOSED MODIFICATIONS

WHEREAS, the Arizona Snowbowl Resort, Limited Partnership (ASR) has made a proposal regarding future development of the Arizona Snowbowl Ski Area (Snowbowl) within the confines of the U.S. Department of Agriculture, Forest Service (USFS), represented by the Coconino National Forest, has participated in consultation for the project, and has been invited to review and comment upon this agreement;

WHEREAS, the USFS proposes to authorize the development of the Snowbowl Ski Area as described in the Draft Environmental Impact Statement for the Arizona Snowbowl Facilities Improvements (February 2004); and

WHEREAS, the San Francisco Peaks (the Peaks) Traditional Cultural Property was determined eligible for nomination to the National Register of Historic Places in July, 2000, under 36 CFR 60.4(a) because of its association with traditional cultural practices and beliefs of living Native American communities that are rooted in their history and are important in maintaining the continuing cultural identity of their community; and

WHEREAS, the USFS has determined that the providing for development at Snowbowl within a Special Use Area (SUA) through the proposed plan may have an adverse effect on the San Francisco Peaks Traditional Cultural Property, and that such potential adverse effects include, but may not be limited to, impacts on the qualities attributed to the San Francisco Peaks by Indian Tribes and others; and,

WHEREAS, concern has been expressed by Tribal governments, organizations, and others about the cumulative impacts of the project and of other actions under USFS jurisdiction on the National Register qualities of the Peaks; and

WHEREAS, the USFS, to resolve the adverse effects of the project on historic properties, has consulted with the Arizona State Historic Preservation Officer (SHPO), who has concurred with the finding of adverse effect; and

WHEREAS, in accordance with 36 CFR Section 800.6(a)(1), the USFS has notified the Advisory Council on Historic Preservation (Council) of its adverse effect determination with specified documentation, and the Council has chosen to participate in the consultation pursuant to 36 CFR Section 800.6(a)(1)(iii); and,

WHEREAS, pursuant to 36 CFR 800.6(b), the USFS has consulted with the Pueblo of Acoma, the Dine' Medicineman's Association, the Fort McDowell Yavapai Nation, the Havasupai Tribe, the Hualapai Tribe, the Hopi Tribe, the Navajo Nation (including the Cameron, Coalmine, Dilcon, Gap-Bodaway, Leupp, Tolani Lake, and Tuba City

Chapters), the San Carlos Apache Tribe, the San Juan Southern Paiute Tribe, the Tonto Apache Tribe, the Yavapai-Apache Nation, the Yavapai-Prescott Tribe, the White Mountain Apache Tribe, and the Pueblo of Zuni (the Tribes), for which the San Francisco Peaks have religious and cultural significance, and, pursuant to 36 CFR 800.6(c), has invited the Tribes and the Arizona Snowbowl Resort to sign this Memorandum of Agreement (MOA) as concurring parties;

NOW, THEREFORE, the USFS, the Arizona SHPO, and the Council agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the undertaking on historic properties.

I. STIPULATIONS APPLICABLE TO ALL ALTERNATIVES

The USFS shall ensure, by its own actions or permit stipulations, that the following measures are carried out:

1. The USFS will complete a National Register nomination for the San Francisco Peaks as a Traditonal Cultural Property for review by the Arizona SHPO and interested Tribes. The area designated as a TCP is inclusive of the Arizona Snowbowl SUA and encompasses 74,380.5 acres of Coconino National Forest lands. The Arizona SHPO and Tribes who hold the Peaks in particular reverence will review and comment on drafts of the nomination, prior to the final draft being sent to the Keeper.

2. The USFS will continue to consult on this undertaking with the Tribes who hold the Peaks in particular reverence in a collaborative and cooperative manner, with mutual respect for differing views and values. The USFS will notify the Tribes of any problems or situations with the potential to adversely impact resources or cause concern to the Tribes.

3. Implementation of any elements of this undertaking will not be authorized to proceed until stipulations have been assured, or are underway, and all responsibilities under Section 106 of the National Historic Preservation Act have been satisfied, as stipulated in this Memorandum of Agreement.

4. The USFS will work with the Tribes to provide periodic inspections by tribal representatives to examine the condition of existing shrines and other existing traditional cultural places on the Peaks.

5. The USFS will continue to guarantee traditional cultural practitioners access within and outside the SUA for traditional cultural uses, such as the collection of medicinal, ceremonial, and food plants. Additionally, such access will be protected during construction, subject to fire closures and other restrictions needed to protect resources and human safety. In such instances, access will be coordinated with the USFS by having traditional cultural practitioners contact the

USFS who will then notify the ASR of the requirements for access.

6. Should any plants of traditional importance be subsequently identified within the project area, the USFS will encourage and protect the natural regeneration of those plants when developing site-specific plans.

7. The USFS will continue to work with tribal liaisons and traditional cultural practitioners to ensure that current ceremonial activities conducted on the Peaks continue uninterrupted.

8. The USFS will continue to work with traditional cultural practitioners and tribal liaisons to identify existing shrines and other special places on the San Francisco Peaks and ensure these places are avoided or otherwise protected during the continued operation of the ski facilities and other USFS permitted activities. The USFS will not draw attention to these places, nor will it allow the ASR to draw attention to these places.

9. The USFS will ensure that the ASR does not advertise or market areas for out-of-bounds skiing that lie within the Kachina Peaks Wilderness and outside the Snowbowl Ski Area permit boundary. Out-of-bounds skiing will be discouraged and skiers will be encouraged to obtain a back country permit for skiing outside of the SUA in the Kachina Peaks Wilderness. The USFS and ASR will discourage others from advertising or promoting "out-of-bounds" skiing.

10. The USFS will protect confidential records, maps, and information about traditional cultural properties, special places, and practices on the Peaks and will provide this information to other USFS personnel, the ACHP, or the SHPO on a need-to-know basis only.

11. The USFS will continue to work with tribal liaisons and traditional cultural practitioners to identify current areas of particular cultural and religious importance on the Peaks and develop a plan for protection of these areas.

12. As logs become available through various activities at the ski area, they will continue to be offered to the Tribes for kiva and other traditional structures construction needs.

13. In the months when ski lifts and trails are closed to skiiers, ASR will allow traditional cultural practitioners to use the ski lifts and trails without charge to access areas to conduct traditional cultural practices, provided the requested lift access is consistent with established operating hours for the summer Skyride program.

II. ADDITIONAL STIPULATIONS APPLICABLE TO ALTERNATIVES 2 AND 3

The USFS shall ensure, by its own actions or permit stipulations, that the following measures are carried out:

1. The specific pipeline centerline will be field staked and reviewed by the USFS (in conjunction with tribal liaisons and traditional cultural practitioners) for any places of traditional cultural importance prior to the completion of final engineering and zoning.

2. The ASR is willing to work with the Tribes and USFS to develop a cultural center and will strive to recruit tribal members to work as interpreters. The USFS and ASR will work with the Tribes to determine appropriate topics and interpretive methods. Tribes and information pertinent to them will not be included if those tribes do not wish to be represented in such a center.

3. The USFS will continue to work with tribal liaisons and traditional cultural practitioners to ensure that current traditional practices and ceremonies conducted in the project area are unimpeded.

4. Should a new disturbance area for facilities identified in the EIS be needed once the project is underway, the USFS will ensure that a survey of all un-surveyed areas of proposed ground disturbance prior to project implementation will occur, and identify any cultural resources to be avoided by construction activities. The USFS will also undertake appropriate consultation with the SHPO and Tribes when determining survey coverage, site eligibility, effect determinations, and mitigation related to particular construction activities.

5. The USFS will schedule additional meetings and on-site inspections as requested by the Tribes.

6. Should snowmaking be approved, the USFS will share with the Tribes any monitoring reports it or ASR authorizes or receives from approved outside contractors regarding water quality and the effects of additional moisture on plants, animals, and the terrain, upon tribal requests to receive such reports.

7. Should snowmaking be approved, the USFS will continue to consult and work with the Tribes to minimize impacts to traditional values, to the extent possible, caused by snowmaking and the use of reclaimed water.

8. The USFS will provide reports to the Tribes documenting project implementation monitoring, conservation, and protection activities related to all resources, upon tribal requests to receive such reports.

9. To the extent practicable, the final location of new ski trails will take advantage of previously disturbed areas or openings such as meadows or beetle kill areas.

III. DURATION

This agreement will be null and void if its terms are not carried out within ten years from the date of execution of the Agreement and approval of the project. Prior to such time, the USFS may consult with the other signatories to reconsider the terms of the agreement and amend in accordance with Stipulation VII below.

IV. MONITORING AND REPORTING

Over the first ten years following the execution of this agreement and approval of the project, or until construction is complete, the USFS shall provide all parties to this agreement an annual summary report detailing work undertaken pursuant to its terms. Such report shall include any scheduling changes proposed, any problems encountered, and any disputes and objections received in the USFS's efforts to carry out the terms of this agreement. Failure to provide such summary reports may be considered non-compliance with the terms of this MOA, pursuant to Stipulation VII, below.

All work related to inventory, evaluation, monitoring, treatment, and management of cultural and historic properties under the terms of this Agreement shall be conducted or directly supervised by appropriately trained persons who meet the Secretary of the Interior's Professional Qualifications Standards (36 CFR 61, Appendix A) for the particular fields of study required by those activities. The USFS will provide project oversight and/or will require ASR to provide a consultant acceptable to the USFS and SHPO to conduct such oversight for the purpose of implementing and monitoring the terms of this Agreement. Inspections will occur commensurate with the pace of construction activities and annually thereafter. This provision does not apply to cultural assessment work conducted or authorized by the Tribes. Tribes will provide the USFS copies of any reports prepared of their own assessment of the inventory, evaluation, monitoring, treatment, and management of cultural and historic properties under the terms of this Agreement.

All studies authorized by the USFS or ASR related to inventory, evaluation, monitoring, treatment, and management of cultural and historic properties, and under the terms of this Agreement, shall meet professional standards, as outlined in the National Park Service's *Archaeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines*, *National Register Bulletin* 38, and other guidance published by the National Park Service, SHPO, and the Advisory Council on Historic Preservation.

The USFS shall ensure that all technical documents prepared to satisfy the terms of this Agreement are responsive to contemporary professional standards, including the Secretary of the Interior's *Standards for Documenting Historic Properties* and the SHPO's *1999* (or most current revision), *Administrative Procedure: Documentation Submitted for Review in Compliance with Historic Preservation Laws.*

V. CONFIDENTIALITY

The USFS shall ensure that all sensitive information, is managed in such a way that historic properties, traditional cultural values, and sacred offerings are not compromised, to the fullest extent available under the law.

Signatory and concurring parties to this Agreement shall safeguard information about the nature and location of prehistoric, historic, and traditional cultural properties and activities on the San Francisco Peaks, and not reveal that information to any additional parties, pursuant to Section 304 of the National Historic Preservation Act, without the express permission of the USFS and the appropriate tribe(s).

VI. DISPUTE RESOLUTION

Should any Signatory to this agreement object at any time to any actions proposed or the manner in which the terms of this MOA are implemented, the USFS shall consult with the objecting Signatory(ies) to resolve the objection and notify SHPO of the objection. If the USFS determines within 30 days that such objection(s) cannot be resolved, the USFS will:

A. Forward all documentation relevant to the dispute to the Council, in accordance with 36 CFR 800.2(b)(2). Upon receipt of adequate documentation, the Council shall review and advise the USFS on the resolution of the objection within 30 days. Any comment provided by the Council, and all comments from the Signatories to the MOA, will be taken into account by the USFS in reaching a final decision regarding the dispute.

B. If the Council does not provide comments regarding the dispute within 30 days after receipt of adequate documentation, the USFS may render a decision regarding the dispute. In reaching its decision, the USFS will take into account all comments regarding the dispute from the Signatories to the MOA.

C. The USFS's responsibility to carry out all other actions subject to the terms of this MOA that are not the subject of the dispute remain unchanged. The USFS will notify all parties of its decision in writing before implementing that portion of the undertaking subject to dispute under this stipulation. The USFS decision will be final.

VII. AMENDMENTS AND NON-COMPLIANCE

If any Signatory to this MOA determines that its terms will not or cannot be carried out, or that an amendment to its terms must be made, that Signatory shall immediately consult with the other Signatories to develop an amendment to this MOA pursuant to 36 CFR 800.6(c)(7) and 800.6 (c)(8). The amendment will be effective on the date a copy signed by all of the original Signatories is filed with the Council. If the Signatories cannot agree

to appropriate terms to amend the MOA, any Signatory may terminate the agreement in accordance with Stipulation VIII, below.

VIII. TERMINATION

If the MOA is not amended following the consultation set out in Stipulation VII, it may be terminated by any Signatory. Within 30 days following termination, the USFS shall notify the Signatories if it will initiate consultation to execute a new MOA with the Signatories under 36 CFR 800.6 (c)(1) or request the comments of the Council under 36 CFR 800.7(a) and proceed accordingly.

IX. EXECUTION

Execution of this Memorandum of Agreement by the USFS and Arizona SHPO, Council, concurring tribes, and ASR, and the submission of documentation and filing of this MOA with the Council, pursuant to 36 CFR Section 800.6(b)(1)(iv), is evidence that the USFS has taken into account the effects of this undertaking on historic properties and afforded the Council an opportunity to comment.

SIGNATORIES:

United States Department of Agriculture-Forest Service

Lucia M. Turner 12/16/2004

for Harv Forsgren Date
Regional Forester, U.S.D.A. Forest Service, Southwestern Region

Arizona State Historic Preservation Officer

James W. Garrison 1/20/05

James W. Garrison Date
State Historic Preservation Officer

Advisory Council on Historic Preservation

John M. Fowler 2/7/05

John Fowler Date
Executive Director

CONCURRING PARTIES:

Pueblo of Acoma

Fred Vallo
Governor

Date

Arizona Snowbowl Resort, Limited Partnership

Eric Borowsky

12/7/04

Eric Borowsky
General Partner

Date

The Fort McDowell Yavapai Nation

11-24-04

Raphael Bear
President

Date

The Havasupai Tribe

Linda Mahone
Chairman

Date

The Hopi Tribe

Wayne Taylor
Tribal Chairman

Date

The Hualapai Tribe

Charles Vaughn 12-10-04

Charles Vaughn
Chairman

Date

The Navajo Nation

Joe Shirley, Jr.
President

Date

The Navajo Nation, Cameron Chapter

Teddy Bedonie
President

Date

The Navajo Nation, Coalmine Chapter

Charlie McCabe
President

Date

The Navajo Nation, Dilcon Chapter

Carol Davis
President

Date

The Navajo Nation, Gap-Bodaway Chapter

Dorothy Lee Date
President

The Navajo Nation, Leupp Chapter

Alex Riggs, Sr. Date
President

The Navajo Nation, Tolani Lake Chapter

Keith Begay Date
President

Navajo Nation, Tuba City Chapter

Frank Bilagody Date
President

Dine' Medicineman's Association

Anthony Lee Date
President

The San Carlos Apache Tribe

Kathleen Wesley-Kitcheyan Date
Chairwoman

The San Juan Southern Paiute Tribe

Johnny Murphy Lehi, Sr. Date
President

The Tonto Apache Tribe

Ivan Smith Date
Chairman

The White Mountain Apache Tribe

Dallas Massey, Sr. Date
Chairman

The Yavapai-Apache Nation

02/07/05
Jamie Fullmer Date
Chairman

Yavapai-Prescott Indian Tribe

Ernest Jones, Sr.
President

Date

Pueblo of Zuni

Arlen P. Quetawki, Sr.
Governor

Date