# Chapter 3

# AFFECTED ENVIRONMENT

## 3.1 INTRODUCTION

This chapter describes the affected environment, with a focus on the existing resources and uses that could be affected by the Proposed Action and alternatives presented in Chapter 2. The affected environment is the baseline against which the impacts that may result from mining exploration and development under each of the alternatives is evaluated in Chapter 4. The affected environment description will vary by resource and is not confined to the proposed withdrawal area for all resources or issues. For example, air quality and water quality issues necessitate describing a large area to account for potential downwind or downstream concerns, whereas addressing issues associated with a specific plant species may be limited to a very discrete location within the proposed withdrawal area.

The affected environment is presented by first profiling the physical setting and conditions, followed by describing the biological resources, and culminating with a description of those uses and resources related to human activities. A systematic, comprehensive approach such as this better reveals the relationships that make up the human environment, both in terms of the natural and physical environment and the relationship of people to that environment [40 CFR 1508.14].

The affected environment discussed in this chapter is divided into sections covering the following: air quality and climate; geology and mineral resources; water resources; soil resources; biological resources, including vegetation, wildlife, and special status species; visual resources; soundscapes; cultural resources; American Indian resources; wilderness resources; recreation resources; and social and economic conditions, including environmental justice and public health and safety. Relevant environmental conditions and human uses in the study area have been identified and described using geographic information system (GIS) data, literature searches, electronic searches, interviews, and information provided by the BLM, Forest Service, NPS, USGS, USFWS, other federal and state agency managers and resource specialists, tribal representatives, county officials, and other sources as identified in this chapter and in Chapter 6, Literature Cited.

For each resource category, the relevant issues from Chapter 1 are presented in Table 3.1-1, along with one or more “resource condition indicators.” These resource condition indicators have been developed to provide an issue-focused analysis of potential impacts from the proposed withdrawal or alternatives, which will be presented in Chapter 4. The information presented in Chapter 3 does not describe impacts, but rather describes the existing environment with an emphasis on the present value of these resource condition indicators.

### 3.1.1 General Setting

The BLM manages public lands under the authority of the Federal Land Policy and Management Act of 1976 [43 USC 1701–1787]. FLPMA provides direction for land use planning, administration, range management, rights-of-way, designated management areas, and prevention of unnecessary or undue degradation.

The Forest Service manages federal lands under the authority of the National Forest Management Act of 1976, which restructured and amended the Forest and Rangeland Renewable Resources Planning Act of 1974. NFMA requires the Secretary of Agriculture to assess National Forest System lands, develop a management program based on multiple-use, sustained-yield principles, and implement a management plan for each unit of the Forest Service.

## 3.1.2 Areas of Critical Environmental Concern

The BLM portions of the proposed withdrawal (North and East parcels) contain administratively designated areas known as ACECs. ACECs contain one or more resources that require special management and protection to maintain the value(s) of the area and its resources. ACECs may contain important cultural or scenic values, special status species, and/or habitat for these species. ACECs are not closed to mineral entry, but all mining activities above casual use require a plan of operations.

There are three ACECs within the North Parcel: Johnson Springs, Kanab Creek, and Moonshine Ridge. There is one ACEC in the East Parcel: Marble Canyon. There are no ACECs in the South Parcel, as these lands are managed by the Forest Service.

Johnson Springs ACEC was designated to protect cultural resources and the threatened Siler pincushion cactus. The ACEC encompasses 3,444 acres; the southern portion of the ACEC is within the North Parcel.

Kanab Creek ACEC was designated for protection of cultural values, the endangered southwestern willow flycatcher (*Empidonax traillii extimus*), and riparian areas. This ACEC encompasses 13,148 acres and is located entirely within the North Parcel.

Moonshine Ridge ACEC was designated to protect cultural resources and the threatened Siler pincushion cactus (*Pediocactus sileri*). The ACEC encompasses 9,310 acres and is located entirely within the North Parcel.

Marble Canyon ACEC was designated to protect cultural resources and the endangered Brady pincushion (*Pediocactus bradyi*) cactus. The ACEC encompasses 11,797 acres and is located entirely within the East Parcel.

Information on the values for which these ACECs were designated is presented later in this chapter.

## 3.1.3 National Monuments

There are two national monuments adjacent to the proposed withdrawal area: Grand Canyon–Parashant National Monument is adjacent to the North Parcel, and Vermilion Cliffs National Monument is adjacent to the East Parcel.

*Grand Canyon–Parashant National Monument*: This monument is jointly managed by the BLM and NPS. The monument encompasses more than 1 million acres of remote and unspoiled public lands. It was designated to protect biological, historical, and archaeological resources.

*Vermilion Cliffs National Monument*: This monument is managed by the BLM. The monument encompasses 294,000 acres. It was designated to protect unique geological resources such as the Paria Plateau, Vermilion Cliffs, Coyote Buttes, and Paria Canyon. The Vermilion Cliffs National Monument is closed to mineral entry under the 1872 Mining Law.

Upon designation, lands within both monuments were withdrawn from location, entry, and patent under the mining laws, subject to valid existing rights. No active mining claims currently exist in either monument, but non-federal mineral estate is not subject to that withdrawal.

## 3.1.4 Grand Canyon National Park

Grand Canyon National Park is adjacent to each of the proposed withdrawal parcels. Although first afforded federal protection in 1893 as a Forest Reserve and later as a National Monument, Grand Canyon did not achieve National Park status until 1919, three years after the creation of the NPS. Grand Canyon National Park is a world heritage site and an international icon. The Park is dominated by the Grand Canyon (or Canyon), a twisting, 1-mile deep, 277-mile-long gorge formed during some 6 million years of geological activity and erosion by the Colorado River on the upraised earth’s crust. The river divides the Park into the North and South rims, which overlook the approximately 10-mile-wide canyon. Grand Canyon National Park encompasses 1,217,403.32 acres (NPS 1995). The Park is closed to mineral entry under the 1872 Mining Law.

## 3.1.5 Game Preserves

In 1906, President Theodore Roosevelt established the Grand Canyon National Game Preserve, generally located between the North and East parcels on the Kaibab Plateau (although a small portion of the preserve does extend into the northern areas of the South parcel). The reason for establishment of the preserve was concerns about the extirpation of game species through unregulated hunting. The preserve is managed by the Forest Service in accordance with the Kaibab LRMP/ROD (Forest Service 1988). The Grand Canyon Game Preserve is closed to mineral entry. More information on the Grand Canyon Game Preserve can be found in Section 3.7, Fish and Wildlife.

## 3.1.6 Indian Reservations

### *Navajo Nation*

The Navajo Reservation was formed under the Navajo Treaty of 1868, and extends into the states of Utah, Arizona, and New Mexico. The reservation encompasses 27,635 square miles; the portion located in Arizona covers 11.6 million acres. While the lands of the Navajo Nation are not contiguous but “checker-boarded,” the Navajo Reservation is the largest reservation under Native American jurisdiction in the United States. The current population in the Navajo Nation surpasses 250,000 people. Upon the discovery of oil on Navajo land in the early 1920s, the modern system of tribal government was established to provide a formal government entity to interact with American oil companies. This tribal government was officially recognized by the federal government in 1923 (Navajo Nation 2008).

Pursuant to the Indian Reorganization Act of 1934 the only non-Indian mining rights or claims that may exist within the Navajo Reservation are valid rights or claims existing prior to the formation of the reservation (1880). The reservation itself is withdrawn from mineral entry. Even for private valid claims, however, the Navajo Nation is closed to uranium activity. On April 29, 2005, Navajo President Joe Shirley signed the Diné Natural Resources Protection Act of 2005, which was passed by the Navajo Nation Council on April 19, 2005. This law is based on the Fundamental Laws of the Diné, as codified in Navajo statutes, and clearly states, “No person shall engage in uranium mining and processing on any sites within Navajo Indian Country.”

### *Havasupai Tribe*

The Havasupai Reservation was established by the executive orders of June 8 and November 23, 1880, with an original size of 3,058 acres. By executive order in 1882, all but 518 acres at the bottom of the canyon were designated public land. However, on January 3, 1976, Public Law 93-620 returned the original acreage, added 185,019 acres surrounding the original lands and an additional 95,300 acres of traditional use area north of the reservation. Pursuant to the Indian Reorganization Act of 1934 the only non-Indian mining rights or claims that may exist within the Havasupai Reservation are valid rights or claims existing prior to the formation of the reservation (1880). The reservation itself is withdrawn from mineral entry. The 95,300 acres of additional traditional use lands are also withdrawn.

The Havasupai Reservation is situated in Coconino County at the southwest corner of Grand Canyon National Park. There are approximately 650 enrolled tribal members; approximately 340 members live in Supai Village—Havasupai tribal headquarters—in the 3,000 foot deep Havasu (Cataract) Canyon. The Tribe is governed by an elected seven-member Tribal Council (ADOC 2009d).

### *Kaibab Paiute Tribe*

The Kaibab Paiute Indian Reservation was formally established by EO 1786 on October 16, 1907, which was superseded by EO 2667 on July 17, 1917. Pursuant to the Indian Reorganization Act of 1934 the only non-Indian mining rights or claims that may exist within the Kaibab Paiute Reservation are valid rights or claims existing prior to the formation of the reservation (1907). The reservation itself is withdrawn from mineral entry.

The reservation encompasses 120,413 acres in Arizona Strip country, including about 107,000 acres in Mohave County and about 13,000 acres in the southeastern part of the reservation in Coconino County. The reservation is composed of five villages: Kaibab, Steamboat, Juniper Estates, Six-Mile, and Redhills. The vast majority of the land is undeveloped. The Tribe is governed by a seven-person Tribal Council (ADOC 2008). Uranium has been found on or near the reservation (Bureau of Indian Affairs 1979).

## 3.1.7 Resource Condition Indicators

The resource condition indicators listed in Table 3.1-1 represent quantifiable measures of change that have been used to guide the impacts analysis presented in Chapter 4, Environmental Consequences. These indicators evolved through many iterations of impact analysis and are based on the original "relevant issues for detailed analysis" identified early in the EIS process through agency and public scoping (see Table 1.5-1).

**Table 3.1-1.** Resource Condition Indicators

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.2 Air Quality*** | | |
| Quantity of criteria and hazardous air pollutants | The emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-6. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the life of the mine of ore production) and cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (Arizona Department of Environmental Quality [ADEQ] 2010a). | *Indicator*: Quantity of criteria and hazardous air pollutants emitted under each alternative. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.2 Air Quality, continued*** | | |
| Regulatory requirements | Each individual mine will be required to obtain an air quality permit. The permit is the mechanism to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air. | *Indicator*: PSD: >250 tons per year (tpy) of a criteria pollutant.<br>*Indicator*: Federal Hazardous Air Pollutant (HAP) Source: >25 tpy combined or >10 tpy of a regulated HAP.<br>*Indicator*: ADEQ Class I Source: >100 tpy to <250 tpy of a criteria pollutant<br>*Indicator*: ADEQ Class II Source: >2 tpy to <100 tpy of a criteria pollutant. |
| NAAQS | As shown in Table 3.2-5 and Figure 3.2-2, the ambient air concentration data obtained from monitors in or near the air quality study area were below the NAAQS. However, based on data obtained from the Grand Canyon National Park, the annual fourth-highest 8-hour ozone concentrations have flat trends nonetheless have values that are very close to 8-hour ozone standard (0.075 part per million [ppm]) and sometimes over it (NPS Public Use Statistics Office 2010).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern. The EPA recommends that this proposed "secondary" standard be in the range of 7 to 21 ppm-hours. | *Indicator*: Comparison of measured and/or modeled air pollutant concentrations with applicable thresholds (i.e., NAAQS). |
| Prevention of significant deterioration (PSD) increment | The PSD increments establish the maximum increase in pollutant concentration allowed above the baseline level. | *Indicator*: PSD is the mechanism that protect Class I areas. |
| GHGs | Qualitative and/or quantitative evaluations of potential contributing factors within the planning area will be included in Chapter 4 where appropriate and practicable. | *Indicator*: The quantity of GHG emission emitted under each alternative. |
| Air Quality Related Values – Visibility | The NPS has classified the visibility at the Grand Canyon National Park as a stable moderate concern. The standard visual ranges for the three Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors in Grand Canyon National Park range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days. | *Indicator*: Discussion of visibility impacts and comparison of measured or modeled values with applicable thresholds. |
| ***3.3 Geology and Mineral Resources*** | | |
| Change in underground geological conditions | Mining of uranium deposits would alter conditions underground that could allow uranium and other minerals to be mobilized, entering the groundwater system. Conversely, mining of uranium deposits could remove a potential source of long-term contamination. | *Indicator*: Number of ore deposits mined.<br>*Indicator*: Chemical quality of water discharge at springs that issue from perched groundwater zones.<br>*Indicator*: Chemical quality of water discharge at springs that issue from the regional R-aquifer system.<br>*Indicator*: Potential for subsidence and alteration of geology or topography. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.3 Geology and Mineral Resources, continued*** | | |
| Availability of mineral resources | Providing a domestic source of mineral resources is one of the legitimate uses of public lands. Restrictions or closures individually and cumulatively decrease this ability. | *Indicator*: Uranium resource endowment available for development.<br>*Indicator*: Cumulative amount of high-potential uranium resources on lands withdrawn from exploration and development.<br>*Indicator*: Availability of high mineral potential lands within the withdrawal area<br>*Indicator*: Amount of uranium mined as percentage of domestic demand, domestic production, global demand, and global production. |
| Depletion of uranium resources | Mining these uranium deposits in the near future depletes domestic resources that may be needed later for energy production or national security purposes. | *Indicator*: Amount of uranium mined as percent of known domestic resources.<br>*Indicator*: Depletion of uranium resources within proposed withdrawal area. |
| ***3.4 Water Resources*** | | |
| Dewatering or contamination of shallow perched aquifers | Mining of some uranium deposits would penetrate near-surface aquifers and could dewater them. The resulting water loss could affect nearby springs or shallow water wells. If mineral extraction occurs within the perched aquifer horizon, dissolved minerals could enter the perched aquifer where the perching layer is re-established by mine reclamation. | *Indicator*: The assumed number of perched aquifer springs and wells that might have water quantity or quality impacts as a result of mining related activities within the groundwater drainage area of the perched aquifers. |
| Contamination of deep regional aquifers by metals dissolved from mined ore deposits | Mine drainage might carry dissolved minerals downward and increase the levels of metals in the deep groundwater aquifers (e.g., Redwall-Muav limestone aquifer). This could occur both during mining and after mine closure and potentially affect downgradient water quality. | *Indicator*: The assumed number of active or reclaimed mines that might contribute impacted water to the deep aquifer, the assumed rate of mine drainage that might occur, and the assumed uranium and arsenic concentrations that might occur in the mine drainage.<br>*Indicator*: The predicted concentrations of uranium and arsenic that might occur at deep aquifer springs if the assumed mine drainage would occur and mix with the deep aquifer spring flow. |
| Depletion of deep aquifer spring flow or well yields from operation of deep mine wells | Groundwater withdrawals from the deep aquifer by mine supply wells could intercept groundwater that supplies springs or could cause water level drawdown in deep non-mine wells. | *Indicator*: The predicted amount of groundwater pumping to supply uranium mining activities as a percent of flow from deep aquifer springs that might be impacted. Also, the predicted changes in groundwater level at deep non-mine wells that might be caused by mine wells. |
| Contamination or loss of the city of Tusayan water supply | The potential for the Tusayan city water supply to be affected by nearby uranium exploration or mineral exploration and development. | *Indicator*: The predicted changes in groundwater level and water quality at the deep city of Tusayan wells as a result of activities related to uranium mining. |
| Contamination of municipal water supplies derived from the Colorado River | The potential for elevated uranium and other metals, in either surface water or groundwater, to enter the Colorado River and affect the major downstream municipalities' primary source of drinking water. | *Indicator*: The assumed quality and quantity of water with elevated uranium and arsenic levels that might result from uranium mining activities and enter the Colorado River.<br>*Indicator*: The predicted change in water quality to the Colorado River that might result from the above occurrences. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.4 Water Resources, continued*** | | |
| Impairment of watershed and surface stream function | Changes in sediment loads and/or perennial and ephemeral stream discharge resulting from potential increased erosion and alteration of drainage patterns related to road, drill site, and mine site development. | *Indicator*: The amount of soil (area) that would be disturbed.<br>*Indicator*: Estimated extent and degree of increased erosion (soil loss). |
| Contamination of surface runoff from active or reclaimed mines | Surface runoff from active or reclaimed mine sites could contain elevated uranium and other metals that would affect downstream water quality. | *Indicator*: Estimated uranium and arsenic levels in surface runoff. |
| ***3.5 Soil Resources*** | | |
| Disturbance of soil resources | Soil resources in the area are valuable and could be difficult to re-establish once disturbed by exploration and mining. | *Indicator*: The amount of soil (area) that would be disturbed. |
| Loss of soil productivity | Erosion on disturbed or reclaimed lands could result in long-term loss of soil productivity, creating potential short-term, long-term, and cumulative environmental impacts on soils and overall watershed function. | *Indicator*: The amount of soil (area) that would be disturbed.<br>*Indicator*: Estimated extent and degree of increased erosion (soil loss). |
| Soil Contamination | Potential distribution of contaminants in soil could result from erosion and subsequent deposition of mine waste-rock or ore from water and/or wind action, or leakage from detention ponds in the vicinity of each mine site. | *Indicator*: Extent of projected concentrations of uranium and arsenic compared to background levels and Soil Remediation Level standards. |
| ***3.6 Vegetation Resources*** | | |
| Disturbance of vegetation | Vegetation in the area are could be difficult to re-establish once disturbed or contaminated by exploration and mining. | *Indicator*: The amount of vegetation that would be disturbed and/or contaminated. |
| Vegetation productivity | Erosion on disturbed or reclaimed lands could result in long-term loss of soil cover and vegetation productivity. | *Indicator*: The estimated loss in vegetation productivity (in Animal Unit Months).<br>*Indicator*: The anticipated time required to return the disturbed or contaminated area to vegetative productivity. |
| ***3.7 Fish and Wildlife Resources*** | | |
| Wildlife habitat | Issues associated with wildlife habitat include fragmentation of habitat by roads, noise from exploration or mining activities that disrupts wildlife, wildlife disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species. | *Indicator*: Acres and type of habitat lost and duration of loss.<br>*Indicator*: Changes in migratory or foraging behavior.<br>*Indicator*: Avoidance or adaptation of species to noise source/visual intrusion.<br>*Indicator*: Acres of habitat loss due to establishment of invasive species caused by mineral activities. |
| Wildlife populations | Potential loss of critical wildlife winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc. | *Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time. |
| Wildlife mortality | The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality. In addition to wildlife vehicle accidents, injury to individual plants from crushing or removal and loss or modification of habitat through actions such as clearing and road construction can have negative impacts on wildlife. | *Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.8 Special Status Species Resources*** | | |
| Special status species habitat | Issues associated with special status species habitat include fragmentation of habitat by roads, noise from exploration or mining activities that disrupts species, species disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species. | *Indicator*: Acres and type of habitat lost and duration of loss.<br>*Indicator*: Changes in migratory or foraging behavior.<br>*Indicator*: Avoidance or adaptation of species to noise source/visual intrusion.<br>*Indicator*: Acres of habitat loss due to establishment of invasive species caused by mineral activities. |
| Special status species populations | Potential loss of critical special status species winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc. | *Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time. |
| Special status species mortality | The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality. | *Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity. |
| ***3.9 Visual Resources*** | | |
| Changes in regional visual quality | Mineral exploration and development could release pollutants, which could increase regional haze (see Air Quality issue) and result in changes in visibility, affecting the scenic quality of the region. | *Indicator*: The extent of the predicted change in regional haze attributable to mineral exploration and development is noticeable. |
| Visual intrusion to Park visitors | Exploration and development activity may be visible to Park visitors from key viewpoints within the Park. This could detract from the visitors' experience. | *Indicator*: Consistency with and conformance to Park visual objectives from key viewpoints within Grand Canyon National Park.<br>*Indicator*: Visual contrast of anticipated activity from these Park viewpoints. |
| Visual intrusion to public outside the Park | Exploration and development activity may be visible to the public from key viewpoints in the Proposed withdrawal area. This could detract from the visitors' experience. | *Indicator*: Consistency with and conformance to designated BLM Visual Resource Management class objectives<br>*Indicator*: Consistency with and conformance to Forest Service scenic quality management or integrity objectives.<br>*Indicator*: Visual contrast of anticipated activity from key viewpoints in the Proposed withdrawal area.<br>*Indicator*: Qualitative analysis of the potential changes to darkness of the night sky in the Proposed withdrawal area and Grand Canyon National Park. |
| ***3.10 Soundscapes*** | | |
| Noise disruption from exploration or development activity | The areas subject to noise effects and the intensity of sound from these activities need to be evaluated for each proposed site and all associated operations. Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park. | *Indicator*: The decibel level due to exploration and mining equipment<br>*Indicator*: The distance and direction between the source and receiver and for the evaluation of noise attenuation to baseline sound levels.<br>*Indicator*: Comparison measured or modeled values with applicable rules, policies, or orders established by the Federal Land Managers.<br>*Indicator*: Comparison of specified values to regulations established by the EPA and the U.S. Department of Transportation. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.11 Cultural Resources*** | | |
| Disturbance of historic and prehistoric sites | Surface disturbance associated with exploration or development activity could expose and cause damage to archaeological sites. Visual and atmospheric changes could adversely affect the integrity of site settings and what certain tribes assert to be cultural landscapes. It may not be possible to mitigate all adverse effects through scientific data recovery. | *Indicator*: The anticipated number of sites known, and unknown if possible, that could be disturbed by mining and exploratory activities.<br>*Indicator*: The anticipated number of the above sites disturbed where information or artifacts would be lost or destroyed. |
| ***3.12 American Indian Resources*** | | |
| Disturbance of traditional cultural practices and uses | Exploration and development activity could affect the integrity of religiously and culturally significant sites and landscapes and could disrupt traditional practices and uses. Such practices include ceremonial activities, gathering of plants or other natural resources, and use of springs and trails. Tribes have expressed concerns about potential disturbance and contamination of culturally important resources. | *Indicator*: Number and types of traditional cultural use areas, sacred sites, cultural landscapes, and trails that could be disturbed by mining and exploratory activities.<br>*Indicator*: Number of acres of total possible disturbance by mining and exploratory activities.<br>*Indicator*: Proximity of traditional use areas to anticipated exploration and development activity.<br>*Indicator*: Types of auditory or visual disruptions would occur in the traditional use area. |
| Effect on TCPs | Surface disturbance associated with exploration or development activity could disrupt the setting or integrity of TCPs such as the Red Butte area on the Tusayan Ranger District or other TCPs located in or near the parcels. | *Indicator*: The proximity and size of possible surface, visual, or auditory disturbance to, or within, identified TCPs. |
| Protection of tribal trust resources or assets | Tribal trust resources and assets are property, or property rights or interests, actually owned by a tribe. These may include property or rights located on- or off-reservation. As a trustee for the tribes, the federal government has the responsibility to preserve and protect tribal trust resources and assets from loss or degradation. One trust resource issue is the potential contamination of Havasu Springs and the economic impact of reduced tourism for the Havasupai Tribe if the springs were to be contaminated. | *Indicator*: Location and nature of tribal trust resource or asset.<br>*Indicator*: Manner and degree to which the resource or asset would be degraded or consumed. |
| ***3.13 Wilderness Resources*** | | |
| Wilderness areas | Congressionally designated wilderness is already withdrawn from entry and location under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to designated wilderness areas, which may affect the wilderness characteristics. | *Indicator*: Changes in wilderness characteristics untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation. |
| ***3.15 Recreation*** | | |
| Access and transportation | Development of roads for mining operations could both facilitate access for some recreational users and provide too much public access in areas currently used for more primitive recreation. | *Indicator*: Road density in terms of linear road miles by road type and designated recreation area and visitor use. |
| Primitive recreation opportunities | Changes in amount of exploration and development activity could change visual and auditory conditions, which in turn could affect primitive recreation opportunities in the area. | *Indicator*: The proximity of recreation settings and opportunities suitable for primitive recreational use to RFD and the expected auditory and visual intrusion to the desired recreation experience. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.16 Social Conditions*** | | |
| Demographics | There could be changes in population levels associated with decreased exploration and development activity under a proposed withdrawal. Likewise, the continued mineral development in the absence of a proposed withdrawal could involve local population increases as additional workers are required. | *Indicator*: The current and projected population for counties and communities in the study area. |
| Stakeholder values | Stakeholder values may be affected by changes in land management related to the proposed withdrawal areas. | *Indicator*: Public comments during scoping indicating general support for the withdrawal or support for exploration and development activity (and no withdrawal). |
| Public health effects | The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport. | *Indicator*: Estimated number of haul trips through local communities.<br>*Indicator*: Potential exposure, public health risk, from single incident, effectiveness of cleanup, and total anticipated incidents. |
| Environmental justice | The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. In the 1994 EO (12898), President Clinton adopted the phrase “environmental justice” to refer to “disproportionately high and adverse human health or environmental effects . . . on minority populations and low-income populations.” Environmental justice is the equitable distribution of proposed withdrawal benefits and risks with respect to low-income or minority populations. In the case of uranium mining in the proposed withdrawal area, it is the distribution of the proposed withdrawal benefits, primarily economic, compared with the distribution of the proposed withdrawal impacts, such as pollution or risk of pollution, that is the issue. | *Indicator*: Identification of populations considered low income and/or minority in the proposed withdrawal area that would either be adversely affected or benefit from the activity.<br>*Indicator*: Distribution of proposed withdrawal risks or adverse effects on the above populations. |
| ***3.17 Economic Resources*** | | |
| Energy resources available | The withdrawal of uranium deposits in the study area would remove a potential source of energy production, which would then be replaced by energy produced from other sources, either additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar. | *Indicator:* Value of energy produced from study area.<br>*Indicator:* Equivalent amount of other energy-producing commodity represented by uranium production. |
| Effects on economic activity from tourism | Tourism represents a large component of the economic activity for many communities in the region and for the states. The manner and degree to which continued mining could change the nature and quality of the natural resources that attract tourism is an issue. | *Indicator*: Visitor user days and value per visitor user days to tourist destinations, primarily Grand Canyon National Park, but also National Forest System and BLM lands. |
| Effects on economic activity from mineral development | Mineral exploration and development represents a large component of the economic activity for many communities in the region. The manner and degree to which the proposed withdrawal could directly change the economic activity in the area, particularly in smaller communities, is an issue. | *Indicator*: Number of persons in the region directly and indirectly employed by the uranium mining industry.<br>*Indicator*: Local and state revenue from property and income taxes directly tied to uranium mineral exploration and development. |

**Table 3.1-1.** Resource Condition Indicators (Continued)

| Resource Category/ Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| ***3.17 Economic Resources, continued*** | | |
| Road condition and maintenance | The use of road systems to service mine operations requires increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. Increased exploration and development activity could presumably increase funding from property and use taxes at the same time at which maintenance needs increase. Conversely, decreases in activity mean less maintenance, along with less potential revenue. | *Indicator*: Number of haul trips anticipated on major public use roads over the next 20 years.<br>*Indicator*: Required maintenance level on public roads systems used for mineral operations.<br>*Indicator*: The net change in funding available for road maintenance. |

# 3.2 AIR QUALITY

This section provides an assessment of ambient air quality in the proposed withdrawal study area (Figure 3.2-1). The air quality of a given airshed or region is determined by the topography, meteorology, location of sources of air pollutants (type and quantity), and combination of air pollutants. The calculated or measured concentrations of various pollutants are then compared with established standards to evaluate the impact of a given source on regional air quality.

The purpose of this assessment is to determine the ambient air quality within the proposed withdrawal area. For the purposes of evaluating air quality resource impacts associated with the proposed withdrawal, the geographic extent of the air quality study area was assumed to extend 31 miles (50 km) from the boundaries of the proposed withdrawal area. A 31-mile radius was chosen in order to be consistent with minimum air quality analysis required for major source air quality permitting. Specifically, when conducting an air quality impact analysis for a major emission source, the analysis considers the geographical area located within at least a 31-mile radius. The region of influence is the total area in which measurable impacts of the proposed action are evaluated and may extend well beyond 31 miles from the proposed withdrawal boundaries.

## 3.2.1 Climate and Meteorology

The three proposed withdrawal parcels are located in northwestern Arizona within the Colorado Plateau, which is characterized by highlands to the north and lowlands to the south and west. The Colorado Plateau contains many unique geographical features (e.g., river narrows, natural bridges, slot canyons, etc.), including Grand Canyon. Six of the seven North American life zones are represented within the Colorado Plateau; only sub-tropic is absent. The Colorado Plateau contains a variety of plant life, from desert-type vegetation in the low-lying rocky areas to forests of ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*) and aspen (*Populus* sp.) in the higher elevations (BLM 1999).

The proposed withdrawal parcels are managed by the BLM Arizona Strip District and the Forest Service Kaibab National Forest–Tusayan Ranger District. The North and East parcels are almost entirely BLM lands, located north of the Colorado River, with small portions of the Kaibab National Forest in each. The South Parcel is entirely National Forest System lands (Kaibab National Forest–Tusayan Ranger District) located south of the Colorado River. All three of the proposed withdrawal parcels border the Grand Canyon National Park, managed by the NPS.

The northwestern portion of Arizona has four defined seasons (e.g., summer, fall, winter, and spring) and is at significantly higher elevation than the lower desert regions in southern Arizona, with an appreciably cooler climate that consists of cold winters and relatively mild summers. Air temperatures vary considerably both diurnally and annually throughout the area and can vary greatly depending on elevation, as evidenced by the monitoring data. During summer, the average air temperature in degrees Fahrenheit (°F) ranges from the mid-40s to the mid-70s, with highs reaching the low 100s. In comparison, the average minimum temperature in winter generally ranges from the mid- to high 10s to the high 30s, with the average maximum temperature reaching the high 50s and low 60s. Cold air systems originating from the northern United States and Canada occasionally make their way into Arizona, bringing temperatures below 0°F to the northern portions of the state. There are several climatic elements that have an impact on air quality. These elements include winds, temperature, and precipitation. Table 3.2-1 summarizes the meteorological conditions in and near the proposed withdrawal area.

Precipitation amounts tend to be highest in the winter months, ranging from approximately 0.5 inch (Houserock, Arizona) to 3.17 inches (Bright Angel Ranger Station, Arizona), and lowest in the spring months, ranging from 0.3 inch (Houserock) to 1.91 inches (Bright Angel Ranger Station). Not all of the meteorological monitoring stations record snowfall during the winter months; the annual average accumulation ranges from 0.3 inch (Phantom Ranch, Arizona) to 136.7 inches (Bright Angel Ranger Station, Arizona).

**Table 3.2-1.** Meteorological Conditions in and near the Proposed Withdrawal Air Quality Study Area

| Monitor Locations (Arizona) | Approximate Distance and Direction from the Nearest Proposed Withdrawal Parcel | Winter Average | Spring Average | Summer Average | Fall Average | Annual Average/ Total |
|---|---|---|---|---|---|---|
| **Mean Monthly Maximum Temperature Average (°F)*** | | | | | | |
| Bright Angel Ranger Station | 10 miles N | 39.1 | 53.0 | 75.1 | 57.7 | **56.2** |
| Gunsight | (In withdrawal area) | 62.0 | 82.4 | 100.3 | 83.3 | **82.0** |
| Houserock | (In withdrawal area) | 61.5 | 82.3 | 99.3 | 81.8 | **81.2** |
| Paria Point | (In withdrawal area) | 56.0 | 76.1 | 93.7 | 76.7 | **75.6** |
| Phantom Ranch | 7 miles N | 59.0 | 82.1 | 103.7 | 82.1 | **81.8** |
| Pipe Springs National Monument | 3 miles N | 50.0 | 69.5 | 92.0 | 72.1 | **70.9** |
| Robinson Tank | (in withdrawal area) | 62.6 | 81.6 | 99.8 | 83.6 | **81.9** |
| Supai | 18 miles NW | 55.1 | 76.3 | 96.8 | 76.6 | **76.2** |
| Telegraph Flat–Kanab 17E Utah | 18 miles N | 57.2 | 79.6 | 98.1 | 80.3 | **78.8** |
| Tuweep | 18 miles S | 51.6 | 68.9 | 91.8 | 73.2 | **71.4** |
| **Mean Monthly Minimum Temperature Average (°F)*** | | | | | | |
| Bright Angel Ranger Station | 10 miles N | 17.5 | 27.6 | 44.3 | 31.3 | **30.2** |
| Gunsight | (In withdrawal area) | 14.7 | 27.8 | 52.4 | 30.4 | **31.3** |
| Houserock | (In withdrawal area) | 19.0 | 31.2 | 55.3 | 34.3 | **35.0** |
| Paria Point | (In withdrawal area) | 10.9 | 23.7 | 49.2 | 26.2 | **27.5** |
| Phantom Ranch | 7 miles N | 38.7 | 55.0 | 74.3 | 57.2 | **56.3** |
| Pipe Springs National Monument | 3 miles N | 23.1 | 35.9 | 55.8 | 39.1 | **38.5** |
| Robinson Tank | (In withdrawal area) | 5.7 | 21.3 | 44.0 | 23.1 | **23.5** |
| Supai | 18 miles NW | 31.3 | 46.0 | 64.7 | 47.9 | **47.5** |
| Telegraph Flat–Kanab 17E Utah | 18 miles N | 6.6 | 21.1 | 42.1 | 24.8 | **23.7** |
| Tuweep | 18 miles S | 28.9 | 40.8 | 61.8 | 45.7 | **44.3** |

**Table 3.2-1.** Meteorological Conditions in and near the Proposed Withdrawal Air Quality Study Area (Continued)

| Monitor Locations (Arizona) | Approximate Distance and Direction from the Nearest Proposed Withdrawal Parcel | Winter Average | Spring Average | Summer Average | Fall Average | Annual Average/ Total |
|---|---|---|---|---|---|---|
| **Mean Monthly Precipitation Average (inches)*** | | | | | | |
| Bright Angel Ranger Station | 10 miles N | 3.17 | 1.91 | 1.66 | 1.65 | **25.19** |
| Gunsight | (In withdrawal area) | 0.8 | 0.5 | 0.7 | 0.8 | **8.4** |
| Houserock | (In withdrawal area) | 0.5 | 0.3 | 0.8 | 0.9 | **7.4** |
| Paria Point | (In withdrawal area) | 0.7 | 0.7 | 0.9 | 0.9 | **9.8** |
| Phantom Ranch | 7 miles N | 0.89 | 0.59 | 0.82 | 0.90 | **9.61** |
| Pipe Springs National Monument | 3 miles N | 1.06 | 0.80 | 0.88 | 0.91 | **10.94** |
| Robinson Tank | (In withdrawal area) | 0.9 | 0.4 | 0.6 | 0.5 | **6.9** |
| Supai | 18 miles NW | 0.73 | 0.54 | 0.95 | 0.64 | **8.59** |
| Telegraph Flat–Kanab 17E Utah | 18 miles N | 0.8 | 0.5 | 0.6 | 0.9 | **8.1** |
| Tuweep | 18 miles S | 1.11 | 0.79 | 1.20 | 0.88 | **11.95** |
| **Mean Monthly Snowfall Average (inches)*** | | | | | | |
| Bright Angel Ranger Station | 10 miles N | 26.6 | 13.4 | 0.1 | 5.5 | **136.7** |
| Gunsight | (In withdrawal area) | – | – | – | – | – |
| Houserock | (In withdrawal area) | – | – | – | – | – |
| Paria Point | (In withdrawal area) | – | – | – | – | – |
| Phantom Ranch | 7 miles N | 0.2 | 0.0 | 0.0 | 0.0 | **0.3** |
| Pipe Springs National Monument | 3 miles N | 1.9 | 0.6 | 0.0 | 0.4 | **8.6** |
| Robinson Tank | (In withdrawal area) | – | – | – | – | – |
| Supai | 18 miles NW | 0.5 | 0.0 | 0.0 | 0.0 | **1.7** |
| Telegraph Flat–Kanab 17E Utah | 18 miles N | – | – | – | – | – |
| Tuweep | 18 miles S | 2.0 | 0.6 | 0.0 | 0.2 | **8.5** |
| **Average Wind Speed (miles per hour)**† | | | | | | |
| Flagstaff Airport | 42 miles S | 6.6 | 8.0 | 5.9 | 5.8 | **6.6** |
| Grand Canyon Airport | (In withdrawal area) | 6.2 | 7.6 | 6.1 | 5.8 | **6.4** |
| Kanab Airport | 10 miles N | 6.7 | 9.5 | 7.7 | 6.6 | **7.6** |
| Page Airport | 13 miles NE | 3.5 | 6.4 | 6.0 | 4.3 | **5.0** |

Sources: Western Regional Climate Center (2010a, 2010b).

Note: – = No data available; N = North; NE = Northeast; NW = Northwest; S = South; SW = Southwest

* For mean monthly temperature, mean monthly precipitation, and mean monthly snowfall, the period used for Bright Angel Ranger Station is 1925–2009; for Gunsight, 1994–2010; for Houserock, 1994–2010; for Paria Point, 1994–2010; for Phantom Ranch, AZ 1966-2005; for Pipe Springs National Monument 1993-2005; for Robinson Tank, 1986–2010; for Supai, 1899–1987; for Telegraph Flat–Kanab 17E, Utah, 1987–2010, and for Tuweep, 1941–1985.

† For average wind speed values, averages are based on data collected between 1996 and 2006.

Based on Table 3.2-1, average wind speeds tend to be highest during the spring and summer months, ranging from approximately 6.0 miles per hour (mph) (Page Airport, Arizona) to 9.5 mph (Kanab Airport, Utah) and lowest during the winter and fall months, ranging from approximately 3.5 mph (Page Airport, Arizona) to 6.7 mph (Kanab Airport, Utah).

The closest meteorological monitoring station to the proposed withdrawal area is the station located at Grand Canyon Airport, Arizona, within the South Parcel. Wind data collected at the Grand Canyon

Airport indicate the prevailing winds are generally from the south-southwest, with significant winds from the northeast in winter with the average annual wind speed approximately 6.4 mph. The daily average peak gust at the Grand Canyon Airport are 25.4 mph with maximum peaks exceeding 60 mph (peak gust of 62 mph recorded on December 13, 2008) (Western Regional Climate Center 2010b).

Wind events near the proposed withdrawal can be extreme, as evidenced by the closure of Interstate 40 (I-40), east of Flagstaff, on numerous occasions in 2010 as a result of blowing dust from sustained winds exceeding 50 mph. As of June 16, 2010, the maximum recorded wind gust at the Flagstaff Airport for the calendar year 2010 was measured at 55 mph. From 2009 through 2006, the maximum gust wind measured, at the Flagstaff Airport, ranged from 56 to 59 mph (Weather Underground 2010).

In the absence of strong prevailing winds, wind movement within the valleys, canyons, and gulches within northern Arizona is extremely complex. The terrain features suggest there is a daily exchange of downslope and upslope flows oriented along the terrain feature axes, which are controlled by surface heating and cooling. Downslope, or drainage flows, which last longer, occur during the evening, night, and early morning hours, while the upslope flows occur during midday, the warmest part of the day (Bowman 2010).

Atmospheric stability is another important factor of meteorology that determines air pollution concentrations. When the atmosphere is stable, emitted pollutants tend to remain within a few hundred feet of the surface (close to the emission sources), and begin to diffuse horizontally across the surface. When the atmosphere is unstable, air pollution is free to mix with the atmosphere, and can vertically rise 1,000 feet or more, and be carried away in the prevailing wind. Therefore, the depth of this “mixing” area is very important when considering the impacts of air pollution on the region of influence.

Within the proposed withdrawal area atmospheric stability depends on the season. During the summer, the frequency of stable and unstable conditions of the atmosphere is relatively equal.

## 3.2.2 Legal and Regulatory Requirements

The following subsections identify federal, state, and local laws and regulations that are applicable to the proposed withdrawal, provide an evaluation of the study area, and analysis of the potential proposed withdrawal impacts.

### *Federal Laws and Regulations*

Since 1970, the CAA and subsequent amendments have provided the authority and framework for EPA regulations of ambient air and pollutant emission sources. The CAA is the primary federal legislation controlling air quality standards and also includes special provisions to help protect air quality in national parks and other federal lands. The CAA gives federal land managers certain responsibilities and opportunities to participate in decisions being made by regulatory agencies that might affect air quality in federally protected areas.

The EPA regulations promulgated pursuant to the authority provided under the CAA established requirements for monitoring, controlling, and documenting activities that would affect ambient air concentrations of certain pollutants that may endanger public health or welfare. Specifically, these regulations have the overall objective of achieving and maintaining adherence to appropriate standards for ambient air quality, which are referred to as NAAQS.

## *National Ambient Air Quality Standards*

As stated above, the CAA established the NAAQS for six criteria pollutants. These pollutants are carbon monoxide (CO), lead (or Pb), nitrogen dioxide ($NO_2$), particulate matter with a nominal aerodynamic diameter of less than 10 micrometers ($PM_{10}$) and fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers ($PM_{2.5}$), ozone (or $O_3$), and sulfur dioxide ($SO_2$). These standards are defined in terms of threshold concentration (e.g., milligrams per cubic meter [$mg/m^3$], micrograms per cubic meter [$\mu g/m^3$], or parts per million [ppm]) measured as an average for specified periods (averaging times). Short-term standards (i.e., 1-hour, 8-hour, or 24-hour averaging times) were established for pollutants with acute health effects; long-term standards (i.e., annual averaging times) were established for pollutants with chronic health effects.

The NAAQS were set at levels to provide an ample margin of safety to protect both public health and the environment. The primary standards are "health effects" standards and were adopted to protect public health, including "sensitive" populations such as asthmatics, children, and the elderly. The secondary standards are "quality of life standards" and were adopted to protect public welfare against decreased visibility as well as damage to animals, crops, vegetation, and buildings. The secondary standards are the same as, or less stringent than, the primary standards.

Effective May 27, 2008, the EPA promulgated a new 8-hour average $O_3$ concentration of 0.075 ppm. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average $O_3$ concentration measured at each monitoring location within an area over each year must not exceed 0.075 ppm. The primary and secondary NAAQS for the criteria pollutants are presented in Table 3.2-2.

**Table 3.2-2.** National Ambient Air Quality Standards

| Pollutant | Averaging Period | Primary Standard | Secondary Standard |
|---|---|---|---|
| CO | 1-hour | 35 ppm (40 $mg/m^3$) | – |
| | 8-hour | 9 ppm (10 $mg/m^3$) | – |
| Pb | Rolling 3-Month Average | 0.15 $\mu g/m^3$ | 0.15 $\mu g/m^3$ |
| | Quarterly Average | 1.5 $\mu g/m^3$ | 1.5 $\mu g/m^3$ |
| $NO_2$ | 1-hour | 0.100 ppm | 0.100 ppm |
| | Annual | 0.053 ppm (100 $\mu g/m^3$) | 0.053 ppm (100 $\mu g/m^3$) |
| $PM_{10}$ | 24-hour | 150 $\mu g/m^3$ | 150 $\mu g/m^3$ |
| $PM_{2.5}$ | 24-hour | 35 $\mu g/m^3$ | 35 $\mu g/m^3$ |
| | Annual | 15.0 $\mu g/m^3$ | 15.0 $\mu g/m^3$ |
| $O_3$ | 1-hour | 0.12 ppm | 0.12 ppm |
| | 8-hour | 0.08 ppm (1997 standard) | 0.08 ppm (1997 standard) |
| | 8-hour | 0.075 ppm (2008 standard) | 0.075 ppm (2008 standard) |
| $SO_2$ | 3-hour | – | 0.5 ppm (1,300 $\mu g/m^3$) |
| | 24-hour | 0.14 ppm | – |
| | Annual | 0.03 ppm | – |

Sources: EPA (2010a–i).

Note: – = No data available; ppm = parts per million; $\mu g/m^3$ = micrograms per cubic meter

Geographic areas commonly referred to as airsheds, which may not coincide with political boundaries, are designated attainment, non-attainment, or unclassified areas for each of the six criteria pollutants covered by the NAAQS. Areas in which levels of a criteria pollutant measure below the NAAQS are designated "attainment" areas. However, when a designated air quality area or airshed within a state exceeds the

NAAQS that area may be designated a “non-attainment” area. Typically, non-attainment areas are urban regions and/or areas with higher-density industrial development. The given status of an area is designated separately for each criteria pollutant; one area may have all three classifications.

To determine whether an area meets the NAAQS, air monitoring networks have been established and are used to measure ambient air quality concentrations. Monitoring sites are typically located in areas where high concentrations occur within a region and where an exceedance is expected to occur.

Air pollution emitted in one area (e.g., North Parcel) is not bound by the parcel boundaries and could spread out and become distributed across the airshed. Air pollutants have the potential to disperse over large geographic areas. For this reason, air pollution levels are generally similar across a given airshed. The boundaries of an airshed can be difficult to determine due to changing meteorological conditions. Topographical features such as, ridges and mountains may prevent the circulation of air and hold pollution within their boundaries. However, weather conditions can change on a daily basis, and features that obstruct the movement of air on some days may represent no barrier at all when a weather front pushes through.

The proposed withdrawal parcels are located in Coconino and Mohave counties, which are designated as being in attainment for all criteria pollutants as defined under the EPA NAAQS.

An unclassified designation indicates that the status of attainment has not been verified through data collection. When permitting new sources, an unclassified area is treated as an attainment area (ADEQ 2010b).

## *Class I and Class II Areas*

Clean air designations were established under the CAA Title I, Part C, Prevention of Significant Deterioration (PSD) of Air Quality. Specific provisions are included in federal, state, and county air quality regulations to preserve the pristine air quality in Class I areas.

Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels. Generally, the Class I air quality/land use classification is the designation for clean, pristine airsheds and would permit little or no development and signifies a goal, which is implemented by requiring the most stringent controls on air pollutant sources. The Class II designation is applied to all other clean air areas that are in attainment of the NAAQS, where development is permitted under the authority of the state. Class I areas include national parks larger than 6,000 acres, and wilderness areas larger than 5,000 acres that were in existence before August 1977.

However, certain areas deserving of preservation, established by the Wilderness Act of 1964, may be designated Class II “Wilderness,” and state or county requirements or permitting policies may be promulgated to protect air quality in these areas. Except for fires and wind erosion, the potential for adverse air quality impacts is from human-caused pollutants transported into these areas by gradient and/or local winds. Class II areas include all other areas of the country that are not Class I.

The proposed withdrawal parcels are designated as Class II for criteria pollutants. One federally designated Class I area, the Grand Canyon National Park, borders the proposed withdrawal parcels (see Figure 3.2-1). There are several other Class I and II areas in close proximity to the proposed withdrawal parcels, including Zion (approximately 21 miles to the north) and Bryce Canyon (approximately 30 miles to the north) national parks, located in Utah (all Class I); Glen Canyon and Lake Mead national recreation areas; Grand Canyon–Parashant, Pipe Springs, Wupatki, Grand Staircase–Escalante, Vermilion Cliffs, and Sunset Crater Volcano national monuments; and Paria Canyon–Vermilion Cliffs and Kanab Creek wilderness (Class II). Other wilderness areas not identified on Figure 3.2-1 include Cottonwood Point, Saddle Mountain, Mount Trumbull, and Mount Logan.

## *Prevention of Significant Deterioration*

In addition to the NAAQS discussed above, the EPA promulgated PSD regulations to further protect and enhance air quality. PSD review is a pollutant-specific review and a federally mandated program. This PSD review applies to new emission sources in areas designated attainment or unclassified, and it applies only to pollutants for which a project is considered a potential major contributor. The PSD provisions use an incremental approach and are intended to help maintain good air quality in areas that attain the NAAQS and to provide special protections for areas of special natural recreational, scenic, or historic value, such as national parks and wildlife areas.

PSD permits are required for major new stationary sources of emissions that emit 250 tons (100 tons for categorical sources) or more per year of an air pollutant. Uranium mining is not listed as one of the 28 designated categories. Therefore, the applicable PSD threshold is 250 tons per year. The main requirements of the PSD review process are to demonstrate that projects would do the following:

- Incorporate best available control technology (BACT);
- Evaluate existing ambient air quality in the area of the project;
- Demonstrate that the project would not cause or significantly contribute to a violation of the NAAQS or PSD increments;
- Determine the impacts on soils, vegetations, and visibility for Class I areas;
- Evaluate the air quality impacts resulting from indirect growth associated with the project; and
- Provide for public involvement.

The PSD regulations at the federal and state levels define numerical values for “increments” that are maximum allowable increases in predicted ambient concentrations at any location. The regulations also define the predicted concentrations that trigger an ambient monitoring requirement for a given project.

“Increments” are maximum increases in ambient concentrations allowed in an area above the baseline concentration. Class I increments have been established for $PM_{10}$, $SO_2$, and $NO_2$ and are listed in Table 3.2-2. These represent the maximum increases in ambient pollutant concentrations allowed over baseline concentrations. Complete consumption of an increment would impose a restriction to growth for the affected area. It does not necessarily indicate an adverse health impact.

The “significant impact levels” (SILs) and “monitoring de minimis concentrations” are numerical values that represent thresholds of insignificance (i.e., de minimis, modeled source impacts or monitored ambient concentrations, respectively). The SIL and monitoring de minimis concentration thresholds are used as screening tools by a major source subject to PSD to determine the level of analysis and data gathering required for a PSD permit application.

PSD regulations state that, in the event the screening-level analysis yields ground-level concentrations that exceed a defined SIL concentration, then a refined air quality analysis must be completed. If the significance analysis modeled impacts are greater than the de minimis levels, a refined analysis would be performed based on at least one year of on-site meteorological data and site-specific topography. In this analysis, existing and permitted sources of pollutants within the region of influence must be considered to evaluate the PSD Class I and Class II increments consumed by the project in conjunction with the background pollutant sources. If modeling shows an increase in ambient concentrations of air pollution by an amount less than the de minimis levels the source is exempted from the site-specific ambient monitoring data requirement.

If and when the regulatory authority reaches a preliminary decision to authorize construction of each proposed major new source, it must provide notice of the preliminary decision and an opportunity for the general public, industry, and others that may be affected by the emissions of the major source to comment before issuing a final decision.

In the context of PSD permitting requirements, a PSD increment evaluation and NAAQS evaluation are conducted to assess potential cumulative impacts on air quality. The PSD increment analysis is used to estimate the degradation of air quality caused by construction of manmade sources of air pollution after certain baseline dates. For PSD baseline purposes, a baseline date is the submittal date of the first completed PSD permit application in a particular area. The NAAQS evaluation, which includes background pollutant concentrations, is used to estimate the total impacts of all natural and manmade sources of air pollution on air quality, compared with the pollutant concentrations at which human health or the environment could be impacted.

The maximum allowable PSD increments over baseline, SILs, and monitoring de minimis concentrations are summarized in Table 3.2-3.

**Table 3.2-3.** PSD of Air Quality Increments, Significant Impact Levels, and Monitoring de Minimis Concentrations

| Pollutant | Averaging Time | PSD Increments Class I (μg/m$^3$) | PSD Increments Class II (μg/m$^3$) | SILs Class I (μg/m$^3$) | SILs Class II (μg/m$^3$) | Monitoring de Minimis Concentrations (μg/m$^3$) |
|---|---|---|---|---|---|---|
| $PM_{10}$ | Annual | 4 | 17 | 0.16 | 1 | N/A |
| | 24-hour | 8 | 30 | 0.32 | 5 | 10 |
| $SO_2$ | Annual | 2 | 20 | 0.08 | 1 | N/A |
| | 24-hour | 5 | 91 | 0.2 | 5 | 13 |
| | 3-hour | 25 | 512 | 1 | 25 | N/A |
| $NO_2$ | Annual | 2.5 | 25 | 0.1 | 1 | 14 |
| CO | 8-hour | N/A | N/A | N/A | 500 | 575 |
| | 1-hour | N/A | N/A | N/A | 2,000 | N/A |

Source: 40 CFR 52.21.

Note: N/A = Not applicable; μg/m$^3$ = micrograms per cubic meter

## Air Quality Related Values

In cases where a proposed project's emissions may adversely affect an area classified as a Class I area, additional review is conducted to protect the increments and special attributes of such an area defined as air quality related values (AQRVs). These AQRVs are scenic, cultural, physical, biological, ecological, or recreational resources that may be affected by a change in air quality as defined by the federal land manager for federal lands. AQRVs are applicable in NPS (Grand Canyon National Park), USFWS, Forest Service, and BLM Class I areas. The specific AQRVs of concern are dependent on a number of variables, including the evolving state of the science, project-specific pollutants, site-specific management concerns, and the existing condition of the AQRVs. Please refer to Section 3.2.3, Existing Air Quality, for a discussion of the specific AQRV, visibility.

In general, the assessment of these impacts is based on dispersion modeling covering both short-range and long-range transport of $PM_{10}$, $SO_2$, and $NO_2$. The AQRV analysis required for PSD permitting of new major sources includes consideration of potential impacts on visibility, acid rain, sensitive species, soils, flora, and fauna that are associated with air emissions of a proposed project.

### New Source Performance Standards

The New Source Performance Standards promulgated by EPA pursuant to Section 111 of the CAA establish emission limitations, work-practice standards, and provisions for monitoring, recordkeeping, and reporting applicable to new stationary sources of criteria pollutants. The New Source Performance Standards are codified at 40 CFR 60. At first, 40 CFR 60, Subpart LL, Standards of Performance for Metallic Mineral Processing Plants, appeared to be applicable; however, upon further review, Subpart LL provided certain exemptions for facilities located in underground mines and uranium ore processing plants, including all facilities subsequent to and including beneficiation of uranium ore. Therefore, no New Source Performance Standards are applicable to uranium mining.

### National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants include emission limitations, work-practice standards, and provisions for monitoring, recordkeeping, and reporting of hazardous air pollutants not covered by the NAAQS. These standards were promulgated pursuant to Section 112 of the CAA and are codified at 40 CFR Parts 61 and 63. The Part 63 standards apply to specific source categories and require affected facilities to implement maximum achievable control technology for specific hazardous air pollutants specified in each subpart.

Radon is a radioactive gas formed as part of the radioactive decay chain of uranium and is considered a hazardous air pollutant. Several subparts under Part 61 appear to potentially apply to uranium mining and processing activities. Those potentially applicable subparts are as follows:

- 40 CFR Part 61 Subpart B, National Emission Standards for Radon Emissions from Underground Uranium Mines;
- 40 CFR Part 61 Subpart T, National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings; and
- 40 CFR Part 61 Subpart W, National Emission Standards for Radon Emissions from Operating Mill Tailings.

Radon-222 emissions from the underground uranium mining activities are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the life of the mine of ore production) cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem. The applicability of 40 CFR Part 61 Subpart B defines which individual processes are subject to the emission limitations established in the regulation. A mine whose production is less than 10,000 tons of ore per year or 100,000 tons of ore over its lifetime is not subject to 40 CFR Part 61 Subpart B.

It should be noted that all mined uranium ore is transported to and processed at the White Mesa Mill, located in Blanding, Utah. No uranium ore processing would occur within the proposed withdrawal area.

### Department of Transportation

The transportation of uranium ore is regulated under 49 CFR Subchapter C – *Hazardous Materials Regulations*. Several parts under Subchapter C appear to potentially apply to transport of uranium ore from the mine location to the processing facility. These regulations were promulgated by the U.S. Department of Transportation, and potentially applicable parts are as follows:

- Part 171 – *General Information, Regulations, and Definitions*;

- Part 172 – *Hazardous Materials Table, Special Provisions, Hazard Materials Communications, Emergency Response Information, Training Requirements, and Security Plans*; and
- Part 177 – *Carriage by Public Highway*.

Compliance with these regulations would be the requirement of any affected mining operation for the transport of uranium ore from the mine location to the processing facility.

## *Clean Air Act Title V Permit Program*

Under the federal operating permit program established by Title V of the 1990 CAA Amendments, federal, state, and local agencies delegated the authority to administer and enforce the program shall issue air quality operating permits to major stationary sources of air pollutant emissions. Under Title V, major sources are those with a potential to emit: 100 tons per year or more of any one regulated pollutant ($PM_{10}$; $NO_x$, $SO_2$, CO, volatile organic compounds [VOCs], and Pb), 10 tpy or more of any one hazardous air pollutant (HAPs), or 25 tpy or more of any two or more HAPs.

The implementing EPA regulations are codified at 40 CFR 70 and 71. Title V permits identify all applicable requirements under the act, create a "permit shield," and establish requirements for monitoring, recordkeeping, reporting, and annual compliance certifications. ADEQ was delegated the authority to administer the federal Title V permit program in all areas of Arizona except Maricopa, Pinal, and Pima counties and all areas within the borders of an Indian reservation. Therefore, any "major" uranium mining facilities would be required to submit a Title V air permit application to the ADEQ.

Under Title V of the CAA some tribal lands have been delegated authority to regulate air quality. In the area of northern Arizona and southern Utah, the Navajo Nation is the only tribal government granted this authority. Other tribal nations in the withdrawal area can participate in permitting activities but have not been granted the authority to regulate air quality.

## *Title 49, Transportation of Hazardous Materials*

Transportation of uranium ore is regulated by Title 49 Parts 171, 172, 173, and 177, which classifies and determines specific transportation requirements for hazardous materials. Uranium ore is classified as a Class 7 radioactive material, and Title 49 Part 173.403 classifies uranium or as a Low Specific Activity (LSA) Group 1 material. The LSA-1 designation of ore shipments general exempts them from most of the labeling and placarding requirements of other Class 7 radioactive materials. Title 49 regulations control loading, shipping, packaging, reporting, and emergency procedures.

## *State Laws and Regulations*

ADEQ has been delegated the authority to administer and enforce the CAA, federal, and state regulations and standards in Coconino and Mohave counties, Arizona (location of the proposed withdrawal parcels); with the exception of those regulations at 40 CFR Part 61 Subpart B. Those regulations are administered by Region 9 of the EPA. The uranium processing site is located in Blanding, San Juan County, Utah. The Utah Department of Environmental Quality (UDEQ) enforces air quality regulations in that area (UDEQ 2010).

### ARIZONA LAWS AND REGULATIONS

The proposed withdrawal parcels are located in Coconino and Mohave counties, Arizona. ADEQ air quality regulations are provided in Title 18, Chapter 2 of the Arizona Administrative Code (AAC). These regulations establish ambient air quality standards for the state that are equivalent to the NAAQS. The

AAC also includes promulgated emission limits and workplace standards for specific categorical sources that might be applicable to certain activities within the air quality study areas.

The EPA has delegated ADEQ the authority under the CAA to regulate air quality and issue air quality permits. This permitting process is the primary way that ADEQ balances environmental protection and economic development. The ADEQ Air Quality Division issues air quality permits to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air. Moreover, the permitting process allows citizens to stay informed and involved as these proposed air quality permitting decisions are made.

ADEQ receives the authority to require air modeling for new major sources and major modifications to existing sources from the AAC R18-2-407. Furthermore, the Arizona Revised Statutes (ARS) §49-422, describes the broad authority of the ADEQ Director in regards to the quantification of the air contaminants. This authority allows the Director to require a source of contaminants, by permit or executive order, to quantify its emissions of air pollution. Therefore, on a case-by-case basis, ADEQ also requires that permit applicants perform modeling analyses for both minor sources and minor modifications.

## Global Climate Change

Climate change is a global problem that results from global GHG emissions. There are more sources and actions emitting GHGs (in terms of both absolute numbers and types) than are typically encountered when evaluating the emissions of other pollutants. These emissions are often categorized as either anthropogenic (human-caused) or non-anthropogenic (naturally occurring). From a quantitative perspective, there is no single dominating anthropogenic source and fewer sources that would even be close to dominating total GHG emissions. The global climate change problem is much more the result of numerous and varied sources, each of which might seem to make a relatively small addition to global atmospheric GHG concentrations. Currently, there are no sites within the study area that are collecting ambient GHG data. Ambient background data that exist are parametrically derived from fossil fuel combustion and other industrial sources.

Projected climate change impacts include air temperature increases; sea level rise; changes in the timing, location, and quantity of precipitation; and increased frequency of extreme weather events such as heat waves, droughts, and floods. These changes will vary regionally and affect renewable resources, aquatic and terrestrial ecosystems, and agriculture. While uncertainties will remain regarding the timing and extent magnitude of climate change impacts, the scientific evidence predicts that continued increases in GHG emissions will lead to increased climate change.

The proposed alternatives would be a source of carbon dioxide ($CO_2$) and other GHGs, which could have an undetermined effect on local, regional, and global climate change. This analysis is unable to identify the specific impacts of the proposed alternatives GHG on global warming and climate change because there is insufficient information and numerous models, which produce widely divergent results.

Therefore, it is difficult to state with any certainty what impacts on global warming may result from GHG emissions, or to what extent the proposed alternatives would contribute to those climate change impacts. As a result, any attempt to analyze and predict the local or regional impacts of the proposed alternatives on GHG emissions cannot be done in any way that produces reliable results. On May 14, 2008, the Director of the USFWS noted, “The best scientific data available today do not allow us to draw a causal connection between GHG emissions from a given facility and effects posed to listed species or their habitats, nor are there sufficient data to establish that such impacts are reasonably certain to occur” (USFWS 2008).

Chapter 4 will quantify GHG emissions from combustion sources (both mobile and stationary sources) associated with the mining-related activities under each of the proposed alternatives.

## 3.2.3 Existing Air Quality

The following section describes the existing air quality within the proposed withdrawal area.

### *Background Air Quality and Regional Sources*

There are many regional sources that may impact the Class I areas. Five permitted major point sources of air-pollutant emissions are located within 50 km (31 miles) of the proposed withdrawal area, with emissions greater than PSD thresholds (Table 3.2-4). A major source is categorized as a source that has the potential to emit more than 250 tons per year (tpy) for a PSD source, or 100 tpy for a categorical source of a criteria pollutant, or more than 10 tpy of any single hazardous air pollutant, or 25 tpy of any combination of hazardous air pollutants.

PSD sources are normally considered to have the potential for significant impacts, and more restrictive permitting requirements are generally imposed. Note that $NO_x$ are produced during combustion, typically those that involve high combustion temperatures, and refer to nitric oxide (NO) and $NO_2$, respectively. Under current federal regulation [40 CFR 86, 87, 89, etc.], the affected sources listed in Table 3.2-4 will not report emissions until the first quarter of 2011, with the exception of $CO_2$ emissions reported by the Navajo Generating Station.

**Table 3.2-4.** PSD Sources Located within and near the Proposed Withdrawal Air Quality Study Area

| Facility Name | Facility Type | Location in Arizona | Emissions (tpy) | Permitting Authority |
|---|---|---|---|---|
| El Paso Natural Gas Company – Seligman Compressor Station | Natural Gas Compressor Station | Seligman | CO – 19<br>$NO_X$ – 165<br>$PM_{10}$ – 4<br>$PM_{2.5}$ – 4<br>$SO_2$ – <1<br>VOCs – 4<br>Pb – <1 | ADEQ |
| El Paso Natural Gas Company – Williams Compressor Station | Natural Gas Compressor Station | Williams | CO – 230<br>$NO_X$ – 1,303<br>$PM_{10}$ – 16<br>$PM_{2.5}$ – 16<br>$SO_2$ – 1<br>VOCs – 55<br>Pb – <1 | ADEQ |
| Salt River Project – Navajo Generating Station | Electric Utility | Page | CO – 2,010<br>$NO_X$ – 33,221<br>$PM_{10}$ – 3,943<br>$PM_{2.5}$ – 2,817<br>$SO_2$ – 3,944<br>VOCs – 241<br>Pb – 0.07<br>$CO_2$ – 20.1 million | Navajo Nation Environmental Protection Agency |
| Chemical Lime Company – Nelson Lime Plant | Lime Plant | Peach Springs | CO – 639<br>$NO_X$ – 599<br>$PM_{10}$ – 480<br>$SO_2$ – 1,955<br>VOCs – 17<br>Pb – 0.0002 | ADEQ |

**Table 3.2-4.** PSD Sources Located within and near the Proposed Withdrawal Air Quality Study Area (Continued)

| Facility Name | Facility Type | Location in Arizona | Emissions (tpy) | Permitting Authority |
|---|---|---|---|---|
| Transwestern Pipeline Company – Flagstaff Compressor Station | Natural Gas Compressor Station | Flagstaff | CO – 11<br>$NO_X$ – 127<br>$PM_{10}$ – 2<br>$PM_{2.5}$ – 2<br>$SO_2$ – 1<br>VOCs – 2<br>Pb – <1 | ADEQ |
| Drake Cement, LLC – Drake Cement Plant | Portland Cement Plant | Drake | CO – 1,200<br>$NO_X$ – 419<br>$PM_{10}$ – 87<br>$SO_2$ – 22<br>VOCs – 39 | ADEQ |
| Peabody Western Coal Company – Black Mesa Complex | Coal Mine | Kayenta | $PM_{10}$ – 1,398<br>$PM_{2.5}$ – 325<br>VOCs – 9 | Navajo Nation Environmental Protection Agency |

Sources: ADEQ (2010c); EPA (2010j); Navajo Nation Environmental Protection Agency (2010); Western Regional Air Partnership (2010).

Note: Emissions include criteria pollutants (CO, $NO_X$, $PM_{10}$, $PM_{2.5}$, $SO_2$, VOCs, and Pb). Emissions data presented are for calendar year 2005 except for the Nelson Lime Plant and Black Mesa Complex, which are for calendar year 2008. Emissions data presented for Drake Cement, LLC – Drake Cement Plant represent maximum annual emissions as reported in the Standard Class I PSD Major Source Permit (Permit Number 1001770, issued on April 12, 2006). CO = carbon monoxide; $NO_X$ = nitrogen oxides; $PM_{10}$ = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; $SO_2$ = sulfur dioxide; VOCs = volatile organic compounds; Pb = lead; tpy = tons per year.

A minor source is categorized as a source having the potential to emit less than 100 tpy of a criteria pollutant, or less than 10 tpy of an individual hazardous air pollutant, or less than 25 tpy of any combination of HAPs. Minor sources located within 31 miles (50 km) of the proposed withdrawal parcels include smaller industrial and commercial operations. Additionally, there are numerous portable sources in the area, such as non-metallic mineral processing industries (e.g., portable crushing and screening plants, hot mix asphalt plants, and concrete batch plants) and the Arizona 1 Mine.

Mobile source emissions from vehicles consist of VOCs, $NO_2$, CO, $PM_{10}$, and $PM_{2.5}$, which may warrant consideration in an assessment of ambient air quality in the air quality study areas. Consideration of major traffic routes located within the air quality study areas may be reasonably limited to SR 64, which serves as the entrance to the South Rim of the Grand Canyon, and U.S. Route (U.S.) 89A through Fredonia, Arizona. Additionally, fugitive dust emissions are generated from traffic traveling on the unpaved Toroweap Road to the Tuweep district of Grand Canyon National Park. Based on information obtained from the National Park Service Public Use Statistics Office, the traffic counts in 2009 for the South District and Tuweep District were 1,122,886 and 8,659, respectively (NPS 2010).

The most recent EPA Emissions Inventory Report provides data for Coconino and Mohave counties in Arizona and Kane and Washington counties in Utah, including statewide totals, shown in Table 3.2-5. The report summarizes criteria pollutant levels in tpy by source type. These data show that the emissions in Coconino and Mohave counties, Arizona, and Kane and Washington counties, Utah, constitute a small percentage of the Arizona and Utah statewide totals.

The largest sources of $NO_x$ and $PM_{10}$ in Coconino and Mohave counties in Arizona and Kane County, Utah, are on-road mobile and area sources. Area sources include small portable and stationary sources such as gas stations or wood burning. The largest sources of $PM_{10}$ in Washington County, Utah, are miscellaneous sources, which include agricultural (crop tilling and livestock dust), construction, gas stations, bulk gasoline terminals, and other miscellaneous sources.

**Table 3.2-5.** 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties, Arizona, Kane and Washington Counties, Utah, and Arizona Statewide

| Source | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_x$ | VOCs | Pb |
|---|---|---|---|---|---|---|---|
| **Coconino County** | | | | | | | |
| On-road Vehicles | 39,250 | 6,475 | 182 | 134 | 140 | 3,066 | – |
| Electricity Generation | 2,010 | 33,221 | 3,943 | 2,817 | 3,944 | 241 | 0 |
| Non-road Equipment | 12,989 | 3,509 | 204 | 192 | 269 | 2,933 | 2 |
| Fossil Fuel Combustion | 514 | 2,652 | 57 | 30 | 114 | 105 | 0 |
| Industrial Processes | 25 | – | 836 | 218 | – | 104 | – |
| Fires | 14,818 | 282 | 1,570 | 1,330 | 168 | 3,497 | – |
| Waste Disposal | 2,045 | 74 | 318 | 306 | 5 | 259 | – |
| Residential Wood Combustion | 348 | 4 | 48 | 48 | 1 | 75 | – |
| Miscellaneous | 7 | 0 | 2,045 | 207 | – | 735 | 0 |
| Solvent Use | – | – | – | – | – | 692 | – |
| Road Dust | – | – | 6698 | 594 | – | – | – |
| Fertilizer and Livestock | – | – | – | – | – | – | – |
| *Subtotal* | *72,006* | *46,217* | *15,901* | *5,876* | *4,641* | *11,707* | *2* |
| **Mohave County** | | | | | | | |
| On-road Vehicles | 43,423 | 7,386 | 208 | 151 | 160 | 3,862 | – |
| Electricity Generation | 7 | 22 | 1 | 1 | 3 | 1 | – |
| Non-road Equipment | 23,633 | 4,339 | 284 | 270 | 356 | 6,413 | 1 |
| Fossil Fuel Combustion | 174 | 788 | 66 | 28 | 149 | 44 | 0 |
| Industrial Processes | 28 | 32 | 839 | 214 | 0 | 28 | 0 |
| Fires | 14,280 | 313 | 1,551 | 1,314 | 171 | 3,384 | – |
| Waste Disposal | 4,437 | 144 | 550 | 539 | 4 | 427 | – |
| Residential Wood Combustion | 278 | 4 | 39 | 39 | 1 | 60 | – |
| Miscellaneous | 10 | 0 | 3,857 | 412 | – | 920 | 0 |
| Solvent Use | – | – | 10 | 9 | – | 1,086 | – |
| Road Dust | – | – | 2,711 | 231 | – | – | – |
| Fertilizer and Livestock | – | – | – | – | – | – | – |
| *Subtotal* | *86,270* | *13,028* | *10,116* | *3,208* | *844* | *16,225* | *1* |
| **Arizona** | | | | | | | |
| On-road Vehicles | 761,670 | 132,317 | 3,866 | 2,711 | 2,909 | 73,626 | – |
| Electricity Generation | 7,340 | 80,370 | 8,968 | 7,131 | 52,765 | 596 | 1 |
| Non-road Equipment | 458,730 | 64,553 | 5,062 | 4,789 | 6,344 | 50,563 | 33 |
| Fossil Fuel Combustion | 4,243 | 13,921 | 1,116 | 528 | 4,061 | 663 | 2 |
| Industrial Processes | 8,071 | 7,051 | 20,328 | 8,184 | 22,107 | 3,595 | 12 |
| Fires | 74,115 | 1,749 | 8,166 | 6,920 | 907 | 17,611 | – |
| Waste Disposal | 24,918 | 981 | 4,068 | 3,757 | 115 | 4,585 | – |
| Residential Wood Combustion | 15,231 | 183 | 2,097 | 2,066 | 28 | 3,200 | – |
| Miscellaneous | 348 | 33 | 70,344 | 8,635 | 3 | 19,736 | 0 |
| Solvent Use | – | 8 | 18 | 16 | – | 49,800 | 0 |
| Road Dust | – | – | 111,387 | 9,085 | – | – | – |
| Fertilizer and Livestock | – | – | 3,079 | 308 | – | – | – |
| *Subtotal* | *1,354,666* | *301,166* | *238,499* | *54,130* | *89,239* | *223,975* | *48* |
| **Coconino and Mohave County Percentage of Statewide Total** | **11.7%** | **19.7%** | **10.9%** | **16.8%** | **6.1%** | **12.5%** | **6.3%** |

**Table 3.2-5.** 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties, Arizona, Kane and Washington Counties, Utah, and Arizona Statewide (Continued)

| Source | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_x$ | VOCs | Pb |
|---|---|---|---|---|---|---|---|
| **Kane County** | | | | | | | |
| On-Road Vehicles | 3,490 | 373 | 10 | 7 | 9 | 279 | – |
| Electricity Generation | – | – | – | – | – | – | – |
| Non-road Equipment | 2,208 | 72 | 24 | 22 | 7 | 760 | 0 |
| Fossil Fuel Combustion | 237 | 46 | 8 | 4 | 73 | 9 | 0 |
| Industrial Processes | 1 | – | 17 | 5 | – | 2 | – |
| Fires | 734 | 11 | 86 | 76 | 9 | 156 | – |
| Waste Disposal | 1 | – | 0 | 0 | – | 1 | – |
| Residential Wood Combustion | 31 | 0 | 4 | 4 | 0 | 5 | – |
| Miscellaneous | 803 | 16 | 393 | 33 | 8 | 277 | 0 |
| Solvent Use | – | – | – | – | – | 127 | – |
| Road Dust | – | – | 631 | 58 | – | – | – |
| Fertilizer and Livestock | – | – | – | – | – | – | – |
| *Subtotal* | *7,506* | *517* | *1,173* | *209* | *105* | *1,616* | *0* |
| **Washington County** | | | | | | | |
| On-Road Vehicles | 22,270 | 3,591 | 78 | 55 | 87 | 1,771 | – |
| Electricity Generation | 16 | 68 | 2 | 2 | 2 | 1 | – |
| Non-road Equipment | 8,843 | 842 | 109 | 103 | 105 | 1,322 | 0 |
| Fossil Fuel Combustion | 1,180 | 263 | 36 | 15 | 138 | 84 | 0 |
| Industrial Processes | 26 | 8 | 145 | 45 | 7 | 31 | 0 |
| Fires | 11,735 | 311 | 1,354 | 1,155 | 135 | 2,776 | – |
| Waste Disposal | – | – | 8 | 0 | – | 23 | – |
| Residential Wood Combustion | 518 | 6 | 68 | 63 | 1 | 91 | – |
| Miscellaneous | 7,256 | 111 | 6,756 | 1,284 | 58 | 2,326 | 0 |
| Solvent Use | – | – | – | – | – | 1,393 | – |
| Road Dust | – | – | 1,041 | 80 | – | – | – |
| Fertilizer and Livestock | – | – | – | – | – | – | – |
| *Subtotal* | *51,843* | *5,200* | *9,599* | *2,803* | *533* | *9,820* | *0* |
| **Utah** | | | | | | | |
| On-Road Vehicles | 541,556 | 66,474 | 1,517 | 1,052 | 1,633 | 40,662 | – |
| Electricity Generation | 4,558 | 65,887 | 6,621 | 5,104 | 34,820 | 368 | 0 |
| Non-road Equipment | 170,322 | 27,848 | 1,838 | 1,729 | 2,520 | 26,606 | 4 |
| Fossil Fuel Combustion | 32,381 | 12,861 | 1,237 | 510 | 8,301 | 1,719 | 0 |
| Industrial Processes | 41,370 | 10,109 | 10,833 | 4,106 | 4,067 | 4,387 | 5 |
| Fires | 114,656 | 2,040 | 14,682 | 13,037 | 689 | 24,000 | – |
| Waste Disposal | 192 | 926 | 975 | 224 | 78 | 533 | 0 |
| Residential Wood Combustion | 12,031 | 150 | 1,575 | 1,465 | 23 | 2,124 | – |
| Miscellaneous | 46,508 | 700 | 53,803 | 10,141 | 364 | 21,201 | 0 |
| Solvent Use | 14 | 37 | 43 | 31 | 0 | 31,847 | 0 |
| Road Dust | – | – | 23,554 | 1,869 | – | – | – |
| Fertilizer and Livestock | – | – | – | – | – | – | – |
| *Subtotal* | *963,586* | *187,030* | *116,677* | *39,270* | *52,496* | *153,447* | *11* |
| **Kane and Washington County Percentage of Statewide Total** | **6.2%** | **3.1%** | **9.2%** | **7.7%** | **1.2%** | **7.5%** | **2.1%** |

Source: EPA (2010j).

Note: – = No data available. ; tpy = tons per year.

CO = carbon monoxide; $NO_X$ = nitrogen oxides; $PM_{10}$ = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; $SO_2$ = sulfur dioxide; VOCs = volatile organic compounds; Pb = lead.

The existing air quality in the area is expected to be typical of undeveloped regions in the western United States. Data collected in the area of the proposed withdrawal area is limited. Areas with limited ambient air quality data typically indicate that ambient pollutant levels are usually near or below detection limits. Locations vulnerable to decreasing air quality include the areas immediately surrounding surface-disturbing activities, such as energy and mineral development projects, farm tilling, and local population centers affected by residential emissions.

Specifically within the Grand Canyon National Park, peak ozone levels have been measured at just 1 part per billion (ppb) below the NAAQS. Particulate levels as measured by the Interagency Monitoring of Protected Visual Environments (IMPROVE) network are generally low, but episodic events (usually, but not always, associated with wildfires in Arizona and California) are significant. CO and $NO_x$ levels have only been measured as part of special studies and were quite low (Martin et al. 2002). Based on 1-hour ozone concentration data obtained from the Grand Canyon National Park—The Abyss Monitor, the annual fourth-highest 8-hour ozone concentrations for 2007 through 2009 have been 69, 71, and 66 ppb, respectively (NPS Public Use Statistics Office 2010). The annual 4th-highest 8-hour ozone concentrations have flat trends, nonetheless the values are very close to the 8-hour ozone standard (0.075 ppm).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern.

Emissions from mining activities and trucks used for hauling the uranium ore to the processing areas are air quality issues. Other potential local sources of air pollution include agriculture, automobiles, generators, trains, and wood stoves/fireplaces (in winter). These sources typically generate and emit CO, $NO_2$, $NO_x$, VOCs, $PM_{10}$, and $PM_{2.5}$. Additionally, $O_3$, a highly reactive form of oxygen, forms when $NO_x$ and VOC emissions from these sources react with sunlight on hot, still days. With the removal of leaded gasoline in the marketplace and the absence of industries such as nonferrous smelters and battery plants, airborne lead pollution is not an issue of concern in the area. In fact, the most recent lead concentration data are from Magna, Salt Lake County, Utah, for 2005, which is more than 300 miles from the proposed withdrawal parcels (EPA 2010k).

The proposed withdrawal parcels are classified as 'attainment areas' for all criteria pollutants. Only two state monitoring stations were identified within the approximately 50-km vicinity of the air quality study area. These two monitors report ambient concentrations of $O_3$, $PM_{10}$, and $PM_{2.5}$. Background air quality levels of CO, Pb, $NO_2$, and $SO_2$ were collected from the next-closest monitors that are outside the immediate 50-km air quality study area and are identified in Table 3.2-5. Refer to Figure 3.2-1 for the monitoring station locations. Concentrations are also graphically presented in Figure 3.2-2. As shown in Table 3.2-6 and Figure 3.2-2, all of the concentrations were below the NAAQS.

Radon is a colorless, chemically unreactive inert gas. The atomic radius is 1.34 angstroms, and it is the heaviest known gas—radon is nine times denser than air. Radon is also fairly soluble in water and organic solvents. Although reaction with other compounds is comparatively rare, it is not completely inert and forms stable molecules with highly electronegative materials. Radon is considered a noble gas that occurs in several isotopic forms. Only two are found in significant concentrations in the human environment: radon-222 and radon-220. Radon-222 is a member of the radioactive decay chain of uranium-238. Radon-220 is formed in the decay chain of thorium-232. Radon-222 decays in a sequence of radionuclides called radon decay products, radon daughters, or radon progeny. It is radon-222 that most readily occurs in the environment. Atmospheric releases of radon-222 result in the formation of decay products that are radioisotopes of heavy metals (polonium, lead, bismuth) and rapidly attach to other airborne materials, such as dust and other materials, facilitating inhalation.

**Table 3.2-6.** 2008 Air Quality Monitor Data from the Air Quality Study Area

| Pollutant | Averaging Period | Measured Concentration (Maximum Value) | Monitor Site ID/Name (County) | Source | Primary NAAQS |
|---|---|---|---|---|---|
| CO | 1-hour | 4.2 ppm | 320030538 | EPA | 35 ppm (40 mg/$m^3$) |
| | 8-hour | 2.5 ppm | Las Vegas, NV (Clark County) | | 9 ppm (10 mg/$m^3$) |
| Pb* | Rolling 3-Month Average | – | – | – | – |
| | Quarterly Average | – | – | – | – |
| $NO_2$ | 1-hour | 0.064 ppm | 3200332002 | EPA | 0.100 ppm |
| | Annual | 0.016 ppm | Las Vegas, NV (Clark County) | | 0.053 ppm (100 µg/$m^3$) |
| $PM_{10}$ | 24-hour | 45 µg/$m^3$ | 04-005-1008 Flagstaff Middle School, AZ (Coconino County) | ADEQ | 150 µg/$m^3$ |
| $PM_{2.5}$ | 24-hour | 13.5 µg/$m^3$ | 04-005-1008 | ADEQ | 35 µg/$m^3$ |
| | Annual | 5.92 µg/$m^3$ | Flagstaff Middle School, AZ (Coconino County) | | 15.0 µg/$m^3$ |
| $O_3$ | 1-hour | 0.078 ppm | 04-005-8001 | ADEQ | 0.12 ppm |
| | 8-hour | 0.073 ppm | Grand Canyon NP – The Abyss (Coconino County) | | 0.075 ppm (2008 standard) |
| $SO_2$ | 3-hour | 0.002 ppm | 320030539 | EPA | 0.5 ppm |
| | 24-hour | 0.002 ppm | Las Vegas, NV | | 0.14 ppm |
| | Annual | 0.001 ppm | (Clark County) | | 0.03 ppm |

Sources: ADEQ (2009a); EPA (2010k).

Note: – = No data available; ppm = parts per million; µg/$m^3$ = micrograms per cubic meter; CO = carbon monoxide; Pb = lead; $NO_2$ = nitrogen dioxide; $PM_{10}$ = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; $0_3$ = ozone; $SO_2$ = sulfur dioxide.

* Ambient lead monitoring data not available for the study area. Nearest monitoring occurs in Magna, Utah.

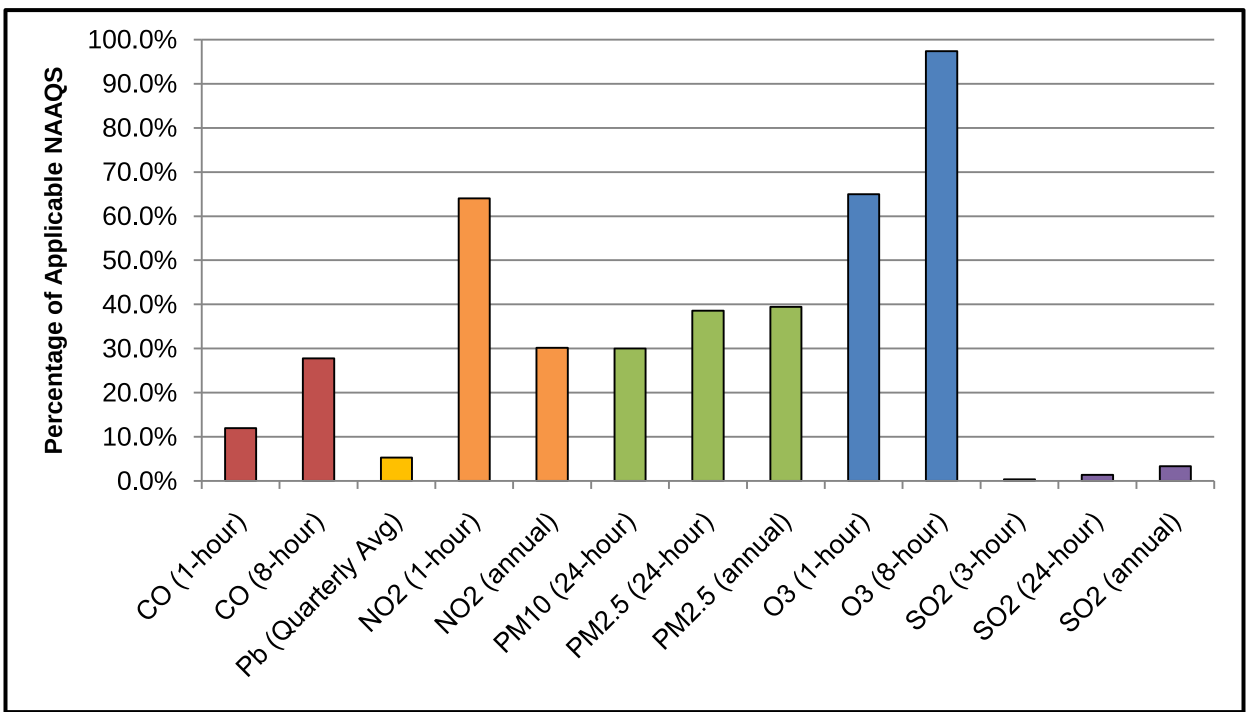



**Figure 3.2-2.** Background concentrations of criteria pollutants from the air quality study area.

People may ingest trace amounts of radon with food and water. However, inhalation is the main route of entry into the body for radon and its decay products. Radon decay products may attach to particulates and aerosols. When they are inhaled, some of these particles are retained in the lungs. Almost all risk from radon comes from breathing air with radon and its decay products. Radon decay products cause lung cancer. The health risk of ingesting radon, in water, for example, is dwarfed by the risk of inhaling radon and its decay products. They occur in indoor air or with tobacco smoke. Alpha radiation directly causes damage to sensitive lung tissue. Most of the radiation dose is not actually from radon itself, however, which is mostly exhaled. It comes from radon's chain of short-lived solid decay products, which are inhaled on dust particles and lodge in the airways of the lungs. These radionuclides decay quickly, producing other radionuclides that continue damaging the lung tissue.

There have been historical issues with radioactive fallout within the withdrawal parcels. The nuclear testing conducted at the Nevada Test Site in the 1940s and 1950s dispersed radioactive material into the atmosphere. This radioactive material was then deposited as radioactive fallout. This radioactive fallout accounts for much of the background radiation in the area.

The natural background radon gas concentration in the vicinity of the Arizona 1 Mine is on the order of 0.2 picocuries per liter (pCi/L), or 125 mrem/yr. Based on previous evaluations of the project (McKlveen 1988), the highest potential exposure projected from radon would be on the order of 106 mrem/yr (ADEQ 2008).

Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the mine life of ore production) and cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (ADEQ 2010a). To put the 10 millirem in context, a typical chest x-ray is approximately 10 millirem per film and smoking one and a half packs of cigarettes daily exposes an individual to approximately 1,300 millirem per year (Cancer Information Service 2001).

The ADEQ-issued Air Quality Permit for the Arizona 1 Mine requires Denison to keep records of all emission related activities and submit for approval a dust control plan that requires them to monitor and track ongoing implementation of dust control measures. Additionally, radon emissions from the vent shaft must be monitored and sent to ADEQ for review (Table 3.2-7).

**Table 3.2-7.** Arizona 1 Mine Potential to Emit (tpy)

| CO | $NO_x$ | $PM_{10}$* | $PM_{2.5}$ | $SO_2$ | VOCs | Radon[†] |
|---|---|---|---|---|---|---|
| 0.28 | 1.3 | 324.44 | 5.7 | 0.08 | 0.38 | – |

Source: ADEQ (2010a).

Note: – = No data available; tpy = tons per year. CO = carbon monoxide; $NO_x$ = nitrogen oxides; $PM_{10}$ = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; $SO_2$ = sulfur dioxide; VOCs = volatile organic compounds.

* Includes fugitive emissions, which are not considered in PSD applicability.

[†] Potential to emit was based on permissible thresholds promulgated in 40 CFR 61.22.

ADEQ required Denison to conduct ambient air dispersion modeling to ensure that emissions from the Arizona 1 Mine would not cause or contribute to an exceedance of the federal NAAQS for particulate matter. ADEQ required that Denison include the 37 miles of unpaved road used by the haul trucks in this analysis.

## *Visibility*

Visibility is the degree to which the atmosphere is transparent to visible light. It is an important air quality value, particularly in scenic and recreational areas. Scenic vistas in most U.S. parklands can be diminished by haze that reduces contrast, dilutes colors, and reduces the distinctness or visibility of distant landscape features. Visibility degradation in national park lands and forests is a consequence of broader, regional-scale visibility impairment from visibility-reducing particles and their precursors, which are often carried long distances to these remote locations (NPS 2007).

Sulfates, organic matter, elemental carbon (soot), nitrogen compounds, soil dust, and their interaction with water cause most anthropogenic visibility impairment. The causes and severity of visibility impairment vary over time and space, depending on meteorological conditions, sunlight, and the size and proximity of emission sources.

Visibility protection requirements are included in EPA PSD regulations requiring protection of AQRVs for Class I areas. In the PSD title of the CAA, "Congress declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution." More specifically, Congress expressed the national desire to preserve the ability to see long distances, entire panoramas, and specific features associated with the statutory Class I areas (NPS 2010). Meeting these visibility objectives occurs when "reasonable progress" is made toward achieving EPA's regional haze regulation goal of restoring natural background visibility conditions by 2064 (EPA 2003a).

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas and publishes IMPROVE data. The purpose of this monitoring is to identify and evaluate patterns and trends in regional visibility. Data from three IMPROVE monitors within Grand Canyon National Park show that fine ($PM_{2.5}$) and coarse ($PM_{10}$) particulates were the largest contributors to the impairment of visibility. These particulates impact the standard visual range for each monitor location. The standard visual range is the distance that can be seen in a given day. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park (GRCA1, GRCA2, and INGA1) range from 149 to 178 mile on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days (IMPROVE 2010).

A change in contrast of not more than 5% at sensitive view areas is considered acceptable. As discussed in the previous section, Bryce Canyon, Zion, and Grand Canyon national parks (all Class I) and Grand Canyon–Parashant National Monument, Glen Canyon and Lake Mead National Recreation Areas, and Paria Canyon–Vermilion Cliffs and Kanab Creek wilderness (Class II) are in close proximity to the proposed withdrawal parcels.

The State of Arizona has addressed both visibility and regional haze in the Class I areas within its State Implementation Plan (SIP). The Regional Haze SIP for the State of Arizona (ADEQ 2003) addresses visibility protection of Arizona's natural features using various long-term strategies addressing the clean air corridor, stationary sources, mobile sources, and fire programs.

More current information is available in the Air Quality Division Revision SIP for Regional Haze (ADEQ 2004). These documents contain measures addressing regional haze visibility impairment to ensure that the State makes reasonable progress toward national goals. The State has implemented long-term strategies to reduce regional haze resulting from various air pollution sources. Pollutant projections affecting regional haze, as identified in the 2004 revised SIP, include the following:

- A 36% decrease in Arizona sources and a 22% decrease for nine Grand Canyon Visibility Transport Commission region states' (Arizona, California, Colorado, Idaho, New Mexico, Nevada, Oregon, Utah, and Wyoming) $SO_2$ emissions between 1996 and 2018.

- A 16% decrease in Arizona sources and 32% decrease for nine Grand Canyon Visibility Transport Commission states' $NO_x$ emissions between 1996 and 2018.
- A 3% decrease in Arizona sources and 3% increase for nine Grand Canyon Visibility Transport Commission region states' $PM_{2.5}$ emissions between 1996 and 2018.
- A 25% decrease in Arizona sources and 30% decrease for nine Grand Canyon Visibility Transport Commission region states' VOC emissions between 1996 and 2018.
- Visibility improvement for the 20% best and worst days for each of the Class I areas (Bryce Canyon, Zion, and the Grand Canyon) from the base year 1996 to the year 2018.

The State of Arizona's reduction in $SO_2$ is due primarily to the long-term reduction strategy for stationary sources of $SO_2$. The reduction in $NO_X$ and $PM_{2.5}$ is due primarily to the implementation of new federal engine and fuel standards.

## *Resource Condition Indicators*

Air quality related to uranium mining activities results from initial heavy-duty construction equipment operations/earthmoving (e.g., trucks backhoes, excavators, etc.) and long-term from production operations (e.g., ore/waste rock handling, travel on unpaved roads, etc.). To properly evaluate any potential air quality effects that could be caused by an individual proposed mine or a number of proposed mines, each mine would need to be evaluated/modeled using the specific mine site location, number and types of equipment, operation schedules, site-specific topography, and meteorological data.

## *Resource Condition Indicators*

The air quality condition indicators to be evaluated in Chapter 4 of this assessment area as follows:

- Discussion of the potential increases in ambient concentrations in air pollutants associated with mine exploration and mining activities to determine compliance with applicable Federal, state, and local regulations;
- The estimated quantity of HAPs emitted under each alternative;
- Discussion of the potential increases in ambient concentrations in air pollutants associated with mine exploration and mining activities Comparison of the maximum $NO_X$, CO, $PM_{10}$, and $SO_2$ concentrations with the NAAQS;
- Discussion of potential increases in $NO_X$, CO, $PM_{10}$, and $SO_2$ concentrations with the PSD air quality increments;
- The estimated quantity of GHG emissions emitted under each alternative, and;
- Discussion of potential impacts in AQRVs relating to visibility.

To assess the current value of the resource condition indicators, the applicant of an individual proposed mine would be required to obtain an air quality permit from ADEQ. Depending on what class of permit would be required and/or the requests of the Department the applicant may be required to estimate its emissions and conduct modeling. The ADEQ Air Quality Division issues air quality permits to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.

## 3.2.4 Current Value Resource Condition Indicators

The current value or condition of the air quality within the study area with respect to each of the resource condition indicators is presented in Table 3.2-8.

**Table 3.2-8.** Air Quality Resource Condition Indicators

| Issue | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Quantity of criteria and hazardous air pollutants | The emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-7. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the life of the mine of ore production) and cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (ADEQ 2010a). A regulated uranium mine under 40 CFR Part 61 Subpart B must submit an application and annual Subpart B compliance reports to the EPA. | Quantity of criteria and hazardous air pollutants emitted under each alternative. |
| Regulatory Requirements | Each individual mine will be required to obtain an air quality permit. The permit is the mechanism to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air. | PSD: > 250 tpy of a criteria pollutant<br>Federal HAP Source: > 25 tpy combined or > 10 tpy of a regulated HAP<br>ADEQ Class I Source: > 100 tpy to < 250 tpy of a criteria pollutant<br>ADEQ Class II Source: > 2 tpy to < 100 tpy of a criteria pollutant |
| NAAQS | As shown in Table 3.2-6 and Figure 3.2-2, the ambient air concentration data obtained from monitors in or near the air quality study area were below the NAAQS. However, based on data obtained from the Grand Canyon National Park, the annual 4th-highest 8-hour ozone concentrations have flat trends nonetheless have values that are very close to 8-hour ozone standard (0.075 ppm) and sometimes over it (NPS 2010).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern. The EPA recommends that this proposed "secondary" standard be in the range of 7 to 21 ppm-hours. | Comparison of measured and/or modeled air pollutant concentrations with applicable thresholds (i.e., NAAQS). |
| PSD Increment | The PSD increments establish the maximum increase in pollutant concentration allowed above the baseline level. | PSD is the mechanism that protects Class I areas. |
| GHGs | Qualitative and/or quantitative evaluations of potential contributing factors within the planning area will be included in Chapter 4 where appropriate and practicable. | The quantity of GHG emission emitted under each alternative. |
| AQRVs – Visibility | The NPS has classified the visibility at the Grand Canyon National Park as a stable moderate concern. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days. | Discussion of visibility impacts and comparison of measured or modeled values with applicable thresholds. |

# 3.3 GEOLOGY AND MINERAL RESOURCES

## 3.3.1 Geological Setting

### *Physiography*

The proposed withdrawal area lies within the Colorado Plateau physiographic province in northern Arizona. The Colorado Plateau covers more than 130,000 square miles and is centered on the Four Corners area. The portion of the Colorado Plateau province that includes the proposed withdrawal area is characterized by predominantly sedimentary rock exposures; a regular, gently dipping surface; and plateaus over 7,000 feet above mean sea level (amsl) that have been incised in some places to depths over 5,000 feet by the tributaries to the Colorado River. Major geological structures that occur in the proposed withdrawal area include faults, anticlines, and monoclines. These structures often form the geographic boundaries for the numerous plateaus located throughout the area proposed withdrawal, and are shown in Figure 3.4-5 in Section 3.4, Water Resources.

The Colorado Plateau is known generally for unique geological features, including the widespread prevalence and color of exposed sedimentary units, the occurrence of isolated volcanic mountain complexes, and erosional features such as mesas, cliffs, escarpments, and incised stream canyons. While not within any of the parcels, the Grand Canyon dominates the geological setting and forms the partial geographic boundary of the East Parcel; the side tributary canyons to the Grand Canyon form the surface drainage network within the parcels.

The major geological structures and geographic features of the North Parcel include the Uinkaret and Kanab plateaus (see Figure 3.4-5). The Uinkaret Plateau extends east from the Hurricane fault zone to the Toroweap fault zone. The Kanab Plateau then extends east from the Toroweap fault zone to the Muav fault zone. These fault zones are largely northerly trending normal faults, downthrown to the west. The Kanab Plateau has also been dissected by Kanab Creek, a tributary to the Colorado River, as well as other tributaries to Kanab Creek, including Hack Canyon, Grama Canyon, and Snake Gulch.

House Rock Valley, where the East Parcel is located, is a geological basin bounded to the west by the East Kaibab monocline, which is the eastern edge of the Kaibab Plateau, to the north by the Vermilion Cliffs, which is the edge of the Paria Plateau, and to the southeast by Marble Canyon, part of the Colorado River gorge (see Figure 3.4-5).

The South Parcel lies completely within the Coconino Plateau, the largest of the plateaus within northern Arizona (see Figure 3.4-5). Major structural features within the South Parcel include the Grandview monocline, East Kaibab monocline, Cataract syncline, and Bright Angel fault.

The unique geological and topographic features of the Grand Canyon were cited as specific criteria for its designation as a World Heritage Site:

> Widely known for its exceptional natural beauty and considered one of the world’s most visually powerful landscapes. . . . Within park boundaries, the geologic record spans all four eras of the earth’s evolutionary history, from the Precambrian to the Cenozoic. The Precambrian and Paleozoic portions of this record are particularly well exposed in canyon walls and include a rich fossil assemblage. Numerous caves shelter fossils and animal remains that extend the paleontological record into the Pleistocene. (United Nations Educational, Scientific, and Cultural Organization 2010)

## Stratigraphy

In terms of geology, the Colorado Plateau in northern Arizona is composed of relatively flat layers of sedimentary rocks of Paleozoic and Mesozoic age deposited on top of Precambrian basement rocks, although in some places more recent Tertiary volcanic activity has created isolated mountains or cinder cones (such as the San Francisco Peaks or Mt. Trumbull). The general stratigraphy of the Colorado Plateau is shown in Figures 3.4-3 and 3.4-4. Specific geological units are discussed in detail in Section 3.4, Water Resources, as the primary importance of these units is their influence on local and regional hydrology.

## Paleontology

Geological units representing nearly 2 billion years of time are present in the proposed withdrawal area, although many are not exposed at the surface. Many of these units are sedimentary in nature, and some contain paleontological resources. The potential for a given geological formation to contain paleontological resources varies by formation age and deposition type. The geological units that contain paleontological resources range from 570 million years to about 10,000 years old.

The paleontological resources within the proposed withdrawal area are widespread and associated with extensive geological formations. These paleontological resources are typically small in size, common in nature, and ubiquitous. Paleontological resources of a highly unique nature are not common within the proposed withdrawal area; for this reason, while some subsurface impact to unexposed paleontological resources could occur from mining activities, it is not of a level sufficient to include in the analysis.

## Mineral Deposits

Minerals of economic interest are classified as leasable, locatable, or salable. Coal, oil shale, oil and gas, phosphate, potash, sodium, geothermal resources, and all other minerals that may be acquired under the Mineral Leasing Act of 1920, as amended, are referred to as leasable minerals. Common varieties of sand, stone, gravel, pumicite, and clay that may be acquired under the Materials Act of 1947 are considered salable minerals or mineral materials. Any minerals that are not salable or leasable, such as gold, silver, copper, tungsten, and uranium, are referred to as locatable minerals. These mineral deposits include most metallic mineral deposits and certain nonmetallic and industrial minerals. Locatable minerals are subject to the Mining Law. The primary geological environments within the proposed withdrawal area with the potential for locatable minerals are breccia pipe–related deposits. Favorable environments also occur for non-metallic industrial minerals such as gypsum. Only locatable mineral resources are subject to the proposed withdrawal. Therefore, leasable and salable mineral resource occurrence and development are not discussed further, although they are considered in Chapter 4 in the context of cumulative impacts.

## Locatable Minerals

The primary economic mineral resource within the proposed withdrawal area consists of locatable mineral deposits, including both stratabound deposits and breccia pipe deposits.

Gypsum deposits are found in northern Arizona associated largely with the Toroweap, Kaibab, and Moenkopi formations. No specific gypsum deposits are known to exist within the proposed withdrawal area, although several tons of alabaster were quarried for ornamental carving from one known location on the North Parcel, which has since been reclaimed. The BLM mineral potential report for the proposed withdrawal area indicates the potential for gypsum occurrence is Low, with a moderate level of certainty (BLM 2010a). Metallic minerals associated with stratabound deposits occur only on the South Parcel, which contains primarily copper in the Francis mining district. Secondary copper minerals, including azurite, chrysocolla, and malachite, are located within siliceous brecciated horizons of Kaibab Limestone (Scott 1992). These deposits were studied and considered small and unattractive for commercial development (Scott 1992).

All other locatable deposits of economic interest are associated entirely with geological features known as breccia pipes. Breccia pipes are vertical collapse features formed from the collapse of karst solution caverns in the Redwall Limestone. As the collapse feature migrated upward from the Redwall, a vertical pipe formed, extending several thousand feet through the overlying sedimentary formations, and within this pipe, breccia formed from broken pieces of the overlying formations. Breccia pipes are quite small, typically averaging only 300 feet in diameter. Subsequent intrusion of mineralized groundwater into the breccia pipes resulted in the precipitation of various minerals within the pipes; while thousands of pipes exist across the Colorado Plateau, it has been estimated that perhaps less than 1% contain levels of mineralization suitable for mining (Wenrich and Sutphin 1988).

A variety of metals are found within breccia pipes. Early prospectors were drawn to exposures of these minerals where breccia pipes had been eroded along the walls of incised canyons, such as the Orphan Mine, which is located on the south rim of the Grand Canyon itself. Precious metals include copper, gold, silver, and vanadium. However, it is the presence of uranium minerals within breccia pipes that has been of the most interest over the past half century. From the 1950s through the 1980s, 12 breccia pipes were mined specifically for their uranium deposits; several other mines were constructed and placed on interim management status in the 1990s partially as a result of low commodity prices. The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85% of the world's known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2010a).

While breccia pipes can have a surface exposure formed by the collapse and tilting of the overlying sedimentary beds, confirmation of the presence of a breccia pipe is typically only possible through drilling. Approximately 45 breccia pipes have been confirmed through drilling within the proposed withdrawal area (see RFD, Appendix B, Table B-1). Uranium reserves are typically expressed in relation to the naturally occurring mineral pitchblende ($U_3O_8$). Known reserves of uranium ($U_3O_8$) within these pipes amount to 10,658 tons, as shown in Table 3.3-1. Note that the term "uranium resources" used in this section is a generic term that encompasses all ore bodies, even ones not yet discovered; by contrast, the term "uranium reserves" refers to confirmed ore bodies that are both economically and technically feasible to mine.

**Table 3.3-1.** Estimated Known Reserves, Undiscovered Uranium Endowment, and Estimated Total Available Uranium Resources

| Parcel | Confirmed Breccia Pipes* | Known Uranium Reserves (tons $U_3O_8$)* | Estimated Uranium Resources in Discovered Pipes not yet Quantified (tons $U_3O_8$)† | Undiscovered Uranium Endowment (tons $U_3O_8$)‡ | Estimated Total Available Uranium Resources (tons $U_3O_8$)§ |
|---|---|---|---|---|---|
| North | 30 | 8,700 | 3,000 | 91,944 | 25,491 |
| East | 1 | 0 | 0 | 22,257 | 3,339 |
| South | 14 | 1,958 | 1,500 | 49,179 | 10,835 |
| **Totals** | **45** | **10,658** | **4,500** | **163,380** | **39,666** |

* Personal communication, E. Spiering, Quaterra Resources, Inc. (2010). Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 to account for this discrepancy.

† Based on 15% of discovered mineralized breccia pipes containing ore bodies, each ore body averaging 1,500 tons.

‡ USGS (2010b).

§ Includes known uranium reserves (Arizona 1, Pinenut, Rim, Kanab North, EZ1, EZ2, DB, Findlay Tank NW, Findlay Tank SE, Canyon, What), estimated uranium resources in known mineralized pipes, and 15% of undiscovered uranium endowment (see RFD, Appendix B, Table B4).

While the entirety of the proposed withdrawal area has a high potential for the presence of breccia pipe deposits, approximately 82% (8,700 tons) of these known reserves occur within the North Parcel. No confirmed reserves are located within the East Parcel, and only 1,958 tons are confirmed within the South Parcel. Note that uranium tonnage refers to the estimated amount of uranium after processing at the mill; the amount of ore needed to be removed from the mine and transported to the mill for processing would typically be 100 to 200 times greater than the noted tonnage of processed uranium.

With respect to undiscovered uranium resources, in 1987 the USGS divided northern Arizona into areas of varying favorability for uranium resources (Finch et al. 1990). The study area for the 1987 estimate covered over 16,700 square miles, and of this area approximately 9,100 square miles were considered to be “Favorable Area A,” the area with the highest potential for breccia pipes to occur (Figure 3.3-1). Almost the entire proposed withdrawal area falls within the area considered to be high potential. Similarly, the mineral report produced by the BLM for the proposed withdrawal area rates the potential for uranium occurrence as high, with a high level of certainty (BLM 2010a).

In addition to uranium reserves confirmed through drilling, the USGS has estimated the amount of undiscovered uranium endowment within the proposed withdrawal area, as shown in Table 3.3-1. The term “endowment” refers specifically to rocks containing uranium exceeding a grade of 0.01% but does not indicate whether the uranium ore can be mined economically. Historically, the mines within the proposed withdrawal area have not contained average uranium concentrations less than 0.5% $U_3O_8$ (personal communication, Spiering 2010). The percentage of the uranium endowment that might be economically mined has not been determined by the USGS; for the purposes of the RFD (see Appendix B), it was assumed that 15% of the endowment might be mined. This percentage of the estimated endowment (24,507 tons $U_3O_8$), the amount of confirmed uranium reserves (10,658 tons $U_3O_8$), and the uranium estimated to be in breccia pipes already discovered (4,500 tons $U_3O_8$) represent the total estimated uranium resource within the proposed withdrawal area (39,666 tons $U_3O_8$), as shown in Table 3.3-1.

## 3.3.2 Resource Condition Indicators

Resource condition indicators for mineral resources include the following:

- Availability of high mineral potential lands.
- Number of ore deposits mined.
- Potential for subsidence and alteration of geology or topography.
- Amount of uranium mined as percentage of known domestic resources, current domestic demand, and current domestic production.
- Depletion of uranium resources within proposed withdrawal area.
- Amount of uranium mined as percentage of global demand and production.
- Cumulative amount of high-potential uranium resource lands withdrawn from exploration and development.

Following is a discussion of the current value or condition with respect to each of the resource condition indicators listed above.

### *Availability of High Mineral Potential Lands*

The approximately 1 million acres of land within the proposed withdrawal area are considered to have high mineral potential for uranium. The resource condition indicator is the availability of these high mineral potential lands. The current value is that these lands have historically been fully available for exploration and possible development of economic mineral deposits.

## Number of Ore Deposits Currently under Approved Plans of Operation

The majority of exploration and development activity associated with breccia pipe uranium deposits within the proposed withdrawal area occurred during the 1980s. During this period, five breccia pipes were mined for recoverable uranium resources on the North Parcel, including the Hack 1, Hack 2, Hack 3, Hermit, and Pigeon pipes. Four additional mines within the proposed withdrawal area were partially developed but placed under interim management when uranium commodity prices collapsed.

These include the Pinenut, Arizona 1, and Kanab North mines on the North Parcel and the Canyon Mine on the South Parcel. Some uranium ore was mined from both the Pinenut and Kanab North mines. The Arizona 1 mine restarted mining operations in December 2009.

The resource condition indicator is the number of ore deposits operating under approved mine plans of operation. The current value of this resource condition indicator is four: Pinenut, Arizona 1, Kanab North, and Canyon.

## Potential for Subsidence and Alteration of Geology or Topography

Mining of any type alters the natural geological formations and topography. The Grand Canyon region is notable for its prominent and unique geology and striking topography, both of which could be altered by mining. This includes the potential for collapse or subsidence of reclaimed or active mine sites and alteration of the area's topography (streams, canyon walls, mesas, or knolls) and/or geology by mines.

Mining of breccia pipes is conducted through underground workings; uranium minerals in breccia pipes typically occur a thousand feet or more below ground and are accessed by a central vertical shaft, allowing for a relatively small mine footprint (typically 20 acres or less). Earlier discoveries, where minerals were exposed along the walls of incised canyons (such as Orphan Mine) also mined using horizontal shafts to reach the ore bodies. Several useful case studies of mined breccia pipes are available to estimate the potential for breccia pipe mines to subside or alter the geology of the area. These include the Orphan, Hack Canyon, Hack Canyon Complex, Pigeon, and Hermit mines; as examples, these represent mining under historic conditions (Orphan Mine and the original Hack Canyon Mine), as well as more modern mining and reclamation techniques (Hack Canyon Complex, Pigeon, and Hermit), in addition to representing three of the most productive breccia pipes mined in northern Arizona (Orphan, Hack 2, and Pigeon).

### ORPHAN MINE

The Orphan pipe was discovered as a mineral exposure on a canyon wall of the Grand Canyon and was mined from the side of the canyon, as well as through a vertical shaft from the South Rim; descriptions of mine techniques are provided by Chenoweth (1986). Uranium mining from the Orphan mine began in 1956, and approximately 500,000 tons of dry ore were removed from the Orphan Mine. Mining was conducted almost entirely underground, with the exception of head structures, and included the central breccia pipe as well as the surrounding ring fractures. Mining took place to a depth of approximately 600 feet, using a series of circular tunnels, shafts, and stopes. Most of the ore bodies mined ranged from 15 to 60 feet wide. Mining ceased in 1969. Surface evidence of the mine still exists within Grand Canyon National Park in the form of open, vertical shafts. The head structure was removed from the mine in 2009. No evidence of subsidence resulting from the mining has been identified.

### HACK CANYON MINES

The original Hack Canyon mine was similarly discovered as a mineral exposure at the base of the canyon wall in Hack Canyon and was mined from the floor of the canyon; descriptions of mine techniques are provided by Chenoweth (1988). Uranium mining from the Hack Canyon mine began in 1950, and approximately 1,400 tons of dry ore were removed from the Hack Canyon mine. Mining was conducted entirely underground through several vertical shafts, horizontal tunnels, and stopes, to a depth of approximately 100 feet. Mining ceased in 1964.

In the 1970s and 1980s, three additional breccia pipes were discovered in the vicinity (Hack 1, Hack 2, and Hack 3 and known collectively as the Hack Canyon Complex). All three breccia pipes were mined for uranium from approximately 1981 through 1987 (USGS 2010b), resulting in the removal of approximately 742,000 tons of dry ore (Hack 1 – 134,000 tons, Hack 2 – 479,000 tons, Hack 3 – 111,000 tons) (personal communication, E. Spiering, Quaterra Resources, Inc. 2010). Reclamation of all three of these pipes, as well as the historic Hack Canyon workings, was completed in 1988. No evidence of subsidence resulting from the mining has been identified.

### PIGEON MINE

The Pigeon Mine is located immediately north of the edge of Snake Gulch, a tributary to Kanab Creek, but unlike the Orphan and original Hack Canyon Mine, the mine was not identified through mineral exposure along the canyon wall. The Pigeon Mine is more typical of breccia pipes that would be mined under present-day conditions, as it involved a single vertical shaft to access the uranium ore body. Approximately 440,000 tons of dry ore were removed from the Pigeon Mine (USGS 2010b). Mining was conducted entirely underground, with surface access through a single vertical shaft. Surface features included a wastewater pond, head structures, and waste rock piles. Mining ceased in 1989. The site has been reclaimed, including the restoration of the natural drainage and returning the topography close to its natural state. No evidence of subsidence resulting from the mining has been identified.

### HERMIT MINE

The Hermit Mine is located approximately 10 miles west of Kanab Creek, and is similar to the Pigeon Mine as being typical of breccia pipes that would be mined under present-day conditions. Approximately 36,000 tons of ore were removed from the Hermit mine (USGS 2010b). Mining was conducted entirely underground, with surface access through a single vertical shaft. Surface features included a wastewater pond, head structures, and waste rock piles. Mining ceased in 1989. The site has been reclaimed, including the restoration of the natural drainage and returning the topography close to its natural state. No evidence of subsidence resulting from the mining has been identified.

## *Amount of Uranium Mined as Percentage of Known Domestic Resources, Domestic Demand, and Domestic Production*

Domestic uranium reserves or resources are difficult to estimate. The U.S. Energy Information Administration (EIA) last completed a domestic uranium reserve summary in 2008, based on analysis of historical data and information reported by uranium mining companies. This estimate indicates that domestic uranium reserves total 269,500 tons $U_3O_8$; it should be noted that the 2008 estimate is dependent on uranium price, and the number shown is based on a commodity price of $50/pound (EIA 2011a). These represent geological reserves only; uranium stockpiles from other sources are not included in this estimate. Other available estimates include a 2007 estimate by the World Nuclear Association, which indicates U.S. domestic reserves of 403,000 tons $U_3O_8$ (World Nuclear Association 2010a).

Total domestic production of uranium (for 2009) was 3.75 million pounds $U_3O_8$, or 1,875 tons $U_3O_8$ (EIA 2010a), from 14 underground mines and four in-situ leaching plants located primarily in Wyoming, Nebraska, Texas, Colorado, and Utah. The total current domestic uranium requirement for nuclear reactors (projected for 2010) was 23,040 tons $U_3O_8$ (World Nuclear Association 2011). Current production within the proposed withdrawal area occurs solely from the Arizona 1 mine, which has an estimated total uranium reserve of 1,228 tons $U_3O_8$.

The resource condition indicator consists of the percentage of known domestic uranium reserves, domestic production, and domestic demand that is accounted for by mining within the proposed withdrawal area. Currently, the actively mined reserves of the Arizona 1 mine, taken as a whole, represent approximately 0.1% of the estimated domestic uranium reserve, 65% of total 2009 domestic uranium production, and 2% of the projected domestic reactor requirement for 2010.

## *Depletion of Uranium Resources within Withdrawal Area*

Uranium resources, once mined, are permanently depleted and unavailable for future mining. The resource condition indicator consists of the percent removal or depletion of estimated uranium resources within the withdrawal area. The estimated amount of uranium resources within the withdrawal area is 39,666 tons $U_3O_8$ (see Table 3.3-1). Currently, once the actively mined reserves of the Arizona 1 mine are depleted, they will represent a 3.1% reduction in the amount of uranium reserves available within the withdrawal area.

## *Amount of Uranium Mined as Percent of Global Demand and Production*

Total global production of uranium (for 2008) was approximately 114 million pounds $U_3O_8$, or 57,000 tons $U_3O_8$ (TradeTech 2010). The total global uranium requirement (for 2008) was approximately 168 million pounds $U_3O_8$, or 84,000 tons $U_3O_8$ (TradeTech 2010). Current production within the proposed withdrawal area occurs solely from the Arizona 1 mine, which has an estimated total uranium reserve of 1,228 tons.

The resource condition indicator consists of the percentage of global production and global demand that is accounted for by mining within the proposed withdrawal area. Currently, the actively mined reserves of the Arizona 1 mine, taken as a whole, represent approximately 2.1% of total 2008 global uranium production and 1.5% of the total 2008 global uranium demand.

## *Cumulative Withdrawal of High Mineral Potential Lands*

Based on the 1987 USGS estimate, approximately 9,100 square miles were considered to be "Favorable Area A," the area with the highest potential for breccia pipes to occur.

Previous withdrawals have removed portions of the following high mineral potential lands from mineral location and entry (see Figure 2.4-1 and Table 2.4-1):

- Grand Canyon National Park, covering approximately 1,900 square miles: approximately 60% is considered high mineral potential.
- Grand Canyon–Parashant National Monument, covering approximately 1,600 square miles: approximately 25% is considered high mineral potential.
- Kanab Creek Wilderness Area, covering approximately 118 square miles: approximately 70% is considered high mineral potential.

- Saddle Mountain Wilderness Area, covering approximately 63 square miles: approximately 90% is considered high mineral potential.
- Grand Canyon Game Preserve, covering approximately 1,000 square miles (inclusive of Kanab Creek and Saddle Mountain Wilderness Areas): approximately 90% is considered high mineral potential.
- Paria Canyon–Vermilion Cliffs Wilderness Area, covering approximately 176 square miles: approximately 95% is considered high mineral potential.
- Navajo Nation. The Navajo Nation covers almost 26,000 square miles; approximately 1,600 square miles of the west side of the Navajo Nation is considered high mineral potential.
- Havasupai Tribe, covering approximately 250 square miles: approximately 80% is considered high mineral potential.
- Hualapai Tribal Nation, covering approximately 1,560 square miles: approximately 30% is considered high mineral potential.
- Kaibab Band of Paiute, covering approximately 200 square miles: approximately 50% is considered high mineral potential.

In all, approximately 5,100 square miles of high mineral potential lands have previously been withdrawn, accounting for approximately 56% of the high mineral potential lands identified by the USGS in northern Arizona and southern Utah (i.e., 56% of Favorable Area A from Finch et al. 1990).

## 3.4 WATER RESOURCES

The focus of this section is existing water resource conditions in the vicinity of the proposed withdrawal area and the resource condition indicators that will be the basis for evaluating potential impacts under each of the alternatives in Chapter 4. The relevant resources for this analysis include surface water, groundwater, and the interaction between these two resources. This analysis is based on review and compilation of available data for selected hydrologic parameters; information in the files of the BLM, NPS, Arizona Department of Water Resources (ADWR), Forest Service, ADEQ, ASLD, and AZGS; interviews with representatives of the mining companies that have operated mining facilities in the proposed withdrawal area; and review of information from numerous previous investigations of the Grand Canyon region, including those by the USGS, several universities, Errol L. Montgomery and Associates (Montgomery), and other environmental consultants.

### 3.4.1 General Description of Study Area

The study area for the water resources analysis is indicated in the inset map on Figure 3.4-1. This figure also shows the proposed withdrawal area boundaries, land ownership, uranium mine sites, and mining claims. The study area for the water resources analysis was selected to include local surface water drainage areas and groundwater basins that could potentially be impacted by reasonably foreseeable activities in the proposed withdrawal area. Additional areas remote from the proposed withdrawal area, such as the Virgin River in Utah and near Littlefield, Arizona, were also considered because of potential hydrologic connections. Figure 3.4-2 (from Beus and Morales 2003) is a generalized map that shows the major plateaus in the area surrounding the Grand Canyon.

Different amounts and types of water resources information are available for each of the three parcels. In general, more water resources investigations have been conducted for the region south of the Grand Canyon than to the north. The studies for the South Parcel and adjacent areas south of the Grand Canyon include other large-scale EISs and a numerical groundwater flow model for the Coconino Plateau

(Montgomery 1985, 1996, 1999), other numerical and conceptual groundwater flow models developed for the Coconino Plateau and adjacent areas (Bills et al. 2007; Kessler 2002; Wilson 2000), and investigations of springs that issue along the South Rim (Fitzgerald 1996; Goings 1985; Johnson and Sanderson 1968; Liebe 2003; Loughlin and Huntoon 1983; McGavock et al. 1968; Metzger 1961; Monroe et al. 2005; Rihs et al. 2004; Zukosky 1995). There are more deep groundwater wells with which to provide information on the Redwall-Muav aquifer system (henceforth referred to as the R-aquifer system or the regional aquifer system) south of Grand Canyon than to the north. However, important research has been conducted by Huntoon (1968, 1970, 1974, 1981, 1982, 1996, 2000), Woodward-Clyde Consultants (1985), Ross (2005), and Bills et al. (2010) in relation to groundwater circulation and selected large springs north of the Colorado River. Except for the Orphan Lode Mine, located at the South Rim of Grand Canyon directly north of Tusayan, and the Canyon Mine, located in the South Parcel, all of the information available for historic and current uranium mining practices in the region of the proposed withdrawal area comes from environmental assessments (EAs), mine plans, reclamation plans, personal communication with former and current mine employees, and other studies conducted for the mines in the North Parcel.

## 3.4.2 Hydrogeologic Conditions in the Study Area

This section characterizes the hydrogeologic components of the water resources system that may be affected by the proposed action or alternatives. Climatic conditions, which vary depending on land surface altitude, control the distribution of precipitation and evapotranspiration in the hydrogeologic framework. To a large extent, the hydrogeologic features of the region control the movement and fate of snowmelt, stormwater runoff, groundwater recharge, and groundwater in the underlying perched and regional aquifer systems. The lithology and structural deformation of the rock units in the study area are principal controls for movement and storage of groundwater. Human activities, such as groundwater withdrawal, diversion of discharge from springs, and development of the land surface, also affect the availability and quality of water.

The study area is located in the Plateau Uplands Hydrogeologic Province of Arizona, which is a high desert plateau region in which landforms are dominated by deeply incised canyons, high isolated mesas and buttes, and volcanic peaks (Cooley 1963; Montgomery and Harshbarger 1989). The land surface over much of the study area consists of fractured, jointed limestone with some permeable volcanic rocks, which provide for rapid infiltration of precipitation and result in meager surface water runoff (Huntoon 2000; Montgomery and Harshbarger 1989). As a result, the study area has a small number of perennial streams and rivers. The Coconino, Kaibab, and Kanab plateaus and the Marble Platform (see Figure 3.4-2) are characterized by very thick, nearly flat-lying sedimentary strata. The Colorado River is the principal drain for the groundwater systems in the plateaus, although groundwater in the north part of the North Parcel is believed to move north toward deep groundwater basins in Utah.

Extensive exposure of aquifer units along deep canyons cutting the plateaus of the study area and the ability to observe groundwater discharge from the aquifers into the canyons, together with well records, provide a degree of information on regional hydrogeologic conditions not commonly available for most regions of the country. This information has led to cogent interpretations of the groundwater systems in the Grand Canyon region, such as those by Huntoon (2000). Nevertheless, because of the size of this remote region and the depth of the groundwater systems, there remains uncertainty regarding deep geological structures, groundwater flow paths, aquifer hydraulic properties, residence times of groundwater in aquifers, and other hydrogeologic features in many parts of the study area.

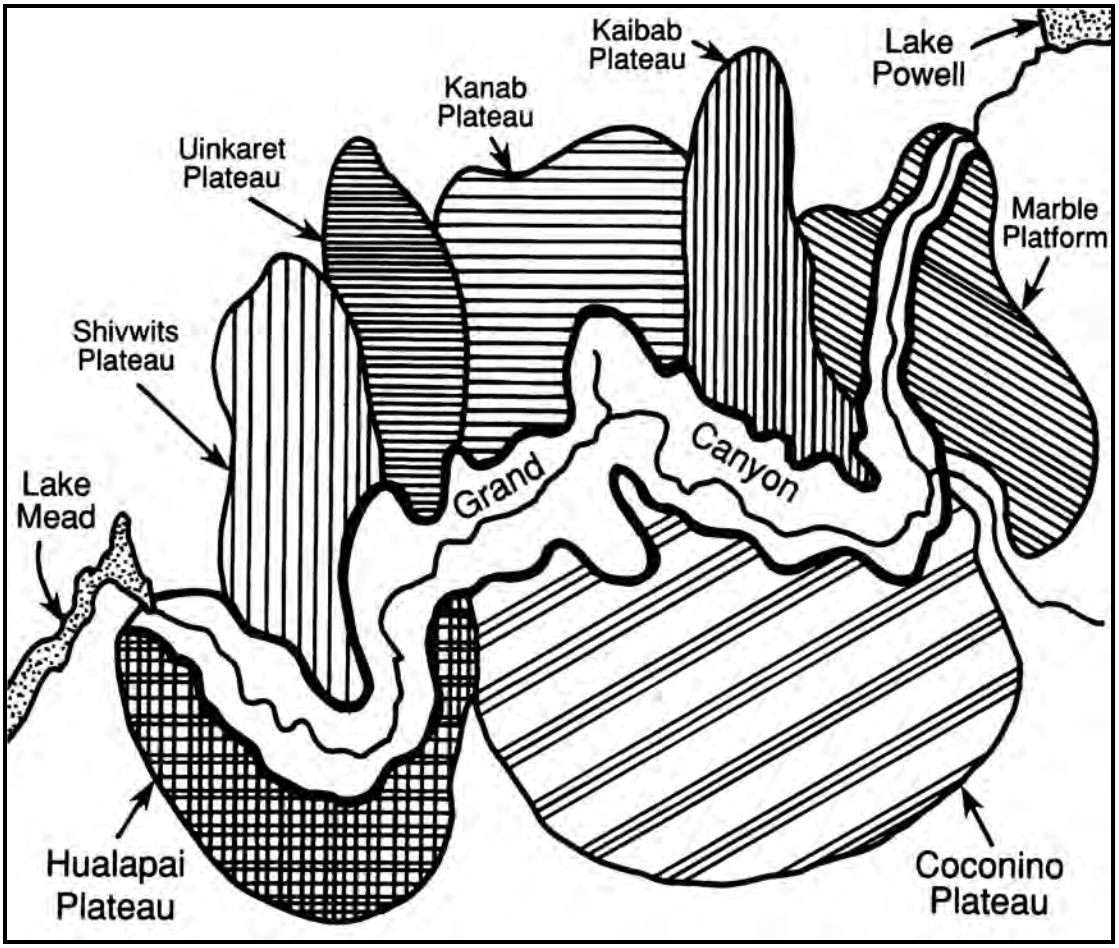



**Figure 3.4-2.** Generalized map showing major plateaus of the area surrounding Grand Canyon (from Beus and Morales 2003).

The most productive aquifer, the R-aquifer, is deep (generally more than 2,000 feet below land surface [bls]) and occurs in limestone and dolomite units that are gently folded and exhibit relatively shallow regional dips. Although the plateau region is often described as a "water-short area," deep groundwater is likely available over large areas. However, because of the great depth of the regional aquifer, costs for drilling, construction, and pump equipment are very high; the total cost can exceed $3 million for one well. Although groundwater yield from the R-aquifer is prolific where karst and other interconnected permeability features are abundant, there is a high degree of risk that wells not encountering these features may be dry or low yielding. There is also a high degree of risk that the water yielded by the well will be mineralized with high total dissolved solids (TDS) content and other constituents, especially in confined (artesian) parts of the regional aquifer (Huntoon 2000). Therefore, financial risk is high for R-aquifer well construction. These risk factors and a lack of understanding by many water developers of the groundwater systems, particularly regarding geological conditions that control locations of aquifer zones that could yield substantial volumes of groundwater to wells, have prevented more extensive development (Montgomery et al. 2000). Records indicate that no non-commercial or non-industrial entities have installed R-aquifer wells on any of the parcels, even though the R-aquifer is recognized as the most reliable source of groundwater. The only existing non-mine R-aquifer wells in the parcel areas are located at Tusayan on the South Parcel.

A summary of records for 1,333 wells in the study area is given in Appendix D. These records include data for location, well construction, water levels, and yield. It should be noted that the well inventory table was compiled from several different databases; thus, some duplication of wells may occur in Appendix D where sufficient data were not available to identify a single well from multiple similar records. The well inventory includes all well records in the ADWR and Arizona Oil and Gas Commission databases, including records for non-water production wells and records cancelled by ADWR for various reasons, such as records for wells that were abandoned or never drilled (ADWR 2005, 2009a; Arizona Oil and Gas Commission 2005). The well inventory was conducted for all wells within the three parcels and a 6-mile buffer perimeter surrounding each parcel, and for all wells 500 feet or deeper in the water resources study area. Of the 1,333 wells listed in Appendix D, those reported to be water wells that have not been cancelled by ADWR or abandoned include the following:

- **North Parcel.** Five R-aquifer wells (including the abandoned Hack Canyon Complex and Pigeon mine wells) and 105 perched aquifer wells in the North Parcel and 100 perched aquifer wells in the 6-mile buffer perimeter.
- **East Parcel.** Seven perched aquifer wells in the East Parcel and 26 perched aquifer wells in the 6-mile buffer perimeter.
- **South Parcel.** Four R-aquifer wells and 16 perched aquifer wells in the South Parcel, 19 perched aquifer wells in the 6-mile buffer perimeter, and four R-aquifer wells beyond 6 miles from the southern and western boundaries of the South Parcel.

Of particular interest in this analysis are the 13 wells constructed to yield groundwater from the R-aquifer within or in the vicinity of the parcels. Records for these regional groundwater wells are provided in Table 3.4-1.

Existing wells of record that are not reported to be abandoned or cancelled (not drilled) are shown on Figures 3.4-9, 3.4-11, 3.4-12, and 3.4-13. However, for the following reasons, the wells shown may not be an accurate representation of all water wells in each parcel:

1. Errors in well registration may have resulted in some records that do not clearly report status or well type (i.e., some wells may not actually be water wells, or may have never been drilled, or may have been abandoned).
2. Some “pre-code wells” (wells drilled prior to establishment of the Arizona Groundwater Code) may have never been registered and are not in the ADWR databases.
3. Some wells may be damaged or have malfunctioning pump equipment that cannot be removed, thereby rendering the wells unusable.
4. Some wells may be dry.

Geological logs for the supply/monitor wells constructed for four of the uranium mine sites in the North and South parcels provide data for rock units encountered at these mine sites. These geological logs are summarized in Table 3.4-2.

Conceptual geological sections shown in Figures 3.4-3 and 3.4-4 provide a regional perspective for subsurface conditions in the study area and vicinity for the following discussion. Figure 3.4-5 is a geological map with surficial geology, major structural features, and breccia pipe locations in the water resources study area. Geological sections, with localized stratigraphic relations and major structural features for the study area, are shown in Figure 3.4-6a (from Brown and Billingsley 2010). Map locations for the geological sections in Figure 3.4-6a are shown in Figure 3.4-5.

The principal geological units that crop out and/or occur in the subsurface in the study area, in descending order, are described in the following sections and are organized by age and stratigraphic position in

Figure 3.4-6b. Where present, each of these units plays an important role in the movement and/or storage of groundwater in the study area. Detailed descriptions of the individual rock formations and aquifers in the Grand Canyon region are given in Beus and Morales (2003), Bills et al. (2007), Bills et al. (2010), Bills et al. (2000), Harshbarger (1973a, 1973b, 1974, 1977), Harshbarger and Associates (Harshbarger) and John Carollo Engineers (1972), Harshbarger et al. (1957), McKee (1974, 1982), McKee and Resser (1945), McNair (1951), Metzger (1961), Montgomery (1985, 1993a, 1996, 1999), Montgomery and DeWitt (1975), and Montgomery et al. (2000). Descriptions of the individual rock formations in the following sections are based on these sources and the experience of Montgomery, BLM, and USGS personnel, and others, in the region.

## Alluvial Deposits

The alluvial deposits are a heterogeneous mixture of unconsolidated to consolidated sediments ranging in grain size from silt and clay to boulders. The alluvial deposits are Quaternary and Tertiary in age and occur chiefly in valley floors and stream channels and along the margins of volcanic rocks. Where exposed in valley floors, the alluvial deposits commonly range in thickness from a feather edge to a few tens of feet. Thickness of older alluvial deposits may be more than 100 feet at the margins of volcanic rocks (Montgomery 1996).

Alluvial deposits that occur in the valley floors are permeable and transmit precipitation and stormwater runoff from the land surface to underlying formations. Where alluvial deposits overlie less permeable rocks, temporary perched groundwater zones may occur in the lower part of the alluvial deposits. Such perched groundwater zones are thin and discontinuous and are generally ephemeral; the stored water is gradually lost via evapotranspiration and slow downward seepage, especially during periods of precipitation deficit.

## Volcanic Rocks

The volcanic rock sequence in the study area comprises lava-flow rocks, dikes, plugs, and pyroclastics, including volcanic ash and cinders that are Quaternary and Tertiary in age. Precambrian volcanic rocks occur at depth in the Grand Canyon but are not important for this investigation. The thickness of the volcanic rocks ranges from about 20 feet at the edge of some lava flows to more than 1,000 feet near the centers of past volcanic eruptions (Montgomery and Harshbarger 1989). Where present at land surface, cinders provide an excellent infiltration medium. As water infiltrates, the subsurface sequence of consolidated volcanic rocks commonly has small vertical permeability and retards the downward movement of water, except where extensively fractured. Thin, discontinuous, perched groundwater zones occur locally in the volcanic rocks and typically discharge at seeps and springs along the margins of volcanic outcrops. These perched groundwater zones have been penetrated by wells and yield small, often poorly reliable, quantities of water for domestic and stock use (Montgomery and Harshbarger 1989).

## Glen Canyon Group

The Glen Canyon Group is Jurassic in age and, in the study area, consists of the following formations in descending order: Navajo Sandstone, Kayenta Formation, and Moenave Formation. This group forms the steep face of the Vermilion Cliffs, which occur a short distance north of the North and East parcels (see Figures 3.4-1, 3.4-4, and 3.4-5). The thickness of the Glen Canyon Group in the study area ranges from about 2,200 feet in the House Rock Valley area to about 2,500 feet in the Kanab Plateau area (Blakey 1989). Navajo Sandstone is a cross-bedded eolian sandstone (Blakey 1989), which, throughout most of the region, has a very consistent lithology composed of medium- to fine-grained, subrounded quartz grains weakly bonded by calcareous cement (Harshbarger et al. 1957). The Navajo Sandstone is partly

**Table 3.4-1.** Summary of Records for Wells Completed in the Regional Aquifer within and adjacent to the Proposed Withdrawal Area

| Site | Well Location | Record Source* | Database Identifier | Date Completed | Total Depth Drilled (feet bls) | Casing Diameter (inches) | Casing Depth (feet) | Casing Cemented | Casing Perforated Interval (feet) | Land Surface Altitude (feet amsl) | Groundwater Level Depth (feet) | Groundwater Level Date Measured | Groundwater Level Altitude (feet amsl) | Design Pumping Capacity (gpm) | Reported Well Yield (gpm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tusayan | A(30-02) 24caa | ADWR<br>GWSI | 523284<br>355811112074501 | 05/01/1989 | 3,108 | 13<br>8 | 0–35<br>0–2,330 | Yes | none | 6,575 | 2,420 | 05/16/1989 | 4,155 | 80 | NR | Canyon Squire Inn; cement grout from 0–35 feet; 150 sacks of grout from 1,500–2,330 feet; South Parcel. |
| Tusayan | A(30-02) 24bac | ADWR | 542928 | 05/03/1994 | 3,000 | 13<br>8 | 0–25<br>0–2,306 | Yes | none | 6,600 | 2,400<br>2,850 | 1994<br>10/25/1995 | 4,200 | 85 | 65 | Quality Inn; South Parcel. |
| Tusayan | A(30-02) 24acd | ADWR† | 560179 | 06/30/1997 | 3,120 | 8<br>7 | 0–2,440<br>0–3,100 | Yes | 2,400–3,100 | 6,600 | 2,400 | 1997 | 4,200 | 100 | 25 | Behind McDonald's; South Parcel. |
| Valle | A(26-02) 11ddb | ADWR<br>GWSI | 543573<br>353843112083301 | 06/15/1994 | 3,450 | 13<br>8 | 0–25<br>0–2,602 | Yes | none | 6,000 | 2,550 | 1994 | 3,450 | 85 | 89 | South of South Parcel. |
| Valle | A(26-02) 01cdd | ADWR | 545765 | 12/28/1994 | 3,200 | 13<br>8 | 0–23<br>0–2,630 | Yes | none | 6,050 | 2,500 | 1994 | 3,550 | 41 | 41 | South of South Parcel. |
| Hack Canyon Mine Complex‡ | B(37-05) 26abb | ADWR | 640855 | 06/17/1980 | 1,760 | 6 | 40 | N/A | none | 4,275 | 1,096 | 06/17/1980 | 3,179 | 5 | 5 | Filled with mud from 1,475–1,760 feet; filled with concrete from 0–1,500 feet on 01/29/1988; filled with limestone from 1,330–1,760 feet; North Parcel. |
| Hermit Mine | B(38-04) 17cca | ADWR<br>GWSI | 518877<br>364123112450501 | 01/12/1988 | 3,030 | 10<br>8⅝<br>5½ | 0–20<br>0–970<br>0–1,796 | Yes | none | 4,886 | 1,513 | 01/12/1988 | 3,373 | 15 | 15 | Presently capped with no pump; unused; North Parcel. |
| Kanab North Mine | B(38-03) 17cca | ADWR | 509198 | 11/05/1984 | 2,700 | 7⅝ | 860 | Yes | none | 5,043 | 1,470 | 11/05/1984 | 3,573 | 10 | 10 | Well collapsed up to 2,460 feet; North Parcel. |
| Pigeon Mine‡ | B(38-02) 05abb | ADWR | 503711 | 09/03/1982 | 2,350 | 6 | – | – | none | 5,406 | 1,736 | 09/03/1982 | 3,670 | 10 | 10 | Land surface altitude estimated from USGS National Elevation data (USGS 2010c); abandoned by filling with cement; North Parcel. |
| Pinenut Mine | B(36-04) 21cbc | ADWR | 513394 | 09/26/1986 | 3,200 | 8⅝<br>6⅝ | 0–900<br>0–2,524 | Yes | none | 5,338 | 2,494 | 09/26/1986 | 2,844 | 11 | 11 | North Parcel. |
| Bar Four | B(32-04) 24cd | Reclamation | N/A | 12/00/1996 | 3,115 | 5½ | 3,107 | – | 2,550–3,107 | 5,680 | 2,370 | 1996 | 3,310 | NR | 50 | Havasupai Reservation; ADWR permit not required; west of South Parcel. |
| Quivero‡ | A(25-02) 27abb | USGS<br>ADWR<br>GWSI | N/A<br>601192<br>353134112094901 | 12/01/1969 | 3,685 | 7 | 3,670 | – | 2,880–3,670 | 6,165 | 2,838 | 12/00/1969 | >3,327 | NR | 28 | Poor water quality; yields from formations deeper than Redwall-Muav aquifer; south of South Parcel. |
| Canyon Mine | A(29-03) 20bcd | Montgomery<br>ADWR | N/A<br>515772 | 12/02/1986 | 3,086 | 8⅝<br>5½ | 0–2,281<br>2,116–3,086 | Yes | 2,584–2,964 | 6,507 | 2,536 | 07/29/1993 | 3,971 | 5<br>40 | 5<br>40 | South Parcel. |

**Notes:**

– = Data not available; N/A = Not applicable; NR = Not reported.

* Record sources:

GWSI = ADWR Groundwater Site Inventory

Reclamation = U.S. Bureau of Reclamation

† Manera Inc. provided data for reported yield.

‡ Well is abandoned.

**Table 3.4-2.** Geological Units Penetrated at Wells for Selected Breccia Pipe Uranium Mine Sites

| Geological Unit | Pinenut Depth Interval (feet bls) | Hermit Depth Interval (feet bls) | Kanab North Depth Interval (feet bls) | Canyon Depth Interval (feet bls) | Pinenut Thickness (feet) | Hermit Thickness (feet) | Kanab North Thickness (feet) | Canyon Thickness (feet) |
|---|---|---|---|---|---|---|---|---|
| Moenkopi Formation | – | 0–168 | 0–31 | 0–10 | – | 168 | 31 | 10 |
| Kaibab Formation | 0–442 | 168–550 | 31–585 | 10–340 | 442 | 382 | 554 | 330 |
| Toroweap Formation | 442–775 | 550–899 | 585–801 | 340–550 | 333 | 349 | 216 | 210 |
| Coconino Sandstone | 775–877 | 899–930 | 801–817 | 550–1,125 | 102 | 31 | 16 | 575 |
| Hermit Formation | 877–1,579 | 930–1,678 | 817–1,467 | 1,125–1,237 | 702 | 748 | 650 | 112 |
| Supai Group | 1,579–2,547 | 1,678–2,850 | 1,467–2,460* | 1,237–2,242 | 968 | 1,172 | 993* | 1,005 |
| Surprise Canyon Formation | – | 2,850–3,010 | – | – | – | 160 | – | – |
| Redwall Limestone | 2,547–3,200 | 3,010–3,030 | 2,460–2,700* | 2,242–2,670 | > 653 | > 20 | > 240* | 428 |
| Temple Butte Formation | – | – | – | 2,670–2,780 | – | – | – | 110 |
| Muav Limestone | – | – | – | 2,780–2,980 | – | – | – | 200 |
| Bright Angel Shale | – | – | – | 2,980–3,086 | – | – | – | > 106 |
| **Total Depth Drilled** | **3,200** | **3,030** | **2,700** | **3,086** | **3,200** | **3,030** | **2,700** | **3,086** |

Note:

– = data not available because not reported.

* = estimated.

> = greater than; base of unit not penetrated.

saturated to completely saturated and is a significant source of groundwater supply north of the study area at Fredonia and the Kaibab Paiute Indian Reservation and is a major source of groundwater to the north in Utah (Cordova 1981) and to the east on the Navajo and Hopi Indian reservations. The lower portion of the Glen Canyon Group in the study area consists of the Kayenta and Moenave formations, which comprise several hundred feet of interbedded and inter-tonguing sandstones and siltstones (Blakey 1989); the fine-grained beds may function as confining layers that retard the downward movement of groundwater.

## *Chinle Formation*

The Chinle Formation is Triassic in age and consists of lacustrine rocks and sediments containing clay, heterogeneous clastic rocks, and minor carbonate rocks (Blakey 1989). The Chinle Formation and its basal conglomerate, the Shinarump Member, were eroded from most of the study area but crop out at the base of the Vermilion Cliffs north of the North and East parcels, and near the top of Red Butte in the South Parcel (see Figures 3.4-1, 3.4-4, and 3.4-5). Thickness of the Chinle Formation in the study area ranges from about 500 feet in the Kanab Plateau area to about 1,000 feet in the House Rock Valley area (Blakey 1989). This predominantly very fine-grained unit is an excellent confining layer that retards the downward movement of groundwater where present in the study area (Harshbarger et al. 1957; Repenning et al. 1969). The Shinarump Member, where present in the North Parcel area, is a discontinuous, perched water-bearing zone that is locally a source of groundwater for springs and wells (Levings and Farrar 1979; Truini et al. 2004).

## *Moenkopi Formation*

The Moenkopi Formation consists chiefly of thin-bedded, fine-grained, red sandstone, siltstone, mudstone, and gypsum and is Triassic in age (Blakey 1989). Although the Moenkopi Formation was completely eroded from large parts of the study area, scattered and discontinuous outcrops of the formation occur on the Shivwits, Uinkaret, Hualapai, and Coconino plateaus (see Figures 3.4-3, 3.4-4, 3.4-5, and 3.4-6a [sections B-B', D-D', and E-E']). These outcrops are generally less than 100 feet thick and typically occur where the formation is capped by erosion-resistant volcanic rocks or where remnant Moenkopi strata fill structural depressions, such as at breccia pipes. Larger, thicker outcrops of the Moenkopi Formation are exposed along the northern part of the study area, in the upper part of the Kanab Creek drainage area of the North Parcel, and in the East Parcel area (see Figure 3.4-3, 3.4-4, and 3.4-5). The thickness of the unit ranges from a few hundred feet in House Rock Valley to more than 1,000 feet near Fredonia, Arizona (Blakey 1989).

The fine grain size and poor sorting of the Moenkopi Formation strata cause the unit to function as a basal confining layer that retards the downward movement of percolating groundwater from overlying formations, except where the unit is extensively fractured (Cosner 1962). Sandstones in the Moenkopi Formation can be water bearing locally in the northern part of the North Parcel, where they yield groundwater to a few springs and low-capacity wells.

## *Kaibab Formation*

The Kaibab Formation consists chiefly of thick- to thin-bedded, jointed, cherty, and sandy dolomitic limestone (McKee 1974), but it also contains dolostone, sandstone, evaporites, and redbeds (Hopkins 1990). The formation is Permian in age, crops out over large parts of the North, East, and South parcels, and forms the rim rock of the Grand Canyon at most locations (see Figures 3.4-3, 3.4-4, 3.4-5, and 3.4-6). Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Kaibab Formation ranges in thickness from about 300 to 450 feet. Thickness of the formation is reported to be more than 500 feet west of Kanab Creek and northwest of the Colorado River (Hopkins 1990) (see Table 3.4-2 for thickness of the Kaibab Formation reported in deep mine wells).

The Kaibab Formation is brittle and extensively fractured in areas where geological structural deformation has occurred. The erosion resistant dolomites that cap most of the plateaus in the eastern Grand Canyon region are permeable as a result of open vertical joints and epikarst localized on joints and partings along bedding planes (Huntoon 2000). Water circulation through these joints and fractures has enlarged the openings by dissolution and has created extensive systems of caves and caverns (Montgomery and Harshbarger 1989; Huntoon 2000). Cave passages in the Kaibab Formation have been observed at many locations in northern Arizona, including Wupatki National Monument (Cosner 1962) north of Flagstaff, Babbitt Ranch (Harshbarger 1973a) southwest of Tusayan, and the Grand Canyon. Where the Kaibab Formation is exposed at land surface, precipitation and runoff infiltrate readily downward via the fractures and solution openings, making the unit an important recharge medium. Many flash floods sink directly into "swallow holes" along fault zones in the Kaibab Formation (Huntoon 2000). However, because of high evapotranspiration, recharge is a small fraction of precipitation. In most of the study area, the Kaibab Formation is above the regional groundwater table; however, well data for the upper part of the Kanab Creek drainage area suggest that, although it may be perched, a viable water-producing aquifer occurs in the Kaibab Formation in that area. The unit is reported to yield small quantities of perched groundwater to a few wells in the Coconino Plateau and regional groundwater to wells near Cameron, Arizona (McGavock et al. 1968), located about 40 miles east of Tusayan (see Figure 3.4-5). Similarly, three water wells near Fredonia, Arizona, have reported pump capacities of between 50 and 400 gpm and are likely completed in the Kaibab and/or Toroweap formations where these units represent a viable aquifer.

## *Toroweap Formation*

The Toroweap Formation is Permian in age and, in the study area, consists of an upper evaporite and red sandstone and shale member (Woods Ranch Member), a middle massive limestone member (Brady Canyon Member), and a lower fine-grained sandstone and evaporite member (Seligman Member) (McKee 1974). Because of the variability in composition, the topographic expression of the Toroweap ranges from a weak slope-former to a cliff-former. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Toroweap Formation ranges in thickness from about 100 to 300 feet. The cementation of the sandstone in the upper and lower members of the Toroweap Formation, which were deposited in a marine environment, is weaker than cementation in the eolian Coconino Sandstone, described in the following section.

Fine-grained strata in the upper and lower members of the formation function as basal confining layers for the local accumulation of thin, discontinuous, perched groundwater zones in overlying sandstone strata. The middle massive limestone member of the Toroweap Formation is brittle and extensively fractured. Fractures in the limestone member have commonly been enlarged by solution activity and solution openings are abundant in this member. Gypsum karst is developed at some locations where solution features are prevalent and the Toroweap Formation is the dominant geological unit exposed at land surface (Huntoon 2000). Groundwater percolates downward readily via fractures and solution openings in the limestone member. The Toroweap Formation is considered to be a minor aquifer in parts of the Coconino and Kanab plateaus and yields small quantities of groundwater to wells from thin, discontinuous perched groundwater zones in the upper and lower members. The Toroweap Formation is reported by McGavock et al. (1968) to yield less than 5 gallons per minute (gpm) from a few wells in the Grand Canyon Village area. Well data for the upper part of the Kanab Creek drainage area suggest that although it may be perched, the Toroweap Formation is a viable water-producing aquifer in that area. For example, the Pah Tempe Spring system, located near Hurricane, Utah, discharges more than 4,100 gpm from the Toroweap Formation (Dutson 2005).

## *Coconino Sandstone*

The Coconino Sandstone is Permian in age and is a very fine- to fine-grained, cross-bedded eolian sandstone composed chiefly of subangular to well-rounded, frosted quartz grains (Metzger 1961). The Coconino Sandstone is commonly a cliff-former in outcrop, is a well-lithified and brittle rock unit, and is extensively fractured near faults and folds. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Coconino Sandstone ranges in thickness from about 500 to 600 feet. Billingsley and Ellis (1984) report that the Coconino Sandstone does not crop out between the Toroweap and Hermit formations along the Kanab Creek Wilderness Area of Snake Gulch, about 18 miles north from the Grand Canyon (see Figure 3.4-1). Inspection of Table 3.4-2 indicates that thicknesses of only 16 and 31 feet of the Coconino Sandstone were penetrated by the supply/monitor wells at the Hermit and Kanab North mine sites, respectively.

The Coconino Sandstone, together with the Toroweap and Kaibab formations, is part of the principal aquifer (also known as the C-aquifer) for water wells in the San Francisco Plateau of northern Arizona (east and southeast of the Coconino Plateau), where the regional groundwater table occurs above the base of the formation. Municipal water supply wells for the city of Flagstaff obtain groundwater from the Coconino Sandstone, and hydraulic parameters have been computed from results of pumping tests (Montgomery and DeWitt 1975). At the Woody Mountain well field near Flagstaff, the permeability of the formation is great as a result of the occurrence of abundant fractures, and pumping rates from individual wells are as great as 1,000 gpm. Where the Coconino Sandstone is not abundantly fractured near Flagstaff, permeability is small, and pumping rates from individual wells are commonly less than 100 gpm.

In the study area, west of the extensive Mesa Butte Fault Zone on the Coconino Plateau, the regional groundwater table (for an unconfined aquifer) or potentiometric surface (level to which the groundwater would rise if not trapped in a confined aquifer) occurs below the base of the Coconino Sandstone and the formation does not contain groundwater at most locations (Bills et al. 2007) (see Figure 3.4-5 for location of Mesa Butte Fault). This condition is observed in the proposed withdrawal area and along the north and south walls of the Grand Canyon. Where favorable structural conditions occur and where mudstone strata in the underlying Hermit Formation provide a basal confining layer that retards the downward movement of groundwater, thin, discontinuous perched groundwater zones may occur in the lower part of the Coconino Sandstone and may supply small quantities of groundwater to springs and wells for domestic and stock use. At mineralized breccia pipes, a sulfide zone or “pyrite cap” often occurs in the base of the Coconino Sandstone or Toroweap Formation at the top of the ore deposit and causes any perched groundwater in the base of the unit to be highly mineralized and of poor quality (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Based on interpretation of regional water quality data, Bills et al. (2010) concluded that elevated concentrations of arsenic, iron, lead, manganese, sulfate, radium, and uranium may be the result of recharge that contains dissolved gypsum derived from overlying formations (such as the Moenkopi and/or Chinle formations) or from natural contact with sulfide-rich mineralization.

### *Hermit Formation*

The Hermit Formation is Permian in age and consists chiefly of interbedded red silty sandstone and sandy mudstone (Blakey 2003). Where the Hermit Formation crops out, it forms a slope between the overlying cliff-forming Coconino Sandstone and the underlying ledge- and slope-forming Supai Group. The Hermit Formation ranges in thickness from about 100 feet in the eastern part of the Grand Canyon to more than 900 feet at the Toroweap Valley and Shivwits Plateau areas (McNair 1951). The formation thickens to the west (Blakey and Knapp 1989). At Snake Gulch, thickness of the Hermit Formation is about 575 feet (Billingsley and Ellis 1984). Because of its fine-grained lithology, the Hermit Formation generally retards the downward movement of groundwater and is considered to be an important basal confining layer for overlying thin, discontinuous perched groundwater zones in the study area.

### *Supai Group*

The Supai Group in the study area is Permian and Pennsylvanian in age and is composed of the following four formations, in descending order: Esplanade Sandstone, Wescogame Formation, Manakacha Formation, and Watahomigi Formation (McKee 1982). The Supai Group consists of alternating siltstone and fine-grained sandstone units, with some limestone beds (Metzger 1961). Where the Supai Group crops out in the Grand Canyon, it is a ledge- and slope-forming unit. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Supai Group ranges in thickness from about 900 to 1,000 feet. The siltstone units are red and occur in flat, lenticular beds. The sandstone units are commonly light brown but in many places are stained red by the overlying siltstone. Because the Supai Group is composed chiefly of siltstone and fine-grained sandstone, groundwater does not move readily through the fine-grained, unfractured rock matrix, although some downward movement of groundwater does occur (Metzger 1961). The upper part of the Supai contains sandstone units that yield small quantities of water from local thin, discontinuous, perched groundwater zones to seeps in the Grand Canyon. The Supai Group is reported to yield small quantities of groundwater to wells in the study area. Fracture permeability along widely spaced fault zones allows water to move downward (Huntoon 2000). However, the Supai functions chiefly as a confining layer, retarding downward groundwater movement to the more permeable underlying formations.

### *Surprise Canyon Formation*

The Surprise Canyon Formation is composed of isolated, lenticular deposits of clastic and carbonate rocks that fill erosional valleys, caves, and other local karst features in the top of the Redwall Limestone (Beus 1990a). The Surprise Canyon Formation is Mississippian in age and can be divided into three units: 1) an upper unit that consists chiefly of marine siltstone and silty, sandy, or algal limestone; 2) a middle unit that consists of marine skeletal limestone; and 3) a basal unit that consists of terrestrial conglomerate and sandstone. The Surprise Canyon Formation is probably the least visible rock unit in the Grand Canyon as a result of the discontinuous nature and extreme remoteness of outcrops; the formation was not identified formally until 1985 (Billingsley and Beus 1985).

### *Redwall Limestone, Temple Butte Formation, and Muav Limestone*

The Redwall Limestone, Temple Butte Formation, and Muav Limestone form a sequence of carbonate rocks comprise the Redwall-Muav aquifer system (henceforth referred to as the R-aquifer system or the regional aquifer system). The Redwall Limestone is Mississippian in age and consists of thick-bedded, cliff-forming, microcrystalline, light to dark gray limestone and dolomite (Metzger 1961; Huntoon 2000). The most abundant rock-forming minerals in the R-aquifer are calcium and magnesium carbonates. The Redwall forms massive vertical cliffs that are 500 to 800 feet thick in the Grand Canyon; thickness increases to the west and to the east from the Grand Canyon Village area (Beus 1989). Where exposed, the Redwall Limestone is commonly stained red by iron oxide material washed down from red beds in the overlying Supai Group (Beus 1990a).

The Temple Butte Formation underlies the Redwall and consists chiefly of microcrystalline dolomite or sandy dolomite with minor beds of sandstone and limestone (Beus 1990b; Huntoon 2000). The Temple Butte is Devonian in age, crops out as thin ledges, and occurs in channels cut into the underlying Muav Limestone. Thickness of the formation ranges from about 100 feet in scattered channel-fill lenses to more than 450 feet west of the Grand Canyon; westward from Hermit Creek, the Temple Butte forms a continuous band of dolomite above local basal channel-fill deposits (Beus 1990b).

The Muav Limestone is Cambrian in age and consists chiefly of thin- to thick-bedded dolomitic and calcareous mudstone and packstone, with intraformational conglomerate (Middleton and Elliott 1990). The Muav forms resistant cliffs above the underlying Bright Angel Shale in the Grand Canyon. The contact with the underlying Bright Angel Shale is gradational and is characterized by complex inter-tonguing of the two formations. Bedding and formation thicknesses increase to the west. McKee and Resser (1945) reported that thickness of the Muav in the study area ranges from 136 feet at the confluence of the Little Colorado and Colorado rivers to 439 feet at Toroweap Valley in the central part of the Grand Canyon.

A sequence of undifferentiated Cambrian-age dolomites, with thicknesses as great as 426 feet in the western part of the Grand Canyon (Middleton and Elliot 2003), overlies the Muav Limestone and is part of the R-aquifer system.

In the study area, the Redwall-Temple Butte-Muav sequence of carbonate rocks (R-aquifer) lies below or partly below the regional groundwater table and constitutes the regional aquifer system. Huntoon (2000) reports that combined thickness of these rocks is 1,300 feet in eastern Grand Canyon, thickening to 2,500 feet in western Grand Canyon. In the Coconino Plateau, total thickness of the formations that constitute the R-aquifer at wells and at the South Rim of the Grand Canyon ranges from about 500 to 1,000 feet; the average thickness is about 750 feet. Results of pumping tests for well (A-29-3)20bcd, located at the Canyon Mine southeast of Tusayan, indicate that transmissivity of the R-aquifer in this relatively unfractured area is about 1,000 gallons per day per foot width of aquifer (gpd/foot) at a 1:1

hydraulic gradient (Montgomery 1993b). Although the permeability of unfractured rock in the R-aquifer is typically very small, in areas where the rocks are extensively fractured by large extensional faults and flexures, solution openings have developed that provide for the transmission of large quantities of groundwater. Extensive interconnected maze cave and cavern systems occur in the R-aquifer, particularly along large fault zones (Huntoon 1968, 1970, 1974, 1981, 1982, 2000; Montgomery and Harshbarger 1989). The term maze cave, used by Huntoon (2000), refers to intersecting, closely spaced dissolution cavities and caves. Progressive upward collapse from caves and caverns in the Redwall Limestone is thought to be the origin of the pipes that eventually were filled with breccia and mineralized with the ore that is the target of breccia pipe prospecting in northwestern Arizona (Huntoon 1996).

### *Bright Angel Shale and Tapeats Sandstone*

Together with the overlying Muav Limestone, the Bright Angel Shale and Tapeats Sandstone form the Tonto Group, which is Cambrian in age. The Bright Angel Shale consists chiefly of mudstone and shale, with minor thicknesses of sandstone and limestone (Metzger 1961). As a result of inter-tonguing with the overlying Muav Limestone, the thickness of the Bright Angel Shale is variable. McKee and Resser (1945) reported that the thickness of the Bright Angel Shale is more than 450 feet in the western part of the Grand Canyon, 270 feet at Toroweap Valley in the central part of the Grand Canyon, and 325 feet along Bright Angel Creek. The Bright Angel Shale functions as an effective basal confining layer for the overlying R-aquifer, even where faulted, as a result of its ductility (Huntoon 2000). The Tapeats Sandstone consists of cross-bedded, poorly sorted, coarse sandstone and conglomerate. Metzger (1961) reports that thickness of the Tapeats Sandstone ranges from a feather edge to 300 feet; thickness typically ranges from 100 to 325 feet (Middleton and Elliot 1990). Only small quantities of groundwater issue from seeps in the Tapeats Sandstone because it is overlain by the fine-grained Bright Angel Shale. The Bright Angel Shale and the Tapeats Sandstone are not known to yield groundwater to wells in the vicinity of the proposed withdrawal area, except at exploration water well (A-25-2)27aba, which was constructed for Black Mesa Pipeline, Inc., about 18 miles north of Williams, Arizona. Water quality and yield from this well are considered poor; therefore, the well is not presently used. The discharge from springs in the Bright Angel Shale and Tapeats Sandstone is commonly saline and limited in quantity.

### *Precambrian Rocks*

The occurrence of sedimentary, metamorphic, and igneous rocks of Precambrian age below the Tapeats Sandstone in the study area is indicated from outcrops in the Grand Canyon and from analysis of deep oil test boreholes in the Flagstaff region. The permeability and porosity of the Precambrian rocks underlying the Grand Canyon region are generally very small, except where open fractures may occur along fault zones, and these rocks are expected to function as the basal confining layer to the overlying rock sequence.

## 3.4.3 Structural Features

The principal structural features in the study area are a series of north- to northeasterly trending fault zones as well as northerly trending folds and associated faults (see Figure 3.4-5). Many more faults and folds occur in the study area than can be shown with the low resolution of Figure 3.4-5. The major north- to northeasterly trending fault zones are the Bright Angel, Redlands, Red Horse, Vishnu, Hurricane, Sevier, Toroweap, Fence, Eminence, and Mesa Butte faults and the West Kaibab (including the Muav and Sinyala faults) and Cataract fault zones (some not shown in Figure 3.4-5). The major northerly trending folds and associated faults include the Supai, East Kaibab, and Echo Cliffs monoclines (not all shown in Figure 3.4-5). Where these geological structural systems are vertically continuous, enhanced by solution processes, and intersect the Grand Canyon, large springs discharge into the Canyon and its tributaries.

When groundwater moves along fractures in carbonate rocks, such as in the R-aquifer, the fractures are often widened by dissolution of soluble carbonate minerals. These preferential pathways are referred to herein as solution-enhanced permeability features or solution features; they range in size from small, interconnected fractures to large, interconnected cavern systems. Solution features preferentially develop along extensional fractures, faults, and folds that are generally aligned with the groundwater hydraulic gradient between points of groundwater recharge and points of discharge.

Permeability of the Kaibab Formation has been greatly increased in some areas by the presence of solution-enhanced fracture openings and joints. Because the Kaibab Formation comprises plateau surfaces over much of the area, karst topography is prevalent. For example, the Markham Dam fracture zone is an area of intense structural deformation along Cataract Creek, where oblique sets of extensional faults in the Kaibab Formation are readily visible at land surface and can be identified by the surface water drainage patterns, which are caused by preferential erosion along the fractured rocks of the fault traces (Montgomery 1996). Similarly, the Kaibab Plateau is broken by intersecting sets of well-developed fault zones and master joints in the Kaibab Formation that provide high capacity for infiltration of surface water flow (Huntoon 1974, 2000). The presence of karst in the parcels results in subterranean drainage, which together with low precipitation and high evapotranspiration contributes to the near absence of perennial flowing surface streams, except in the upper reach of Kanab Creek at Clearwater Spring, short reaches of Kanab Creek below Hack Canyon, and at a number of short, spring-fed perennial reaches of Kanab Creek tributary canyons.

The rocks underlying the Coconino Plateau (South Parcel) are folded into a gentle northwest-plunging syncline, referred to as the Cataract Syncline. The regional dip for the northern limb of the Cataract Syncline south from the Grand Canyon ranges from ½ to 1½ degrees to the southwest (Huntoon et al. 1986). This bedding dip controls the direction of groundwater movement away from the Grand Canyon in areas where faults are few or hydraulically isolated (see Figure 3.4-3). In areas where faults and cave systems occur, groundwater may be collected and conveyed toward or away from the Canyon, depending on the direction of hydraulic gradient.

The Kaibab Plateau is located on a north-south trending, doubly plunging anticlinal fold (Huntoon 2000). The rock units underlying the Kaibab Plateau (between the North and East parcels) are higher than correlative rock units underlying the Kanab Plateau and Marble Platform as a result of movement and deformation along the West Kaibab Fault Zone (including the Muav and Sinyala faults) and the East Kaibab Monocline (see Figures 3.4-2, 3.4-5, and 3.4-6a [section C-C']). The Kaibab Plateau also lies at a higher altitude than the Coconino Plateau to the south (see Figures 3.4-3 and 3.4-5) and receives a greater amount of precipitation and snowmelt than the other areas.

Near the South Rim of the Grand Canyon, the Eremita Monocline (west of Hermit Creek), the Grandview Monocline, and other monoclines cause beds to dip locally northward toward the Grand Canyon (Huntoon et al. 1986). The north-dipping beds and bedding offsets associated with the monoclines and faults near the South Rim result in local areas where recharge collects along fracture systems, moves northward along bedding planes, and discharges at small springs and seeps where faults and fracture systems intersect canyon walls. Recharge in these local drainage catchment basins along the Canyon rim is very important to the occurrence and sustainability of local water-bearing zones that support the discharge at many small springs and seeps (average generally less than about 50 gpm) and at a few moderate-sized springs (average about 50 gpm to several hundred gallons per minute) within the Grand Canyon or its tributary canyons. Because of the northward dip and small discharge, these springs and seeps are considered to be poorly connected or in some cases not connected hydraulically to the regional solution-enhanced circulation systems of the R-aquifer (Montgomery 1996, 1999). However, the results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that the apparent residence time in the aquifer of the water discharged at the small R-aquifer springs along the South Rim ranges from “modern” to 3,400 years. These results suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, possibly south of the R-aquifer divide of Bills et al. (2007). Modern residence times are defined as being less than 50 years by Monroe et al. (2005) and as being less than 250 years by Bills et al. (2007). For comparison, the largest residence time reported was 22,600 years for an R-aquifer well in the city of Williams, Arizona, located about 52 miles south of the South Rim (Bills et al. 2007). Residence time reported for the Canyon Mine well, about 9 miles south of the South Rim, was 10,600 years (Bills et al. 2007).

Fracture systems associated with major structural features provide preferential pathways for recharge, transmission, and discharge of groundwater in the R-aquifer (Huntoon 1974, 1982, 2000; Montgomery 1985, 1996). Recharge from precipitation and ephemeral stream flow infiltrates downward through fracture systems associated with major structural features. Most groundwater discharged from the R-aquifer issues from several large springs located near major structural features in the Grand Canyon and its tributary canyons, such as Havasu Springs, Blue Springs, Fence Fault Spring complex, and Tapeats/Thunder River Spring complex (Huntoon 1982, 2000; Montgomery 1985, 1996; Montgomery et al. 2000). Therefore, these large springs are considered to be well connected hydraulically to the regional circulation systems of the R-aquifer. Thunder River is tributary to Tapeats Creek.

### 3.4.4 Breccia Pipes and Uranium Mining Legacy

Bills et al. (2010) and Otton et al. (2010) provide a comprehensive study of 1980s legacy mining issues related to uranium mining in the Grand Canyon region. Breccia pipes have been defined in other sections of this EIS, and a comprehensive overview of the history of breccia pipe uranium mines and genesis of the pipes and ore bodies is given in Wenrich and Titley (2008). The presence of naturally occurring dissolved uranium is nearly ubiquitous in groundwater and spring-fed surface water in the study area. Other trace metals associated with ore deposits are also common in groundwater. An important source for these dissolved constituents appears to be the mineralized rock that occurs in breccia pipes. The highest-grade uranium deposits in the United States occur in solution-collapse breccia pipes in northwestern Arizona (Wenrich and Titley 2008).

Figure 3.4-5 shows the locations provided by the USGS (Brown and Billingsley 2010) for 207 breccia pipes exposed by erosion (shown as solid red circles) and for 759 collapse features (shown as solid black circles), which also may include breccia pipes, located some distance from the canyon rims. Figure 3.4-7 shows the stratigraphic relation of perched groundwater zones and the regional R-aquifer to mineralized breccia pipe deposits. Figure 3.4-8 is a conceptual diagram showing various types of solution-collapse features in northwestern Arizona. All of the breccia pipes are surrounded by zones of ring fractures that may or may not be interconnected and that, where open, can create secondary permeability in the rocks and expose ore bodies in contact with the fractures to groundwater from perched water-bearing zones. Where exposed to erosion or oxidation from groundwater or surface water contact, ore minerals in breccia pipes tend to dissolve away, leaving little economic mineral value. These conditions have been observed in many breccia pipes exposed in the walls of the Grand Canyon (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010a, 2010b). Conditions that prevent significant exposure are required to preserve economically viable breccia pipe uranium deposits.

The continuum of conditions at breccia pipe ore deposits in the study area may be divided into three broad categories. In the first category, where breccia pipes and especially their ore bodies have been exposed in canyon walls for a significant amount of time, the uranium ore has largely been removed prior to modern times by oxidized surface water and groundwater. Exposure of breccia pipes in canyon walls results in accelerated weathering and fracturing of the pipe, which provides significant routes of access for water to dissolve and leach minerals out of the ore body. This condition may also occur where breccia pipes are developed along open fracture or fault systems. In the second category, where breccia pipes or their ore bodies are not significantly exposed, far less contact with migrating water is possible; this condition results in slow and longer term release of uranium into the groundwater or surface water. In the third category, breccia pipes containing economically viable uranium ore that could be targeted for mining in the study area are generally characterized by well-cemented, very low permeability breccias and adjacent formation rocks, which do not permit the flow of groundwater through the tightly locked mineral deposits. This condition inhibits dissolution of mineral deposits associated with these economically viable breccia pipes into groundwater.

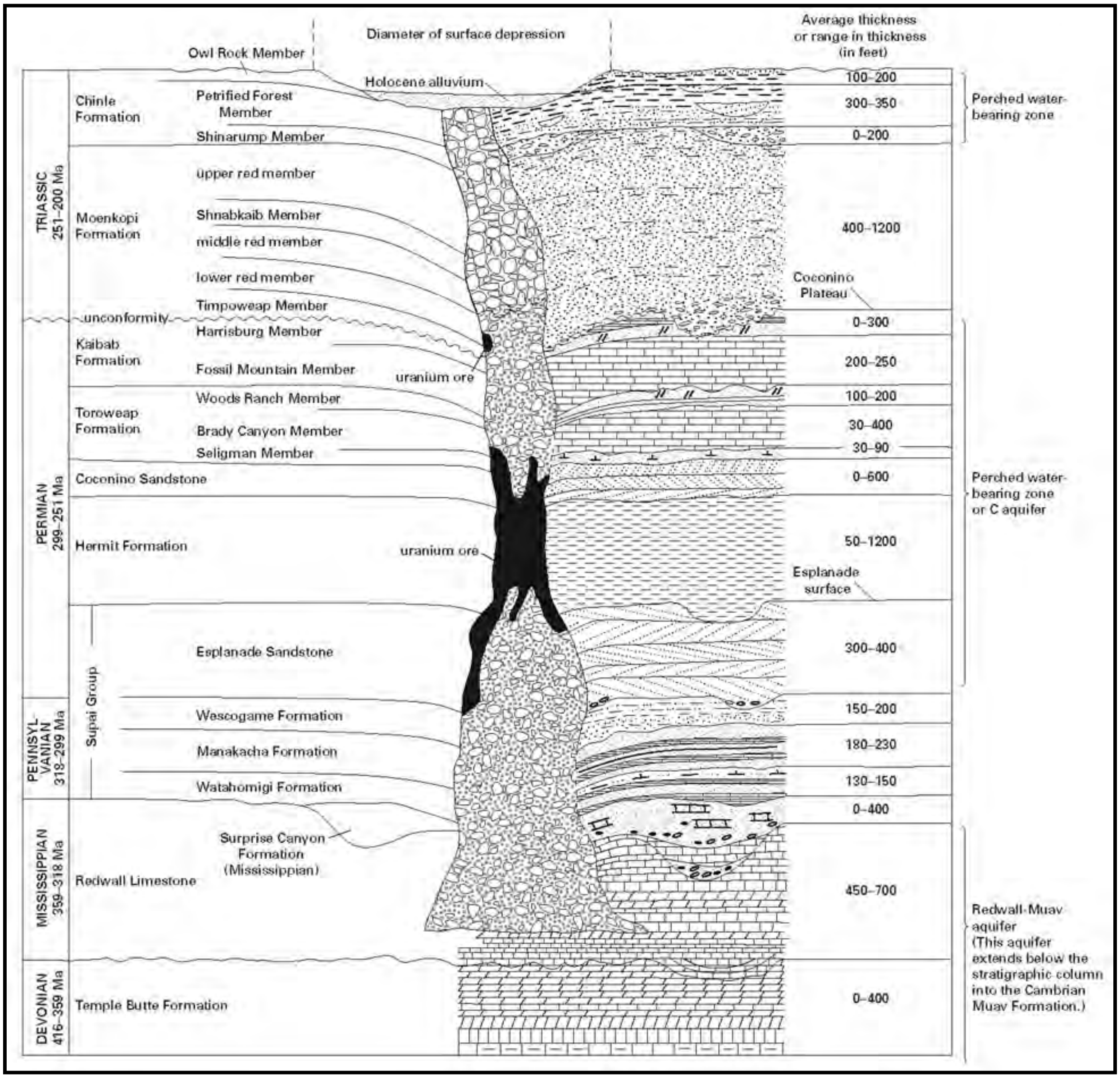
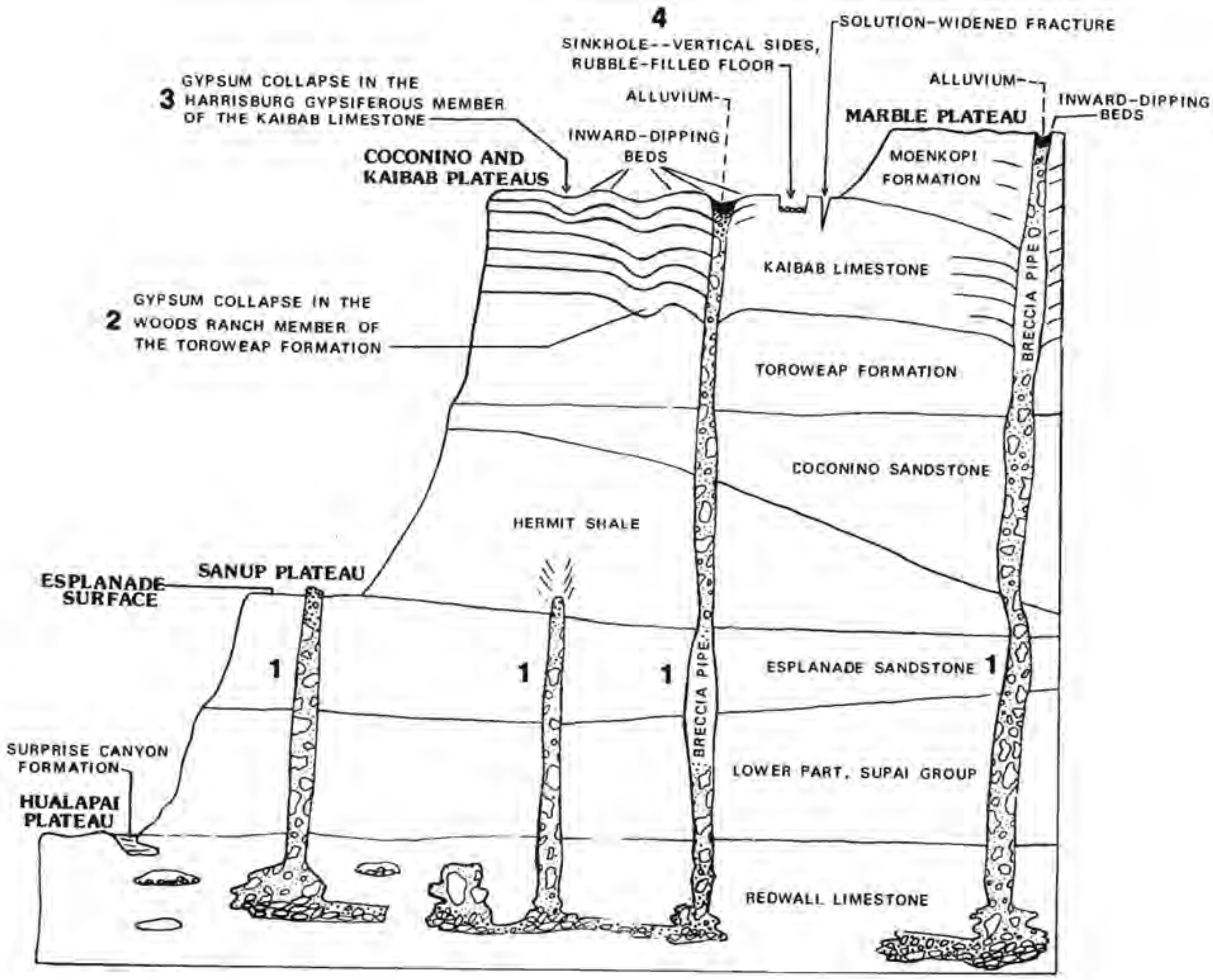



**Figure 3.4-7.** Stratigraphic relation of perched groundwater zones and regional aquifer to mineralized breccia pipe deposits in northern Arizona (from Bills et al. 2010 and modified from Van Gosen and Wenrich 1989).




**(1) Breccia pipes that bottom in the Redwall Limestone, (2) Collapse due to dissolution of gypsum beds in the Woods Ranch Member of the Toroweap Formation, (3) Collapse due to dissolution of gypsum beds in the Harrisburg Gypsiferous Member of the Kaibab Limestone, and (4) Collapse (with vertical sides, as opposed to the gently-sloping sides of the other 3 collapse types) due to recent sinkholes in the limestone beds of the Kaibab Limestone.**

**Figure 3.4-8.** Conceptual diagram showing various types of solution-collapse features found in northwestern Arizona (from Wenrich 1992).

Based on a review of ADEQ (1985, 1988a–c, 1995, 1999, 2009b–2009d), Energy Fuels Nuclear (1984, 1986, 1987, 1988a, 1988b, 1990a–c, 1995a, 1995b), BLM (2010b, 2010c), Dames and Moore (1985, 1987a, 1987b), JBR Environmental Consultants (2010), Montgomery (1993b), and Canonie Environmental Service Corporation (Canonie Environmental 1988, 1991), the modern (post-1980) breccia pipe uranium mine sites in the study area are generally of the third general type and are characterized by well-cemented, very low permeability breccias and adjacent formation rocks. Some ring fracture zones and the cemented breccia itself at these sites have locally contained some connate water (water trapped during formation of the geological feature), which drained away quickly when intercepted by mine openings; at many places, the ring fracture zones had been completely healed by carbonate or other mineralization and did not yield water (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010a).

In each case, these ore deposits are on the order of 1,000 feet or more above the R-aquifer system and are underlain by the poorly permeable breccias and siltstones/mudstones of the Hermit Formation and Supai Group. Therefore, conditions are not favorable for downward migration of leached minerals and constituents (such as uranium and arsenic) from the ore deposits to the R-aquifer (Dames and Moore 1987b).

Most of these sites have or had supply/monitor wells completed in the R-aquifer. Exploration drilling was also conducted at the sites. AAC R12-15-817 for exploration wells and AAC R12-15-816 for water wells require proper abandonment to prevent cross-contamination of different aquifers. ADWR records indicate that all but one of the water supply wells were constructed with cement seals and blank steel casing to prevent downward drainage of perched groundwater via the annular space between the blank casing and the borehole wall. Although not sealed during operation, the well for the Hack Canyon 1, 2, and 3 mines was abandoned by being filled with cement during reclamation. The Pigeon Mine well was also abandoned by being filled with cement (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). The wells are generally designed to yield groundwater from a significant thickness of the R-aquifer; therefore, groundwater samples obtained from the wells typically represent composite samples from the aquifer rather than the uppermost part of the saturated interval, which is required for many environmental monitor wells. Nevertheless, none of the studies conducted for water quality at these wells, one of which included periodic sampling data for up to 9 years after completion of mining activities (Hermit well), concluded that uranium mining activities have affected the R-aquifer. Based on their 2009 water quality sampling study, which included sampling of the Pinenut and Canyon mine wells, Bills et al. (2010) concluded that relations between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive.

At the breccia pipe uranium mines in the study area, perched water-bearing zones, if present (typically above the Hermit Formation basal confining unit), are small, thin, and discontinuous. Water yield to mine openings from these perched zones typically decreases over the first few months to 2 years of mining, from several gallons per minute to no measurable flow (Canonie Environmental 1988). Because of the dipping of adjacent formation layers down toward the solution-collapse breccia pipe, any perched groundwater that is present is expected to drain inward to the mine openings, which function as local hydrologic sinks. This water collects in the sump at the bottom of the mine and is used for mine operations; the water remaining after the demands of mine operations are met is pumped to lined evaporation and containment impoundments at land surface (Energy Fuels Nuclear 1984, 1986, 1987, 1988a; JBR Environmental Consultants 2010; personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Therefore, movement of perched water away from the mine openings is not anticipated to occur during mine operations. JBR Environmental (2010) reported that estimated maximum average flow of perched groundwater into the mine openings for previous breccia pipe uranium mines in the North Parcel was about 0.9 gpm (0.119 acre-feet per month). There are no accounts of rapid recharge through underground mine workings at breccia pipe uranium deposits, even after significant stormwater runoff at land surface.

In accordance with applicable state and federal permits, the entrances to reclaimed mines have typically been sealed to prevent surface water from entering the mine openings (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Requirements for reclamation of the mines changed over time during the 1980s so that earlier mines, such as the Hack Canyon 1, 2, and 3 and Pigeon mines, were not specifically required to seal the perched groundwater zones. Perched groundwater drainage at these mines had either ceased or was very small (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). For example, inflow of perched groundwater to the Pigeon Mine ranged from a maximum rate of 7.1 gpm in May 1985 to a minimum rate of 0.08 gpm in June 1987 (Canonie Environmental 1988). However, reclamation for the Hermit Mine (the last mine closed) included sealing of the perched groundwater zones using bentonite and cement (personal communication, John Stubblefield, Denison 2010). Existing regulations allow for the requirement of sealing perched groundwater zones from new mines. To the extent that reclamation does achieve re-establishment of the perching layer, the perched water-bearing zones may be slowly replenished over time (possibly several years) until natural lateral movement in the perched system resumes. If the reclamation does not re-establish the perching layer, the area of the perched aquifer that is affected may continue to drain into the mine openings in response to seasonal recharge events. At existing mines operating under interim management (some for decades), conditions would be expected to be similar to mines in operation, and there is the potential for drainage and accumulation of perched groundwater, if present, in these mines as natural recharge occurs. Frequent and comprehensive monitoring, data collection, and reporting are necessary for pre-mining, mining, and post-mining periods to fully document subsurface conditions in mines and conditions at perched aquifer springs near mines.

It should be noted that environmental issues surrounding the Orphan Lode Mine (which is outside the proposed withdrawal area) are the result of the lack of mine reclamation, which has allowed surface water and/or perched groundwater to collect within one or more of the mine adits (Hom 1986) and drain through the mine openings to the R-aquifer. The location of this mine at the South Rim of Grand Canyon increases the risk of mine drainage via enhanced secondary permeability of faults or flexure fractures from “relaxation” due to lithostatic unloading near the Grand Canyon. Because significant volumes of ore-grade uranium deposits are present in the Orphan Lode Mine, this breccia pipe is of the second general type described previously in this section (some exposure of the pipe). This is confirmed from the cross-section of the mine provided in Hom (1986), which shows that only a very small portion of the breccia pipe/ore body was exposed to weathering prior to mining (Hom 1986:Figure 3). Drainage from the mine appears to have affected water quality in Horn Creek, which issues directly from the R-aquifer (Liebe 2003). See Section 3.4.7 and Appendix H for more information on impacts to groundwater from the Orphan Lode Mine. No pre-mining water quality data exist for Horn Creek to compare with post-mining data. Although the Orphan Lode Mine is a singularly poor example of post-mining practices, it does provide data with which to compare other mine sites. These comparisons are made in subsequent sections.

## 3.4.5 Surface Water Resources of the Study Area

Except for the main stem of the Colorado River, virtually all of the perennial surface water base flow in the study area, including the base flow for the Little Colorado River, is supported solely by flow from springs and seeps. Hydrologic features, including the location of selected wells, springs, and streams, for the study area are shown on Figure 3.4-9. Stream base flow is augmented by seasonal surface water runoff from precipitation and snowmelt. The source of water for the springs and seeps is groundwater in the R-aquifer and in small, discontinuous perched groundwater zones located above the regional aquifer. Groundwater recharge in the region occurs chiefly via infiltration of precipitation in areas of higher altitude, such as in the northeastern part of the Coconino Plateau (South Parcel area) and the Kaibab Plateau (between the North and East parcels). Recharge also occurs on the Hualapai Plateau (west of Cataract Creek), and at the Bill Williams Mountain and San Francisco Mountain complexes (south and southeast of the South Parcel, respectively), and via infiltration of surface water runoff in ephemeral stream channels located along major fault zones.

The Colorado River is the largest surface water body in the study area and is supported primarily by releases from Glen Canyon Dam, which is located about approximately 12 miles upstream of the East Parcel. For the period of record from 1971 to 2010, flow in the Colorado River at six gaging stations from Glen Canyon Dam to Diamond Creek, which is located downstream of the proposed withdrawal area, ranged from an average of 1.6 million gpm to 28.5 million gpm (USGS 2010d). The average flow during this period at the six stations was about 8.2 millon gpm.

Figure 3.4-10 shows mean annual precipitation from 1971 through 2000 in the study area. Most of the annual precipitation in Arizona occurs in late summer and mid-winter. Precipitation is provided by winter storms of the Pacific Ocean system and annual summer monsoon storm systems originating in the southern Pacific Ocean and the Gulf of Mexico (Jones 1993). Although the late summer monsoons provide intense rainstorms, these storms are of relatively short duration and are believed to provide limited groundwater recharge as a result of high rates of evapotranspiration during the summer. It is the longer duration of winter rain and snow and subsequent snowmelt that provide most of the groundwater recharge to the aquifers in the study area. Losses of rain and snow to evapotranspiration and sublimation are high in the region.

Figures 3.4-11, 3.4-12, and 3.4-13 show hydrologic features for the North, East, and South parcels, respectively. These figures include the same content as Figure 3.4-9 but are enlarged and centered on each respective parcel for clarity.

### North Parcel

Kanab Creek is the only perennial surface water drainage in the North Parcel; all other drainages are ephemeral. Kanab Creek is perennial in its lower reach near the Colorado River, in a 2- to 3-mile-long reach associated with Clearwater Spring in the northern part of the North Parcel (see Figure 3.4-11), and in short reaches below a few small springs in its tributary canyons. Kanab Creek and its numerous ephemeral tributaries drain southward to the Colorado River. A north-south-trending surface water divide along Little Hurricane Ridge in the western part of the parcel separates the Kanab Creek surface water drainage basin from the Virgin River surface water drainage basin to the west (see Figure 3.4-11). Surface water on the North Parcel west of this divide flows northwestward into Clayhole Wash, which flows northwest toward the Virgin River in Utah. Several small springs and seeps issuing from perched water-bearing zones in the Moenkopi Formation, together with an extensive system of surface water retention dams constructed to reduce the salinity of runoff downstream (personal communication, Lorraine Christian, BLM 2010b), occur in the upper reach of Clayhole Wash in the western part of the North Parcel. A small area in the southwest corner of the North Parcel appears to overlap the surface water drainage areas for Tuckup Canyon and Toroweap Valley. Tuckup Canyon is tributary to the Colorado River, and Toroweap Valley is tributary to Toroweap Lake, which overflows to the Colorado River during periods of substantial surface water runoff.

### East Parcel

The surface water drainage system of House Rock Valley is composed of several ephemeral washes that drain into North Rim canyons, including, from south to north, Bedrock (tributary to South Canyon), North, Rider, Soap Creek, and Badger canyons. These canyons are tributary to the Colorado River, which flows southward through Marble Canyon along the entire eastern boundary of the East Parcel (see Figure 3.4-12). There are no perennial surface water drainages in the East Parcel; however, some perched water-bearing zones discharge at a few small seeps and springs in these North Rim canyons, and several small to large R-aquifer springs discharge to the Colorado River along the west wall of Marble Canyon and into the bottom of the river channel downstream of its confluence with North Canyon. A small area (about 2 square miles) of the northernmost extent of the East Parcel lies within the surface water drainage area of the Paria River, which drains a short distance northward into Utah and then returns to Arizona and is tributary to the Colorado River near Lees Ferry.

### South Parcel

No perennial surface water drainages occur in this parcel; however, numerous ephemeral washes occur across the area. Most of the parcel lies in the surface water drainage basin of Havasu and Cataract creeks, and the remainder is tributary to the Little Colorado River (see Figure 3.4-13). The perennial reach of Cataract Creek is called Havasu Creek, which begins at Havasu Springs. West of the surface water divide, ephemeral surface water on the South Parcel flows downgradient to the south, southwest, and west. During intense rainstorms, runoff from this part of the South Parcel may ultimately reach Havasu Creek, which is tributary to the Colorado River. However, permeable surficial deposits and sinkholes in the Kaibab Formation in ephemeral stream channels along major fracture zones, such as the Markham Dam fracture zone of Cataract Creek, have a high capacity to intercept surface water and convey it underground.

East of the surface water divide, ephemeral surface water on the South Parcel flows downgradient to the south and east (see Figure 3.4-13). During intense storms, runoff from this part of the South Parcel may ultimately reach the Little Colorado River, which is tributary to the Colorado River.

## 3.4.6 Groundwater Resources of the Study Area

Groundwater moves from areas of recharge to areas of discharge. In the study area, groundwater recharge occurs from infiltration of precipitation and ephemeral stream flow. The Grand Canyon and its larger tributary canyons function as groundwater drains. The principal aquifer in the study area is the regional R-aquifer system, which transmits and stores large quantities of groundwater. The R-aquifer includes the carbonate rocks of the Redwall Limestone, Muav Limestone, and Temple Butte Formation. Groundwater movement in this aquifer occurs chiefly via fracture zones and interconnected cave passages, which are most abundant where faults are associated with tensional tectonic stresses (regional geological movements within the earth that cause extensional stress [pulling apart] in rocks versus compressional stress [pushing together]). These features together comprise a complex groundwater system that supports springs having diverse water quality and discharge characteristics. Uncertainty regarding specific flow paths and hydrologic connections in these types of groundwater systems is greater than for other types of systems, such as alluvial basins.

The C-aquifer includes the Coconino Sandstone and overlying or underlying water-bearing strata, including, at places, the Toroweap Formation, Kaibab Formation, and upper part (Esplanade Sandstone) of the Supai Group (see Figure 3.4-7). Outside the study area, east of the Mesa Butte Fault Zone, the C-aquifer is the principal groundwater source for the city of Flagstaff water supply; however, it is a thin, discontinuous perched water-bearing unit in the proposed withdrawal area (west of the fault). Bills et al. (2007) and Bills et al. (2010) indicate that the saturated thickness in this aquifer decreases to the west between Flagstaff and the Mesa Butte Fault Zone and north of the Little Colorado River as a result of downward drainage of groundwater to deeper units. South from the Little Colorado River, Bills et al. (2007) indicate the Mesa Butte Fault Zone functions as a barrier to groundwater movement in the C-aquifer. The rock units that form the C-aquifer west of the Mesa Butte Fault Zone, together with other perched water-bearing systems in the proposed withdrawal area store and transmit small amounts of groundwater, and their discontinuous nature allows only local flow of perched groundwater.

Groundwater moves in sedimentary rocks by flowing through pore spaces between the particles that form the rock matrix, as well as through fracture openings in the rock. The property of rocks that relates to their ability to transmit water through intergranular porosity is known as primary permeability. Where particles are relatively large, as in the case of sandstone, intergranular pore spaces may also be relatively large, and groundwater may flow with moderate ease unless cementation is substantial. Primary permeability for sandstones is commonly fairly large unless the pore spaces have been filled with carbonate or silica cement; sandstones may constitute aquifers that are conducive for water supply. Where particles are exceedingly small, as for mudstone or shale strata, intergranular spaces are also exceedingly small, and resistance to groundwater flow is substantial. Therefore, mudstone and shale strata, such as the Hermit Formation and parts of the Supai Group and Moenkopi Formation, generally function as barriers to groundwater movement (Montgomery et al. 2000). Intergranular spaces in carbonate rocks, such as many limestones and dolomites, are also usually exceedingly small. Unless larger openings occur, such as those associated with fractures and cave passages, carbonate rocks such as the Redwall Limestone may also constitute barriers to groundwater movement (Montgomery et al. 2000).

Both the C- and R-aquifer systems consist of brittle rock strata (Montgomery et al. 2000). When tectonic activity occurs, such as movement on faults, both units accommodate the associated stress and strain by fracturing. Where fractures are abundant in brittle rocks, the fractures enhance permeability and provide preferential pathways for groundwater movement. This “secondary permeability” of sandstones in the C-aquifer and carbonate rocks in the R-aquifer is substantially improved where fractures are abundant and interconnected. Because shale and mudstone strata tend to be ductile rather than brittle, these strata often flex rather than fracture when subjected to tectonic stresses (Montgomery et al. 2000). Open fractures that do occur in these strata tend to become filled or “healed,” blocking off pathways for groundwater movement. Because of the ductile nature of shale and mudstone strata, such as in the Bright Angel Shale and Hermit Formation, it is likely that these strata will continue to act as barriers to retard groundwater movement, even where tectonic activity has occurred.

Where groundwater movement occurs chiefly via the preferential pathways provided by interconnected fractures and solution-enlarged features such as caves, there is little opportunity for the removal of some groundwater contaminants via slow filtering through the intergranular pore spaces of the rock units. Therefore, where the hydraulic gradient of the groundwater system is sufficiently large, rapid movement of contaminated groundwater over large distances can occur via the fracture and cave passage network. These conditions can occur in the R-aquifer but primarily occur in the Kaibab Plateau (Huntoon 2000). However, it should be emphasized that the long residence times estimated for groundwater in the R-aquifer (Bills et al. 2010; Monroe et al. 2005), outside the immediate vicinity of springs along canyon walls where hydraulic gradients tend to be steeper, indicate that the typical condition in the aquifer of the Havasu Springs groundwater sub-basin supports slow groundwater movement conducive to gradual mixing and dilution as fracture and cave systems interconnect along the pathway to points of discharge.

## *Recharge*

Groundwater beneath the study area originates as recharge from infiltration of rainfall and snowmelt. Average precipitation measured at Grand Canyon Village, in the northern part of the Havasu Springs groundwater sub-basin, during the period from 1941 through 1970, was about 14.5 inches per year (Sellers and Hill 1974). Normal annual precipitation for 1961 through 1990 measured at Williams, in the southern part of the Coconino Plateau, was 21.17 inches (Owenby and Ezell 1992). Metzger (1961) estimated average annual recharge to the R-aquifer to be about 0.3 inch per year, which is about 2% of the average annual precipitation measured at Grand Canyon Village. Montgomery et al. (2000) estimated a recharge rate of about 4% of the average annual precipitation for the Coconino and San Francisco plateaus based on total groundwater discharge from the principal aquifers. Bills et al. (2007) estimated an average recharge rate of about 3.5% of the average annual precipitation for the Coconino Plateau and adjacent areas.

Rainstorm events are often sporadic and localized, resulting in amounts of short-term, local groundwater recharge that can vary substantially from long-term, regional average recharge estimates. The frequency and magnitude of these events for a specific area can range widely from year to year. Therefore, although long-term average recharge for an area may be small, amounts of local, rainstorm-based recharge may be relatively large.

Most of the precipitation is lost via evaporation, transpiration, and surface water runoff. The remaining fraction infiltrates chiefly through permeable surficial deposits, volcanic rocks, and fractures and solution openings in the Kaibab Formation. Many flash floods sink directly into “swallow holes” along fault zones in the Kaibab Formation (Huntoon 2000). Where open, extensive, interconnected vertical fractures and solution openings occur, recharge can be conveyed directly to the deep aquifer system. Groundwater travel time from land surface to the deep aquifers varies temporally and spatially owing to variations in precipitation, air temperature, properties and thickness of the root and soil zone, presence of faults and fractures, and hydrologic properties of the geological strata in the unsaturated zone (Flint et al. 2004).

Where fractures and solution openings are not extensive or well connected, infiltrated precipitation moves downward until it encounters a confining rock layer with sufficiently small permeability to impede vertical movement of the water. At these locations, a thin, saturated zone, referred to as a perched groundwater zone, may form above the confining layer, and lateral groundwater movement may occur. Because confining layers are not completely impermeable, part of the perched groundwater eventually seeps downward through the confining layer matrix. The remaining perched groundwater moves laterally until it 1) encounters the edge of the confining unit and moves downward; 2) encounters fractures or other openings that permit downward movement through the confining layer; 3) discharges along canyon walls as seeps, springs, or evapotranspiration; or 4) is withdrawn from the perched aquifer via active wells. These conditions limit the extent of the perched aquifers, which are typically small, thin, and discontinuous.

### *Groundwater Occurrence in Perched Aquifers*

In areas where confining layers are laterally continuous, groundwater may be perched. In the proposed withdrawal area, these conditions occur most commonly in the Toroweap Formation, where groundwater is perched in sandstone units that overlie fine-grained confining strata, and at the base of the Coconino Sandstone (or base of the Toroweap Formation in the north area, where the Coconino is absent), where groundwater may be perched on fine-grained strata of the Hermit Formation. The Moenkopi and Kaibab formations can also contain perched water-bearing zones, especially in the northern part of the North Parcel. At these locations, the perched aquifers may yield small quantities of groundwater to wells for domestic and stock use and to springs. These perched reservoirs are commonly small, thin, and discontinuous, and generally depend on annual recharge to sustain yield to wells and springs (Bills et al. 2010; Montgomery et al. 2000). The perched aquifers overlie and have no direct hydraulic connection to the deep R-aquifer; therefore, any downward movement of perched groundwater is by gravity drainage.

### *Discharge from Perched Aquifer Springs*

In the proposed withdrawal area, seeps and springs issue from fractures, bedding planes, or sandstone strata in perched aquifers in the Chinle, Moenkopi, Kaibab, and Toroweap formations, Coconino Sandstone, and Supai Group along the walls and channels of canyons or from outcrops on the plateaus. Available data for the North Parcel and the South Rim of Grand Canyon indicate that groundwater discharge from individual seeps and springs is small, and the chemical quality of groundwater discharged from perched aquifer systems ranges widely from location to location (Appendix G; see Figures 3.4-11 and 3.4-13) (Bills et al. 2007; Bills et al. 2010; Monroe et al. 2005; Montgomery 1996, 1999). Available data for the East Parcel indicate that discharge from individual seeps and springs is small (Appendices D and E; see Figure 3.4-12); no water quality data are available. Records indicate that only one seep (Miller Seep) occurs on the South Parcel and there are no data for discharge quantity or quality; however, a recent visit to the seep by Forest Service personnel indicated the spring was dry (personal communication, Liz Schuppert, Forest Service 2010).

## Groundwater Occurrence and Movement in the R-Aquifer

The R-aquifer is the only aquifer of regional extent that is capable of consistently yielding large quantities of groundwater to wells and springs in the proposed withdrawal area. On the Colorado River, from about river mile (RM) 50, 11 miles upstream from the mouth of the Little Colorado River in east Grand Canyon, to about RM 142, about 1.5 miles upstream from the mouth of Kanab Creek, the base of the R-aquifer is exposed in outcrop above river level (see Figure 3.4-9). Saturated thickness in the aquifer decreases toward the Grand Canyon (Metzger 1961).

Groundwater enters the R-aquifer in the proposed withdrawal area chiefly by downward migration of precipitation and stormwater runoff via vertical fractures and solution-enhanced features in overlying strata. Groundwater also enters as underflow from those portions of the R-aquifer that are hydraulically upgradient from the proposed withdrawal area. After groundwater enters the saturated zone in the R-aquifer, it becomes part of groundwater in storage in the regional system. Lateral groundwater movement is believed to occur chiefly via fracture and solution openings that are concentrated along principal structural features (Huntoon 1982, 2000). Arterial groundwater migration pathways, with large storage capacity and transmissivity, are believed to have developed in response to dissolution in the direction of the hydraulic gradient toward the principal drains for the aquifer system, such as the Little Colorado River, Havasu Springs, Tapeats Creek, Thunder River, Bright Angel Creek, and the Fence Fault complex reach of Marble Canyon (including Vasey's Paradise), and downgradient areas to the north in Utah. The majority of the discharge from the R-aquifer in the vicinity of Kanab Creek occurs at Tapeats Creek and Thunder River, which are associated with the West Kaibab Fault Zone (including the Muav and Sinyala faults).

Direction of groundwater movement developed by Bills et al. (2007) and Bills et al. (2010) for the R-aquifer in the study area is shown in Figure 3.4-14. Direction of groundwater movement developed by Huntoon (1974) for the Kaibab Plateau region is shown in Figure 3.4-15 and is shown to be focused along principal fault zones.

Basin-type karsts, such as those associated with the fully saturated artesian conditions in the R-aquifer of the Havasu Springs groundwater sub-basin, are characterized by well-developed two-dimensional, or even three-dimensional, maze cave systems that provide maximum groundwater storage, high permeability, interstitial spaces approaching on a macro scale the conditions of porous media, and gentle groundwater hydraulic gradients (Huntoon 2000). The pulse-through hydraulics of this type of system cause fluctuations in spring discharge to be highly moderated and, in large basins, remarkably steady (Huntoon 2000). Groundwater in these systems tends to have elevated TDS content and temperature because most of the water has relatively long residence time in the aquifer due to large storage (Huntoon 2000).

Uplift-type karsts, such as those associated with partially saturated, unconfined conditions in the R-aquifer of the Kaibab Plateau, are characterized by simple vadose zone stream tubes along widely spaced extensional fault zones that provide minimal groundwater storage, localized large fracture permeability, and relatively steep hydraulic gradients (Huntoon 2000). The flow-through hydraulics of this type of partially saturated system cause spring discharge to be highly variable from season to season (Huntoon 2000). Groundwater in these systems tends to have relatively small TDS content and low temperature because most of the water is derived directly from seasonal recharge events and has relatively short residence time in the aquifer (Huntoon 2000).

Huntoon (2000:159) describes the difference between pulse-through (basin karst) and flow-through (uplift karst) systems by comparing porous media and surface water systems as follows:

> In porous media, recharge water moves into the aquifer and enters storage in the rock matrix causing hydraulic heads in the recharged zone to increase. The increased heads propagate toward the discharge points causing a steepening of the hydraulic gradient, thereby increasing flow rates through the aquifer. When the steepened gradient arrives at a spring, flow rates increase as the water in storage closest to the spring is pushed from the aquifer by piston flow. Notice, the water that flows from the spring does not contain much if any of the water which entered the aquifer during the recharge event. Rather it is older water in the most downstream part of the aquifer that is displaced out. The increased spring discharge is therefore called a Pulse-through event because it represents the arrival of the energy at the spring but not the recharge water itself. The recharged water is left behind in storage in the upstream part of the aquifer. As the energy from the recharge pulse passes through the aquifer, it is dissipated so that the spring response will be attenuated and drawn out over time.
>
> Surface water systems respond differently. A precipitation event in the upstream part of a basin produces a flash flood that moves down the channel as a hydraulic pulse in the form of a flood wave. When the pulse arrives at the downstream end of the basin, the water that caused the pulse is carried in it. The increased discharge represents a flow-through event. Comparable flow-through hydraulics operate in many unconfined karst aquifers because storage is minimal and the flood waters are actually coursing through relatively simple, well interconnected, open conduits analogous to surface streams. Actual flow rates approach surface water velocities. As a result, spring discharges from unconfined systems tend to be flashy.

It is likely that a range of conditions, with basin karst (pulse-through) and uplift karst (flow-through) at the endpoints, occurs in the Grand Canyon region (Huntoon 2000).

The potentiometric surface (level to which the groundwater would rise if not trapped in a confined aquifer) of the R-aquifer on the Coconino Plateau and directions of groundwater movement in the study area are shown in Figure 3.4-14 (modified from Bills et al. 2010). These contours were developed by extrapolation of observed data to show general directions of groundwater movement, but do not account for groundwater flow in specific fault and fracture zones. These contours generally illustrate the same general directions of flow as the groundwater flow model developed by Montgomery (1999) for the Coconino Plateau, which did simulate flow along major faults and fracture zones. Figure 3.4-14 also depicts a groundwater divide (shown as a blue dotted line) along the South Rim that is further from the Grand Canyon than was simulated by Montgomery (1999). North of the Grand Canyon, insufficient data are available to construct potentiometric level contours for the R-aquifer groundwater system; however, general directions of groundwater movement and general locations for groundwater divides are shown in Figure 3.4-14. Groundwater movement in the R-aquifer at each of the parcels is described in the following sections.

## NORTH PARCEL

Groundwater data for the R-aquifer are sparse for the area north of Grand Canyon and the flow system is not as constrained by points of discharge at springs in the Grand Canyon watershed. However, a conceptual model for groundwater movement in the R-aquifer north of Grand Canyon has been developed based on groundwater levels in five R-aquifer wells on the North Parcel, the regional dip of geological formations (see Figures 3.4-4 and 3.4-6a [sections B-B’ and C-C’]), the location of major springs and fault zones (see Figures 3.4-5 and 3.4-11), and conceptual directions of R-aquifer groundwater movement developed by Bills et al. (2010), personal communication Don Bills, USGS (2010a), and Huntoon (1974, 1982, 2000). Indirect evidence suggests that R-aquifer groundwater in the North Parcel collects into solution-enhanced permeability features along fault zones and interconnected cave systems and thence generally moves along the pathways described below.

- Groundwater in the area of Kanab Creek and its tributaries likely moves chiefly southward toward springs in the lower reach of Kanab Creek. The area of the Hermit, Kanab North, Pigeon, Hack Canyon Complex, and Pinenut mines occurs within this flow regime (see Figure 3.4-14).
- Groundwater in the southernmost part of the North Parcel may move south toward small springs along the north wall of the Grand Canyon and potential discharge areas in the channel of the Colorado River, where it cuts into the R-aquifer (downstream from Kanab Creek) (see Figure 3.4-14). Spring discharge along the north wall of Grand Canyon in this reach is meager; therefore, it is believed that this flow regime is minor for the North Parcel.

  The large springs at Deer Creek and Thunder River shown east from the Sinyala Fault in Figure 3.4-11 are not part of the groundwater discharge from the North Parcel. These springs are southward points of discharge for groundwater collected by the West Kaibab Fault Zone (including the Muav and Sinyala faults) from the Kaibab Plateau. This relation is also illustrated in Figure 3.4-15.
- Groundwater in the westernmost and northwesternmost areas of the North Parcel may move northward into southern and central Utah along ancient (more than 200-million-year-old) preferential pathways that are believed to have existed during the formation of the breccia pipes in northern Arizona (see Figure 3.4-14). These pathways likely include deep, interconnected maze cave systems and major fault zones, such as the Sevier and Hurricane faults (see Figure 3.4-9). The R-aquifer dips deeply northward from near the Grand Canyon to thousands of feet in depth (see Figure 3.4-4) and does not directly feed springs along the Virgin River north of the North Parcel (Cordova 1981; Dutson 2005). Only oil and gas wells are known to penetrate to these depths in Utah, where the R-aquifer is not considered a viable drinking water supply. The large spring system (total flow of more than 4,100 gpm) that discharges into the Virgin River, where it intersects the Hurricane Fault near Hurricane, Utah issues from the Toroweap Formation.
- Similarly, groundwater in the northeasternmost part of the North Parcel may also move northward into Utah by collecting into major structural preferential pathways, such as the West Kaibab Fault Zone (including the Muav Fault) (see Figures 3.4-9 and 3.4-14).

Groundwater divides occur between these directions of groundwater movement in the North Parcel. Although available data are not sufficient to determine the exact locations for the divides, the conceptual locations are sufficient for the purposes of describing relative groundwater movement.

The R-aquifer crops out along the Virgin River near Littlefield, Arizona and upstream in the lower Virgin River gorge in the northwest corner of Arizona (see Figure 3.4-9). Discharge from springs related to these outcrops has been reported by various sources to range from about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex (personal communication, Don Bills, USGS 2010b). The potential for a hydraulic connection in the R-aquifer between the North Parcel and these spring complexes is not known. Several major north-trending fault zones, including the Sevier, Toroweap, Hurricane, and Main Street faults, occur between the North Parcel and the Virgin River area in northwest Arizona (see Figure 3.4-9). These faults are thought to function like the Mesa Butte Fault Zone south of the Grand Canyon, which provides a preferential pathway where groundwater is intercepted and conveyed along the fault zone to spring systems along the Little Colorado River to the north and the Verde River valley to the south (see Figure 3.4-3). Another example is the West Kaibab Fault Zone (including the Muav and Sinyala faults), which is believed to intercept westward moving groundwater from the Kaibab Plateau and convey it south and north. The fault zones west of the North Parcel, as well as ancient cave systems, likely collect and convey groundwater chiefly north toward central and southern Utah and lesser amounts south toward the Grand Canyon, and may prevent or limit westward movement of R-aquifer groundwater from the North Parcel across the faults to the Virgin River area in northwest Arizona. In addition, although the R-aquifer and other formations at the north end of the Virgin Mountains are abundantly faulted and fractured, the main body of the north-south-trending crystalline bedrock core of the Virgin Mountains east and southeast from the Littlefield spring complex likely functions as a barrier to east-west groundwater movement. Nonetheless, it is possible that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona. However, if such a connection does occur, the contribution to large spring flow along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small.

Figure 3.4-15 shows the conceptual groundwater flow regime developed by Huntoon (1974) for the R-aquifer beneath the Kaibab Plateau, which is a source of recharge for the aquifer east of Kanab Creek. Huntoon (1974, 1982, 2000) indicated the occurrence of several R-aquifer groundwater divides in the Kaibab Plateau caused by collection of groundwater into solution-enhanced permeability features along principal fault and fracture zones, many of which eventually circulate to springs in the Grand Canyon and its tributaries. Huntoon (2000) indicates that the West Kaibab Fault Zone intercepts substantial R-aquifer recharge and groundwater flow moving west in the Kaibab Plateau and conveys the water along the fault zone to the Tapeats Creek and Thunder River spring system, thereby capturing groundwater that might have provided substantial spring flow into the Kanab Creek system. This interpretation explains the lack of large springs west from the fault zone and the relatively limited discharge of R-aquifer springs near the mouth of Kanab Creek. Therefore, exploration and development activities in the North Parcel can not affect the springs that are supported by recharge and groundwater movement in the Kaibab Plateau.

## EAST PARCEL

There are no data available to define the groundwater flow regime in the R-aquifer beneath the East Parcel. However, the presence of a major source of recharge to the west on the Kaibab Plateau and the location of a major R-aquifer discharge area along the Fence Fault complex reach of Marble Canyon, including Vasey's Paradise, suggest that groundwater generally moves along preferential pathways from west to east or southeast beneath the East Parcel (see Figure 3.4-14). The flow pathway may be somewhat convoluted as a result of the north and northwest orientation of the faults and folds in the East Parcel area. Large quantities of groundwater discharge from the R-aquifer along the Fence Fault and at Vasey's Paradise (see Figure 3.4-12). Underflow in the R-aquifer may occur beneath the river channel in Marble Canyon, and unknown quantities of groundwater may discharge directly into the bottom of the Colorado River, where the aquifer crops out in the river channel downstream of North Canyon (Huntoon 1981). R-aquifer groundwater in the small area at the northernmost extent of the East Parcel may move northward into Utah, but like groundwater in the North Parcel, it is unlikely to discharge to any of the large springs along the Virgin River.

## SOUTH PARCEL

Most of the South Parcel lies in the R-aquifer groundwater sub-basin of Havasu Springs (see Figures 3.4-13 and 3.4-14). R-aquifer groundwater south and west of the groundwater divide flows downgradient to the south, southwest, and west, eventually discharging to the large Havasu Springs complex (see Figures 3.4-13 and 3.4-14).

R-aquifer groundwater north of the groundwater divide and the Grandview Monocline flows downgradient to the east and northeast, discharging to the Little Colorado River and the large Blue Springs complex (see Figures 3.4-13 and 3.4-14). Based on groundwater contours shown on Figure 3.4-14, there may be some R-aquifer groundwater north of the Grandview Monocline that flows northward to discharge at small springs and seeps along the south wall of Grand Canyon. Fault and fracture zones along the northern extent of the monocline likely provide pathways for R-aquifer groundwater to discharge at small springs and seeps along the south wall of Grand Canyon, such as Miner's and O'Neill springs. The Grandview Mine breccia pipe is located within the monocline between these two springs (Alter et al. 2009). It should be noted that the outcrop pattern of the Redwall Limestone shown on maps in this section of the EIS is offset in some areas with respect to the locations for R-aquifer springs shown on the maps because of map scale and map corrections that are not yet available from the USGS; some R-aquifer springs erroneously appear to be above the Redwall Limestone.

In the northern part of the South Parcel, which lies in the Havasu Creek surface water drainage basin, R-aquifer groundwater north of the groundwater divide, which is near and approximately parallel to the South Rim of Grand Canyon, flows north toward the Colorado River and springs and R-aquifer seeps along the south wall of Grand Canyon (see Figures 3.4-13 and 3.4-14). These springs include the Hermit Springs and Garden Spring complexes, each of which has an aggregate discharge of about 300 gpm. It should be noted that each of the groundwater drainage areas that support the Hermit Springs and Garden Springs complexes likely extend southwestward along the associated southwest-trending fault zones that intersect the Grand Canyon at these locations. These groundwater drainage areas may extend farther southwest than indicated by the R-aquifer groundwater divide estimated by Bills et al. (2007) and shown in Figure 3.4-14.

## *Discharge from R-Aquifer Springs*

Groundwater in the R-aquifer south of the Colorado River discharges chiefly at the Blue and Havasu spring complexes. North of the Colorado River, the R-aquifer discharges chiefly at Tapeats Creek, Thunder River, Kanab Creek, Bright Angel Creek, Deer Creek, Shinumo Creek, the Fence Fault complex, and Vasey's Paradise. There is also significant, but undefined, groundwater discharge, as well as underflow, from the R-aquifer in Marble Canyon. Assuming steady-state conditions, the amount of recharge to and groundwater movement through the R-aquifer can be estimated by summing discharge from large springs that occur on the margins of the plateaus. Appendix E provides a summary of reported locations and discharge rates for springs and seeps.

Recharge from infiltration of precipitation in local drainage catchment basins along both rims of the Grand Canyon is very important to the occurrence and sustainability of local water-bearing zones that support the discharge at many small springs and seeps and at a few moderate-sized springs within the Grand Canyon or its tributary canyons. The drainage area necessary to support the small but environmentally important discharge from these springs and seeps is limited and can be contained within the near-rim areas of more weathered and fractured rock. As described previously, the small springs and seeps are considered to be poorly connected or in some cases not connected hydraulically to the regional circulation systems of the R-aquifer (Montgomery 1996, 1999; U.S. Bureau of Reclamation 2002). The results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, and that the small, local drainage basins at the Canyon rim may not be the only source of water for these springs.

Rihs et al. (2004) studied several springs discharging from the R-aquifer along the South Rim of Grand Canyon. They concluded that there was a significant decreasing trend in discharge from some springs but not others. The cause of the decrease was not identified and could be the result of a complex set of circumstances, including decreasing precipitation trends and pumping from the aquifer at Tusayan since 1989. This decrease is not attributed to uranium mining operations because there have been no uranium mining or groundwater withdrawals from the R-aquifer for mining in the South Parcel or adjacent areas during the period of the Rihs et al. (2004) study, and only minor use of the Canyon Mine well since it was drilled.

### *Yield from Wells*

Records indicate that only 13 wells are completed in the R-aquifer in the study area (see Table 3.4-1, Figure 3.4-9). Many more wells are completed in the perched aquifers and yield small quantities of water with varying reliability and chemical quality. Records for pumping rates at wells are given in Appendix D. It should be emphasized that the reported pumping capacity of a well is often limited to the size of the pump and the diameter of the well casing, rather than the capacity the aquifer.

Reported pump capacity for all wells in the study area ranges from 0.1 to 1,200 gpm. The highest pump capacities reported (600 to 1,200 gpm) are for several water wells located far to the northeast of the East Parcel in the vicinity of Lake Powell. Reported pump capacities for water wells completed in Mesozoic-age geological units in North and East parcels range from 0.5 to 600 gpm. Three water wells near Fredonia, Arizona have reported pump capacities of between 50 and 400 gpm and are likely completed in the Kaibab and/or Toroweap formations where these units represent a viable aquifer. Other water wells completed in perched aquifers in the three parcels and their immediate vicinity have recorded pump capacities of 15 gpm or less; pump capacities of these wells average about 4 gpm. Reported pumping rates for R-aquifer water wells range from 5 to 89 gpm; average rate is about 29 gpm (see Table 3.4-1).

In most parts of the study area, long-term pumping of significant volumes of groundwater from R-aquifer wells within the drainage basins of R-aquifer springs would intercept groundwater that, in the absence of pumping, would have discharged at these springs. It should be emphasized that because of complex subsurface relationships, some springs would be affected more than others, and some would not be affected at all. If pumping were to continue for a sufficiently long period at a rate less than the total groundwater recharge rate for the system, a new condition of dynamic equilibrium would be established where the average rate of groundwater discharge at the springs would be equal to the average rate of recharge minus the average rate of groundwater pumping at the wells. Groundwater levels would slowly stabilize in the aquifer at a level that is less than the pre-pumping level. However, if the rate of long-term pumping exceeds the rate of recharge, groundwater would continue to be removed from storage, and groundwater levels and spring flow reductions would continue until groundwater levels eventually decline to the bottom of the pumps in the wells. In either case, the amount and duration of impact to springs would depend on site-specific conditions. In some cases, springs could dry up. If pumping stopped at any point, recharge would eventually replenish the aquifer over time and re-establish pre-pumping water levels and discharge rates at the affected springs.

## 3.4.7 Water Quality

Natural processes and human activities (including improperly abandoned mines and improperly disposed mine waste or waste rock) can cause concentrations of dissolved trace elements and radionuclides to be elevated in groundwater and surface water. Water chemistry data for wells, springs, seeps, and mine sumps within the study area have been obtained, compiled, and reported by numerous academic, government, and industry sources. The most relevant of these data have been reviewed and compiled for the EIS. Uranium and uranium decay products are the principal mine-related constituents of concern for water quality in the proposed withdrawal area. Other trace elements reported to be associated with uranium in mineralized breccia pipes include antimony, arsenic, barium, cadmium, cobalt, copper, lead, molybdenum, nickel, silver, strontium, vanadium, and zinc (Wenrich et al. 1994). However, except for arsenic, not all of these constituents are known to necessarily correlate with dissolved uranium in water because of a lack of data. Thus, only impacts to water resources related to uranium and arsenic are analyzed in Chapter 4.

Bills et al. (2010) evaluated historic water quality data compiled for the region to identify exceedances of drinking water standards and health-based guidance levels for the following additional constituents of concern: arsenic, lead, mercury, and molybdenum. The following uranium-series decay products were identified by Hinck et al. (2010) to present a potential hazard to fish and wildlife in the area if present in the environment: uranium, thallium, thorium, bismuth, radium, radon, protactinium, polonium, actinium, and francium. Unfortunately, very sparse data exist for these radionuclides other than uranium in the study area, so uranium data must be used as a proxy for assessing potential levels of decay-chain products. Hinck et al. (2010) report that species in the region may be susceptible to adverse effects at uranium concentrations ranging from 0.57 to 46,000 micrograms per liter (μg/L). Water quality thresholds for wildlife are discussed in detail in Section 3.7.

Bills et al. (2010) conducted a recent, comprehensive survey of water chemistry data and compilation of historical uranium data for the study area. Historical water-chemistry data from selected data sources were compiled and reviewed by USGS for streams, wells, and both perched aquifer and R-aquifer springs. In addition, in 2009, new water-chemistry data were obtained by USGS and NPS at 24 sites to augment historical data for the three parcels. USGS reviewed more than 1,000 water samples obtained from more than 400 sites in the Grand Canyon and surrounding regions. The results of this USGS study form an important part of the database used for analysis of water quality for this chapter of the EIS; additional analyses were compiled and reviewed for the EIS.

Numerous mineralized breccia pipes are exposed in the walls of the Grand Canyon and adjoining canyons. Many others, located some distance from canyon walls, remain undisturbed (see Figure 3.4-5). Uranium and associated minerals may occur naturally in groundwater in northern Arizona and southern Utah. Bills et al. (2010) reported that concentrations of dissolved uranium were less than 5 μg/L for about 66% of all historic samples in their data set and were less than 20 μg/L for about 95% of all historic samples in their data set. Their historic data set consisted of 1,014 samples from 428 documented sites that have analyses for dissolved uranium, including 480 samples from 63 stream locations, 385 samples from 288 springs, 138 samples from 74 wells, and 11 samples from three mines.

The EPA has established National Primary Drinking Water Regulations that set mandatory water quality standards for drinking water contaminants. These are enforceable standards called maximum contaminant levels (MCLs), which are established to protect the public against consumption of drinking water contaminants that present a risk to human health. An MCL is the maximum allowable amount of a contaminant in drinking water that is delivered to the consumer. In addition, EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these secondary MCLs. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the secondary MCL.

Bills et al. (2010) reported that the results of chemical analyses indicated that, at about 16% of the sites, concentrations exceeded either the primary or secondary MCL for a few major ions and trace elements such as arsenic, iron, lead, manganese, sulfate, radium, and uranium. Arsenic and lead are commonly associated with uranium deposits. The average concentration of arsenic was found to exceed the primary MCL at 70 sites, and lead concentrations were determined to exceed the primary MCL at only three sites in the data collected and compiled by the USGS.

Sample data for dissolved uranium content of the Colorado River were also compiled in the USGS Report (Bills et al. 2010:Figure 15, Appendix 4). These data indicate that the dissolved uranium concentration of the river was about 3 to 4 µg/L from January 1996 through June 1998 at Lees Ferry, which is immediately upstream from the East Parcel. These concentrations are similar to those detected downstream of the withdrawal area at Diamond Creek; dissolved uranium averaged 3.2 µg/L at Lees Ferry and 3.1 µg/L at Diamond Creek from 1996 through 1998.

Water type varies throughout the study area. Water quality results reported by Bills et al. (2010) were generally categorized as shown in Table 3.4-3, based on the principal anions and cations.

**Table 3.4-3.** Summary of Water Types

| Aquifer or River | Location | Water Type |
|---|---|---|
| Perched Aquifer | North of Colorado River | $CaMg-SO_4$ |
| Regional (R-aquifer) | North of Colorado River | $Ca-HCO_3$ |
| Perched Aquifer | South of Colorado River | $CaMg-HCO_3$ |
| Regional (R-aquifer) | South of Colorado River | $CaMg-HCO_3$ |
| Regional (R-aquifer) | West part of Grand Canyon | $CaMg-SO_4$ |
| Regional (R-aquifer) | Little Colorado River (at Blue Springs) | Na-Cl |
| Regional (R-aquifer) | Marble Canyon | $Ca-HCO_3$ |
| Regional (R-aquifer) | Southwest of Kaibab Plateau | $Ca-HCO_3$ |
| Regional (R-aquifer) | Kanab Plateau | $Ca-HCO_3$ |
| Little Colorado River | Cameron | $Na-SO_4$ |

Source: Bills et al. (2010)

Note: Ca = Calcium; Cl = Chloride; $HCO_3$ = Bicarbonate; Mg = Magnesium; Na = Sodium; $SO_4$ = Sulfate

A principal conclusion of the 2010 USGS report was that "observation of groundwater-chemistry relations between concentration and mining condition (no exploration or development activity, active mines on interim management, or reclaimed mine areas) were limited and inconclusive" (Bills et al. 2010:194).

The ambient water quality of perched groundwater near mines is generally of poor quality as a result of mineralization from the ore bodies. Groundwater that is contained within the breccia pipes (connate water) is also generally of very poor quality as a result of mineralization (personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010).

Water sample data compiled for the EIS include results for TDS content, flow rate at springs, dissolved arsenic, dissolved uranium, and a small number of dissolved lead analyses. Analytical results for uranium, arsenic, and lead were generally composed of filtered samples that were analyzed for dissolved constituents. Sources for TDS, flow rate, arsenic, and uranium data that were compiled include USGS (2010d); Bills et al. (2010); Grand Canyon National Park (2010a); ADWR (2009b); Grand Canyon Wildlands Council, Inc. (2002); Fitzgerald (1996); Montgomery (1993a, 1993b); and Woodward-Clyde Consultants (1985). In addition, historical data on selected sites, including mine wells and sumps, reported in Bills et al. (2010) for arsenic and uranium were included in the compilation. Sample results for dissolved lead were obtained from USGS (2010d). Additional information from the EPA's STORET database, primarily composed of site information, was used to supplement data compiled from the above sources (EPA 2010l).

Locations and estimates of discharge rate for all sample locations for springs and seeps, as well as for selected sample locations for streams compiled for the EIS, are summarized in Appendix E. Information compiled for locations of all water quality sampling and flow rate estimates is summarized in Appendix F. Sample statistics for each sample location are summarized in Appendix G for the study area; statistics include the total number of reported sample results for each summarized constituent, and the minimum, maximum, and average parameter values for each constituent.

Results for water quality analyses were compiled from the sources noted above for a total of 687 sampling locations in the water resources study area and for 6-mile buffers around each of the parcels. These buffer areas allow for characterization of features adjacent to the parcels that may have a relationship with the parcels. For example, the numerous small springs and streams located north of the Grand Canyon's South Rim are outside the South Parcel but may have drainage areas that overlap portions of the South Parcel. Of the total number of sites for the regional study area with sample results, 265 were classified as discharging from aquifers composed of Mesozoic rock, 154 sites were classified as discharging from the perched aquifer, 148 sites were classified as discharging from the R-aquifer, 32 were classified as discharging from a source below the R-aquifer, five sites were associated with mine seepage, and the remaining 83 sites were from a zone that is not classified under a specific aquifer; samples were obtained from wells, springs, and streams. Sample statistics are summarized in Table 3.4-4 for the study area and proposed withdrawal area; statistics include the total number of sites in each aquifer or sample source category, the number of sites constituting each summarized constituent, and the minimum, maximum, and average parameter values for each constituent (averages consist of the numeric mean of all parameter averages calculated for each site).

Results reported for TDS are from laboratory analyses, where available. Where laboratory results were not available, TDS was estimated by multiplying measured electrical conductivity of the water sample by a conversion factor of 0.65 (Hem 1985). Table 3.4-4 summarizes relevant information provided in Appendix G regarding parameter values reported for the combined data set, including all sample sources (wells, springs, and streams) classified as being associated with the perched and regional aquifer systems.

For all samples in the water resources study area, samples for the perched aquifer system showed that concentrations of the principal constituents ranged from 17 to 7,500 milligrams per liter (mg/L) for TDS, 0.4 to 241.6 µg/L for arsenic, and 0.02 to 44 µg/L for uranium. For all samples in the R-aquifer system, concentrations of the principal constituents ranged from 70 to 25,000 mg/L for TDS, 0.11 to 220 µg/L for arsenic, and 0.15 to 400 µg/L for uranium. Higher concentrations of TDS in groundwater and springs generally indicate that the rock unit in which the groundwater resides has more soluble minerals and/or that the groundwater has resided in the aquifer for longer periods.

Estimated background concentrations of parameters stored in the database for the entire water resources study area are provided by calculating summary statistics for all sample sites, regardless of aquifer or source (Table 3.4-5). However, in order to obtain statistics representative of natural conditions, samples that are known to be affected by mining operations (such as samples of mine seepage obtained from mine sumps and shafts) and samples obtained from water that may be impacted by mining (such as samples obtained from Horn Creek [see Appendix G]) were not included in the calculations.

## North Parcel

Results for water quality analyses were compiled for a total of 118 sampling locations in the North Parcel and for a 6-mile buffer region outside the area. Of these locations, 64 were classified as discharging from aquifers composed of Mesozoic rock, 34 sites were classified as discharging from the perched aquifer, nine sites were classified as discharging from the R-aquifer, no sites were classified as being below the R-aquifer, seven sites were classified as stream sample sites, and the remaining four sites were classified as mine seepage.

**Table 3.4-4.** Summary of Statistics for Water Quality Samples

| Sample Source | Total Number of Sites | TDS (mg/L) Min | TDS (mg/L) Max | TDS (mg/L) Avg | Number of Sites with TDS Results | Arsenic (µg/L) Min | Arsenic (µg/L) Max | Arsenic (µg/L) Avg | Number of Sites with Arsenic results | Uranium (µg/L) Min | Uranium (µg/L) Max | Uranium (µg/L) Avg | Number of Sites with Uranium Results | Flow Rate (gpm) Min | Flow Rate (gpm) Max* | Flow Rate (gpm) Avg* | Number of Sites with Flow Rate Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **All Data within Water Resources Study Area** | | | | | | | | | | | | | | | | | |
| Mesozoic | 265 | 79 | 12,600 | 1,097 | 153 | 0.41 | 105.6 | 15.6 | 21 | 0.00 | 249.6 | 11.6 | 70 | 0 | 673 | 13 | 114 |
| Perched | 154 | 19 | 7,750 | 908 | 98 | 0.4 | 241.6 | 22.0 | 32 | 0.02 | 44 | 5.3 | 59 | 0 | 673 | 10 | 89 |
| R-aquifer | 148 | 70 | 25,000 | 1,066 | 110 | 0.11 | 220 | 22.5 | 61 | 0.15 | 400 | 10.9 | 92 | 0 | 48,000 | 1,460 | 106 |
| Below Regional | 32 | 109 | 8,320 | 1,212 | 24 | 6 | 350 | 86.2 | 12 | 1.5 | 29 | 10.8 | 21 | 0 | 5,270 | 209 | 18 |
| Mine seepage | 5 | 1,920 | 1,920 | 1,920 | 1 | 5 | 1,090 | 152.6 | 5 | 20.7 | 36,600 | 7,693.6 | 5 | – | – | – | 0 |
| N/A (Stream) | 66 | 87 | 3,560 | 656 | 47 | 0.5 | 310 | 40.9 | 13 | 0.14 | 29.21 | 5.8 | 29 | 0 | 2,200,000 | 11,100 | 45 |
| N/D (Well) | 17 | 117 | 3,150 | 1,401 | 8 | 0.5 | 248.1 | 116.4 | 7 | 1.21 | 13.47 | 3.7 | 9 | – | – | – | 0 |
| **North Parcel** | | | | | | | | | | | | | | | | | |
| Mesozoic | 64 | 79 | 6,810 | 1,253 | 37 | 0.5 | 4 | 2.4 | 8 | 0.11 | 249.6 | 24.0 | 24 | 0 | 170 | 25 | 19 |
| Perched | 34 | 293 | 3,380 | 1,486 | 23 | 0.4 | 28 | 4.6 | 13 | 0.50 | 44 | 10.3 | 19 | 0 | 90 | 9 | 24 |
| R-aquifer | 9 | 455 | 3,970 | 1,418 | 8 | 0.5 | 34 | 6.9 | 8 | 0.15 | 24 | 4.7 | 8 | 1 | 274 | 65 | 8 |
| Mine seepage | 4 | 1,920 | 1,920 | 1,920 | 1 | 5 | 1,090 | 168.2 | 4 | 20.7 | 36,600 | 9,462.1 | 4 | – | – | – | 0 |
| N/A (Stream) | 7 | 820 | 3,560 | 2,007 | 6 | 0.5 | 10 | 1.5 | 6 | 0.5 | 18.9 | 6.5 | 7 | 189 | 31,900 | 8,530 | 5 |
| **East Parcel** | | | | | | | | | | | | | | | | | |
| Mesozoic | 56 | 109 | 4,200 | 607 | 30 | – | – | – | 0 | 0.6 | 5.05 | 1.9 | 5 | 0 | 18 | 2 | 44 |
| Perched | 3 | 897 | 897 | 897 | 1 | 1.44 | 5 | 3.2 | 2 | 0.77 | 4.64 | 2.1 | 3 | 0 | 0 | 0 | 1 |
| R-aquifer | 14 | 163 | 1,600 | 777 | 14 | 1.3 | 21 | 9.6 | 13 | 0.5 | 2.5 | 1.6 | 13 | 1 | 4,480 | 391 | 14 |
| N/D (Well) | 1 | 2,353 | 2,353 | 2,353 | 1 | – | – | – | 0 | – | – | – | 0 | – | – | – | 0 |
| **South Parcel** | | | | | | | | | | | | | | | | | |
| Perched | 8 | 145 | 1,120 | 525 | 6 | 0.5 | 0.5 | 0.5 | 1 | 0.6 | 7.2 | 3.4 | 3 | 1 | 1 | 1 | 3 |
| R-aquifer | 30 | 70 | 1,829 | 372 | 27 | 0.26 | 20 | 8.8 | 8 | 1.06 | 400 | 29.3 | 23 | 0 | 359 | 45 | 22 |
| Below regional | 11 | 275 | 1,235 | 581 | 10 | 54 | 54 | 54 | 1 | 1.75 | 18 | 7.3 | 9 | 0 | 54 | 6 | 8 |
| Mine seepage | 1 | – | – | – | 0 | 90 | 90 | 90 | 1 | 620 | 620 | 620 | 1 | – | – | – | 0 |
| N/A (Stream) | 16 | 166 | 853 | 424 | 9 | – | – | – | 0 | 1.4 | 29.21 | 7.6 | 9 | 0 | 1,020 | 128 | 9 |
| N/D (Well) | 1 | – | – | – | 0 | 237.3 | 237.3 | 237.3 | 1 | 3.12 | 3.12 | 3.1 | 1 | – | – | – | 0 |

**Notes:**

Samples reported for the proposed withdrawal area include all results within 6 miles of the parcel boundaries.

Avg = average value.

Min = minimum value.

Max = maximum value.

N/A = not applicable.

N/D = not determined.

– = Data not available.

* Three significant figures assumed for all flow rate results.

**Table 3.4-5.** Summary Statistics for All Non-mine-Related Samples

| Parameter | Number of Sites | Minimum | Maximum | Average |
|---|---|---|---|---|
| TDS (mg/L) | 438 | 19 | 25,000 | 1,015 |
| Arsenic (µg/L) | 146 | 0.11 | 350 | 32.8 |
| Uranium (µg/L) | 275 | 0.001 | 249.6 | 7.16 |
| Lead (µg/L) | 70 | 0.03 | 210 | 8.7 |

For the North Parcel, discharge rate and TDS results are shown in Figure 3.4-16a, arsenic results are shown in Figure 3.4-16b, and uranium results are shown in Figure 3.4-16c. For the perched aquifer system, concentrations of the principal constituents ranged from 293 to 3,380 mg/L for TDS, 0.4 to 28 µg/L for arsenic, and 0.5 to 44 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 455 to 3,970 mg/L for TDS, 0.5 to 34 µg/L for arsenic, and 0.15 to 24 µg/L for uranium.

## East Parcel

Results for water quality analyses were compiled for a total of 74 sampling locations in the East Parcel and for a 6-mile buffer region outside the area. Of these locations, 56 were classified as discharging from aquifers composed of Mesozoic rock, three sites were classified as discharging from the perched aquifer, 14 sites were classified as discharging from the R-aquifer, no sites were classified as being below the R-aquifer, and one site was from zones not classified as being associated with a specific aquifer.

For the East Parcel, discharge rate and TDS results are shown in Figure 3.4-17a, arsenic results are shown in Figure 3.4-17b, and uranium results are shown in Figure 3.4-17c. For the perched aquifer system, concentrations of the principal constituents were 897 mg/L for TDS, ranged from 1.44 to 5 µg/L for arsenic, and ranged from 0.77 to 4.64 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 163 to 1,600 mg/L for TDS, from 1.3 to 21 µg/L for arsenic, and from 0.5 to 2.5 µg/L for uranium.

## South Parcel

Results for water quality analyses were compiled for a total of 67 sampling locations in the South Parcel and for a 6-mile buffer region outside the area. Of these locations, none were classified as discharging from aquifers composed of Mesozoic rock, eight sites were classified as discharging from the perched aquifer, 30 sites were classified as discharging from the R-aquifer, 11 sites were classified as being below the R-aquifer, 16 sites were classified as stream sample sites, one site was classified as mine seepage, and the remaining site was from zones not classified as being associated with a specific aquifer.

For the South Parcel, discharge rate and TDS results are shown in Figure 3.4-18a, arsenic results are shown in Figure 3.4-18b, and uranium results are shown in Figure 3.4-18c. For the perched aquifer system, concentrations of the principal constituents ranged from 145 to 1,120 mg/L for TDS, 0.5 µg/L for arsenic (only one sample available), and from 0.6 to 7.2 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 70 to 1,829 mg/L for TDS, from 0.26 to 20 µg/L for arsenic, and from 1.06 to 400 µg/L for uranium. If the water samples from Horn Creek, which is believed to be impacted by mine drainage as discussed in the next section, are excluded, the maximum uranium concentration is 31.2 µg/L and the average uranium concentration is 5.6 µg/L.

### *Legacy Impacts to Water from Uranium Mining*

Uranium concentrations exceeding the regional average of about 7 µg/L detected in groundwater or springs near existing and/or former mines do not necessarily indicate that the water is impacted by exploration and development activities. Naturally occurring concentrations of uranium at specific springs or stream sites are likely to vary from site to site because of variability in aquifer materials, source waters, and environmental conditions (reduction-oxidation potential). Site-specific uranium concentrations may be higher than the regional average of 7 µg/L. For example, samples collected at Pigeon Spring in 1982 indicate that the uranium content of the spring was 44 µg/L prior to initiation of mining (Hopkins et al. 1984b). Thus, concentrations of contaminants of concern at specific sites should be considered in light of both regional average and maximum values at sites of a given type when evaluating the magnitude of a potential impact. Ideally, background conditions and their variability at sites of concern prior to initiation of mining must be known with a reasonable level of confidence to infer that an impact has likely occurred. There are no sample results in the water quality database that meet these requirements, except for samples obtained from the Canyon Mine well.

Under certain circumstances, impacts to water quality may be inferred in the absence of pre-mining data. In hydrologic systems poorly connected to the regional groundwater circulation system in the R-aquifer, it is unlikely that discharge to springs is substantially mixed with groundwater from distant sources. The isotopic composition of uranium in water from such systems may be used to evaluate whether high uranium concentrations result from the natural dissolution of uranium-bearing rocks or from anthropogenic activities at uranium mines (Appendix H). Samples exhibiting high $^{234}U$ activity relative to $^{238}U$ activity are indicative of ambient groundwater because of the preferential mobility of $^{234}U$ in natural waters. Conversely, samples having $^{234}U$ activity approximately equal to $^{238}U$ activity represent conditions of aggressive water-to-rock interaction symptomatic of water impacted by mine drainage. Isotopic and dissolved uranium data compiled for the study area and Colorado River indicate that only samples collected from Horn Creek springs, which originate from the R-aquifer about ½ mile or less north of the Orphan Lode Mine, have high concentrations of dissolved uranium (>30 µg/L) and an $^{234}U/^{238}U$ activity ratio near one. Apparently, surface water and/or perched groundwater seepage into the abandoned, unreclaimed mine workings of the Orphan Lode Mine have interacted with mine waste and/or disturbed ore deposits to generate elevated concentrations of uranium in water that has moved vertically downward from the mine openings into the R-aquifer. Additional monitoring data are necessary to rule out the possibility that groundwater in locations other than Horn Creek springs may also be impacted from uranium mining because potential mixing of impacted water with native groundwater may mask the isotopic signature.

## 3.4.8 Resource Condition Indicators for Water Resources

Based on the information presented in Chapter 3, the resource condition indicators for water resources to be carried forward for analysis in Chapter 4 include the following:

- **Perched Aquifer Water Quantity.** Quantity of water discharge at springs and wells supported by perched groundwater zones that may be depleted by drainage into nearby subsurface openings related to mining.
- **Perched Aquifer Water Quality.** Chemical quality of water discharge at springs and wells supported by perched groundwater zones that may be affected by operations at nearby mine sites, with emphasis on metals.

- **R-aquifer[1] Water Quantity.** Quantity of water discharge at springs and deep wells supported by the R-aquifer system that may be depleted by mine water supply wells.
- **R-aquifer Water Quality.** Chemical quality of water discharge at springs and deep wells supported by the R-aquifer system that may be affected by operations at mine sites, with emphasis on metals.
- **Condition of Surface Waters.** Quantity and chemical quality (with emphasis on metals), and hydrologic function of perennial and ephemeral surface drainages that receive discharge from springs and/or surface water runoff. Quantity and quality of water retained in non-mine surface impoundments.

# 3.5 SOIL RESOURCES

This section provides a description of existing soil resources in the vicinity of the proposed withdrawal area and the current value of resource condition indicators that will be the basis for evaluating impacts in Chapter 4. The description is based on review and compilation of available data for selected soil properties obtained from the National Resources Conservation Service (NRCS), Forest Service, and BLM, as well as review of information from numerous previous investigations of the Northern Arizona region, including those by the USGS, mining companies, and other consultants.

## 3.5.1 Soil Resource Condition Indicators

Soil information obtained from NRCS soil surveys for the North and East parcels and from TES results for the South Parcel was reviewed to determine the conditions likely to be affected as a result of the construction, operation, and maintenance of anticipated future access roads, utility corridors, mine facilities, and exploration drill sites in the proposed withdrawal area, as outlined in the RFD scenario. These conditions include the following:

- **Soil Disturbance.** Soil physical properties would be expected to be affected from the surface disturbance that is required for the development of mine facilities, drill sites, access roads, and power lines. The indicator values are the anticipated acreage (area) of disturbed soils. Existing soil disturbance associated with previous and current mining is about 713 acres, of which roughly 603 acres have been reclaimed.
- **Soil Erosion.** Rates of soil loss would be expected to increase as a result of vegetation removal, soil compaction, and changes in drainage patterns related to anticipated surface disturbance. The indicators are qualitative evaluations of potential increased erosion rates, and the extent of off-site effects, relative to undisturbed conditions. These impacts are assessed relative to erosion hazard ratings, which identify areas of erosion-sensitive soils; such areas are typified by steep topography and/or thin soils.
- **Soil Contamination.** Soil chemical quality would be expected to be altered by distribution of mine-related constituents in soil from erosion and subsequent deposition of mine waste rock or ore from water and/or wind action, or leakage from detention ponds in the vicinity of each mine site. Indicators values are expected levels of mine-related contaminants in soil compared to background levels and ADEQ Soil Remediation Levels (SRLs). Investigation of legacy mining impacts on the North Parcel determined that the two most abundant elements associated with

[1] The R-aquifer is the regional carbonate aquifer composed of the Redwall Limestone, Temple Butte Formation, undifferentiated Cambrian dolomites, and Muav Limestone; this aquifer is also referred to as the Redwall-Muav aquifer or the regional aquifer. Perched aquifers are separated from the R-aquifer by low-permeability confining layers and are typically thin and discontinuous.

uranium mining detected in impacted soils are uranium and arsenic (Otton et al. 2010). This study indicated average concentrations of uranium and arsenic in soils on-site (reclaimed) and off-site ranged from below regional ambient levels to as much as one order of magnitude above ambient levels. Soils in the area surrounding reclaimed mines and those in operation for a short time were generally less impacted than unreclaimed mines or mines in operation for longer periods. Although concentrations of the constituents of concern exceeded ambient conditions at some locations, concentrations were generally below the SRL for uranium. Concentrations were generally above the SRL for arsenic but below the maximum reported concentration for an unmined, mineralized breccia pipe in the study area.

### 3.5.2 General Description of Study Area

Soil types within the study area vary widely, reflecting differences in the environmental and geomorphic conditions under which soils were formed and differences in the parent materials. The environmental and geomorphic conditions are controlled primarily by the topography of the region, which ranges from nearly level valley bottoms and gently sloping plateaus to vertical cliffs; elevations range from less than 2,000 feet amsl in the Grand Canyon to more than 8,000 feet amsl on the Kaibab Plateau. Although the proposed withdrawal area is characterized primarily by plateaus, several canyons associated with Kanab Creek are incised into the Kanab Plateau in the North Parcel, and the Marble Canyon section of the Grand Canyon, including several tributary canyons, is located directly adjacent to the East Parcel. Soil characteristics range from shallow, weakly developed, rocky soils on plateaus, cliffs, and ridges to deeper, more productive soils on alluvial fans and in valley bottoms. In general, soils in the proposed withdrawal area are fine textured and contain a wide range of rock fragments, both internally and at the surface. The dominant parent materials that occur in the proposed withdrawal area are sedimentary rocks, including sandstone, carbonate (chiefly limestone and dolomite), mudstone, shale, and gypsum. Igneous rocks, including basalt, basalt cinders, and granite, are also prevalent (Hendricks 1985).

The dominant soil orders that occur in the proposed withdrawal area are Alfisols, Aridisols, Entisols, and Mollisols; these soil orders are described by Hendricks (1985) and via personal communication (personal communication, Christopher MacDonald, Forest Service 2010a), as follows:

- Alfisols and Aridisols are the more developed soils of arid and semi-arid environments, with Aridisols occurring at lower elevations and in drier climates. Alfisols generally form under forest vegetation and have subsoils composed primarily of clays. Aridisols are typically light colored and very low in organic matter content.
- Entisols occur in young landscapes and develop from parent materials resistant to weathering. These soils are commonly shallow and overlie rock on steep slopes.
- Mollisols are typically dark-colored soils with high organic matter content near the surface and occur at higher elevations under subhumid to semiarid climates in landscapes dominated by grassland vegetation.

Soils identified in the study area have a mesic soil temperature regime (mean annual soil temperature of about 46°F–59°F) and an aridic (6–10 inches annual precipitation) to semiaridic (10–15 inches annual precipitation) soil moisture regime. Soil mineralogy is generally carbonatic, mixed, or smectitic (NRCS 2006a). Some areas also exhibit a carbonatic gypsic mineralogy (personal communication, Robert Smith, BLM 2010b).

## 3.5.3 Soil Extents and Characteristics

Available soil surveys were obtained from the NRCS State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) databases,[2] and Terrestrial Ecosystem Survey (TES) information was obtained from the Forest Service, Kaibab National Forest (Brewer et al. 1991).[3] Soil surveys and terrestrial ecosystem surveys are conducted in accordance with the National Cooperative Soil Survey, which is a nationwide partnership of federal, regional, state, and local agencies, along with private entities and institutions. This partnership works to cooperatively investigate, inventory, document, classify, interpret, disseminate, and publish information about soils of the United States and its trust territories and commonwealths (NRCS 2007).

The NRCS has completed detailed soil surveys that encompass the North and East parcels. The Kaibab National Forest has completed a detailed TES that encompasses the South Parcel. Detailed soil data were obtained from the following surveys:

- AZ625 – Mohave County Area, AZ, Northeastern Part and Part of Coconino County (NRCS 2008). Soil survey coverage includes the western portion of the North Parcel.
- AZ629 – Coconino County Area, AZ, North Kaibab Part (NRCS 2009). Soil survey coverage includes the eastern portion of the North Parcel and the East Parcel.
- Kaibab National Forest TES (Brewer et al. 1991). Coverage of the TES includes all of the South Parcel, except for a few very small areas to which the survey may be reasonably extrapolated.

Generalized digital soil survey data were also obtained from the NRCS for generation of regional soils maps for the North and East parcels (NRCS 2006b). Generalized digital soil map data for the South Parcel were obtained from the Forest Service's Southwestern Region General Terrestrial Ecosystem Survey (GTES) data set (Forest Service 1998).

Soil mapping of the Northern Arizona region indicates that soil types are distributed in a repetitive pattern consistent with the topography, parent rock, and/or climatic setting across the proposed withdrawal area. Figure 3.5-1 presents the distribution of soils mapped at a scale of 1:250,000 in each area, grouped by soil association, or by soil group names for the TES, to represent the dominant occurring soil types. Figure 3.5-1 for the North and East parcels was developed using the general soils map for the United States (NRCS 2006b), modified using the detailed soil surveys (NRCS 2008, 2009). The GTES data were used to generate a soils map for the South Parcel (Forest Service 1998). Soil associations consist of several major soils and some minor soils but are named for major soils. The dominant soil associations or group names that occur in each parcel are summarized in Table 3.5-1 and described below. Detailed soil maps at a scale of 1:24,000 may be obtained for the parcels from the soil surveys and TES referenced above.

### *North Parcel*

Twelve soil associations were identified in the North Parcel. The northwestern portion of the parcel is dominated by the Gypsiorthids-Grieta-Clayhole-Jocity and Pennell-Bacobi associations (see Figure 3.5-1). In general, the soils in these associations are well drained, shallow to deep, moderately coarse to moderately fine textured, nearly level to rolling and occur on sandstone and shale plateaus (NRCS 2008). The northeastern and southern portions of the parcel are dominated by the Mellenthin-Curhollow and Mellinthin-Poley-Moab-Rock Outcrop associations, respectively. These associations comprise well-drained, shallow, medium- to fine-textured, undulating to rolling soils on plains and plateaus (NRCS 2008, 2009).

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[2] Available at: <http://websoilsurvey.nrcs.usda.gov/app/>.

[3] Available at: <http://www.fs.fed.us/>.

**Table 3.5-1.** Area and Proportionate Extent of Soils

| Parcel | Soil Association or Group Name | Approximate Area (acres) | Approximate Extent (%) |
|---|---|---|---|
| **North** | Mellinthin-Poley-Moab-Rock Outcrop | 166,664 | 27.8 |
| | Gypsiorthids-Grieta-Clayhole-Jocity | 123,105 | 20.5 |
| | Mellenthin-Curhollow | 114,802 | 19.1 |
| | Pennell-Bacobi | 74,527 | 12.4 |
| | Torriorthents-Rock Outcrop | 27,169 | 4.5 |
| | Yumtheska-Showlow-Lozinta-Goesling | 25,835 | 4.3 |
| | Kinan-Hatknoll-Grieta | 22,374 | 3.7 |
| | Yumtheska-Houserock | 13,497 | 2.2 |
| | Barx-Rock Outcrop | 12,427 | 2.1 |
| | Barx-Manikan-Palma-Bond-Bidonia | 8,041 | 1.3 |
| | Strych-Monue-Bison | 6,564 | 1.1 |
| | Torriorthents-Barx-Manikan-Mellenthin | 5,171 | 0.9 |
| | *Subtotal* | *600,171* | *100* |
| **East** | Pennell-Kinan-Jocity | 56,261 | 38.8 |
| | Curob-Monue-Bison-Clayhole-Strych | 49,367 | 34.0 |
| | Aneth-Torriorthents-Pagina-Wahweap | 16,280 | 11.2 |
| | Typic Haplustalfs-Rock Outcrop-Eutric Glossoboralfs | 15,158 | 10.5 |
| | Typic Haplustalfs | 3,211 | 2.2 |
| | Torriorthents-Rock Outcrop | 3,161 | 2.2 |
| | Mellenthin-Curhollow | 1,510 | 1.0 |
| | Other soils with minor representation | 64 | <1 |
| | *Subtotal* | *145,011* | *100* |
| **South** | Lithic Ustochrepts | 107,026 | 32.9 |
| | Typic Eutroboralfs-Lithic Ustochrepts | 85,744 | 26.3 |
| | Lithic Ustochrepts-Fluventic Ustochrepts | 81,480 | 25.0 |
| | Lithic Ustochrepts-Typic Haplustalfs-Fluventic Ustochrepts | 43,298 | 13.3 |
| | Typic Eutroboralfs-Typic Haplustalfs-Typic Ustochrepts-Rock Outcrop | 6,134 | 1.9 |
| | Typic Haplustalfs-Typic Calciustolls | 1,930 | 0.6 |
| | *Subtotal* | *325,593* | *100* |

Note: Parcel areas based on mapped withdrawal area boundary, including land where mineral rights are controlled by private entities.

## *East Parcel*

The East Parcel is characterized by seven soil associations. The northwestern portion of the parcel is dominated by the Curob-Monue-Bison-Clayhole-Strych and Aneth-Torriorthents-Pagina-Wahweap associations (see Figure 3.5-1). Soils in these associations are generally well-drained, shallow to deep, moderately coarse to moderately fine textured, and nearly level to rolling (NRCS 2009). The southeastern portion of the parcel is dominated by the Pennell-Kinan-Jocity association. Soils in this association are generally well drained, shallow, medium to fine textured, and undulating to rolling and occur on plains and plateaus. Torriorthents-Rock Outcrop soils occur along the eastern edge of the parcel adjacent to

Marble Canyon; this association comprises well-drained, shallow to deep soils developed on 25% to 65% slopes from gypsiferous colluvium and/or alluvium derived from sedimentary rock.

### *South Parcel*

Soils on the South Parcel are dominated by Typic, Lithic, and Fluventic Ustochrepts. The northeastern and northwestern portions of the parcel are dominated by Typic Ustochrepts (see Figure 3.5-1). These shallow to moderately deep, well-drained, gravelly, fine- to loamy-skeletal-textured soils occur on hills, ridges, plateaus and mesas, with slopes ranging from 0% to 120% (Brewer et al. 1991). The north-central portion of the parcel is dominated by Typic and Lithic Eutroboralfs. These moderately deep to deep well-drained, fine- to very fine-textured soils occur on hills, plateaus and benches, with slopes ranging from 5% to 40%. The southern portion of the parcel is dominated by Lithic Ustochrepts. These shallow, well-drained, gravelly and cobbly, loamy-skeletal-textured soils occur on flat to rolling terrain with slopes ranging from 0% to 15%.

## 3.5.4 Current Resource Conditions

This section describes the current conditions of soil resources in the proposed withdrawal area in terms of the resource indicators summarized earlier. These resource conditions are described in general terms relevant to the most likely impacts. Quantitative indicator values are presented where possible; otherwise, conditions are described qualitatively.

### *Existing Soil Disturbance*

Construction activities, such as grading, excavation, and removal of vegetation and ground cover, related to the installation of support infrastructure for mining operations would inevitably result in soil disturbance. This disturbance would be expected to alter soil physical properties from compaction and/or displacement. Soil displacement could include loss of horizons, changes in thickness, and alteration of soil slope and drainage patterns. Disturbance from exploration activities would generally be less significant than disturbance associated with mining. According to the RFD scenarios, exploration activities do not usually require construction of access roads or drill sites. Disturbance would be expected to be limited to the area surrounding the drill sites but may include limited excavation for mud pits, site grading, and removal of vegetation. In addition, the drill rig and service vehicles would be expected to cause some soil compaction along off-road access routes and at the drill sites.

Review of mine reports submitted to ADEQ and the BLM indicates that previous mining activities in the North Parcel, including installation of access roads and utility lines, resulted in about 237 acres of total disturbance (Energy Fuels Nuclear, Inc. 1984, 1986, 1987, 1988a, 1988b). This is equivalent to an average surface disturbance of about 26 acres per mine for nine mine sites, including the Hack Canyon Mine (pre-1980s mine that produced mostly copper, silver, and manganese). In the South Parcel, approximately 17 acres of surface disturbance are associated with the Canyon Mine (Forest Service 1986a). According to information provided in the RFD scenarios, the total estimated area of historic disturbance related to exploration drilling is approximately 459 acres, or about 1.1 acres per exploration project. This estimate covers only the period during the peak of uranium mineral exploration and development between 1980 and 1988. The total amount of soil disturbance that has occurred to date is about 713 acres, of which roughly 603 acres have been reclaimed. The remaining 110 acres represent a very small fraction (0.011%) of the 1,006,545 acres proposed for withdrawal.

## *Existing Soil Erosion and Hazard Ratings*

Increased rates of erosion, or soil loss, would be expected to occur following surface disturbance resulting primarily from increased runoff related to soil compaction, removal of vegetative cover, and re-routing of drainage pathways. Soil loss in undisturbed areas within the parcels is controlled by vegetative cover and soil physical characteristics, such as texture and topography (slope). Thus, rates of erosion vary, depending on site-specific conditions, but generally would be expected to be greatest where ground cover is minimal, soils are fine grained, and the surface slope is steep. Erosion hazard ratings for soils relate the physical properties and occurrence of different soils to the potential for increased soil loss under various uses, thus providing a useful tool in land management. Hazards related to the potential for accelerated erosion following land disturbance include hazards of off-road erosion, hazards of erosion on roads, and wind erodibility.

### NORTH AND EAST PARCELS

Descriptions and data for soil properties related to increased erosion for the North and East parcels are drawn from the NRCS soil survey reports (NRCS 2008, 2009) and the National Soil Survey handbook (NRCS 2010).

- **Erosion Hazard from Off-Road Areas.** Soil loss potential from water action in off-road areas is determined from slope and soil erosion factor "K," which is related to the susceptibility of a soil to sheet and rill erosion based on soil texture, organic matter content, soil structure, and saturated hydraulic conductivity (NRCS 2008, 2009). The soil loss is caused by sheet or rill erosion in areas without roads where 50% to 75% of the surface has been exposed by disturbance. Soil loss by water from other processes, such as gully erosion and mass wasting, are not considered. The hazard is classified as being slight, moderate, severe, or very severe. A rating of slight indicates that erosion is unlikely under ordinary climatic conditions. A rating of moderate indicates that some erosion is likely and that erosion-control measures may be needed. A rating of severe indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised. A rating of very severe indicates that significant erosion is expected, and erosion-control measures are costly and generally impractical.
    - **North Parcel.** The off-road erosion hazard is moderate to severe for the vast majority of soils in the North Parcel, which indicates that off-road erosion is likely under ordinary climatic conditions (personal communication, Robert Smith, BLM 2010a). Areas north of Snake Gulch and adjacent to the Kaibab National Forest are generally rated higher than the rest of the parcel. Soils within the canyon of Kanab Creek are not rated but would be expected to exhibit a moderate to severe off-road erosion hazard, depending on slope.
    - **East Parcel.** Most soils in the East Parcel are rated as having a moderate off-road erosion hazard, which indicates that erosion is likely under ordinary climatic conditions (personal communication, Robert Smith, BLM 2010a). Localized areas within the tributary washes of the Marble Canyon area have a higher off-road erosion hazard than most of the rest of the parcel (NRCS 2009).
- **Erosion Hazard from Unsurfaced Roads.** Soil loss potential due to water erosion from unsurfaced roadways is based on soil erosion factor K, slope, and content of rock fragments (NRCS 2008, 2009). The hazard is classified as being slight, moderate, or severe. A rating of slight indicates that little or no erosion is likely. A rating of moderate indicates that some erosion is likely, that the roads may require occasional maintenance, and that simple erosion-control measures are needed. A rating of severe indicates that significant erosion is expected, that the roads require frequent maintenance, and that costly erosion-control measures are needed.
    - **North Parcel.** Road erosion hazard ratings are generally moderate for soils in the North Parcel (personal communication, Robert Smith, BLM 2010a). There are localized areas

with a severe road erosion hazard rating in the northeastern portion of the parcel, adjacent to the Kaibab National Forest and southeast of the town of Fredonia (NRCS 2009).

- **East Parcel.** The road erosion hazard is moderate for the majority of soils in the East Parcel (personal communication, Robert Smith, BLM 2010a). In the eastern portion of the parcel along Marble Canyon, the hazard rating is severe, which indicates that significant erosion is expected under normal climatic conditions (NRCS 2009).

- **Wind Erodibility.** Soil loss from wind action is related to properties of surface layers, such as soil texture, organic matter content, rock and pararock fragment content, moisture content, and mineralogy, especially carbonate content (NRCS 2010). Soils are categorized based on the similarity of these properties as related to resistance of the soil to wind erosion in cultivated areas, also referred to as Wind Erodibility Groups (WEGs). Numeric estimates of susceptibility to wind erosion are assigned to each WEG, known as the Wind Erodibility Index (WEI). The WEI is expressed in tons per acre per year (tons/acre/year). WEG categories range from 1 to 8, with 8 indicating no susceptibility to wind erosion and 1 corresponding to a WEI of between 160 and 310 tons/acre/year. A soil in WEG category 5 has a WEI of 56 tons/acre/year.
  - **North Parcel.** WEG ratings in the North Parcel range from 5 to 8 in the southern and western portions of the parcel; local areas in the north central part of the parcel are category 3 (NRCS 2008). Ratings are 7 to 8 along the eastern margin of the North Parcel adjacent to the Kaibab National Forest; much of the remainder of the eastern portion is category 4, with local areas rated category 3 and 5.
  - **East Parcel.** The East Parcel is characterized by WEG ratings ranging from 5 to 8 along the southwestern margin of the parcel to ratings of 1 adjacent to Vermilion Cliffs (NRCS 2009). The central and northwestern portions of the parcel are rated between category 3 and 5. The eastern margin of the parcel is predominantly rated category 3; ratings of 6 occur locally.

## SOUTH PARCEL

Descriptions and data for soil properties related to erosion for the South Parcel were obtained from the TES for the Kaibab National Forest (Brewer et al. 1991) and the TES handbook (Forest Service 1986b). These soil property descriptions are not directly analogous to the properties determined for NRCS soil surveys; however, some TES soil properties are applicable to erosion hazards in disturbed areas. The applicable soil properties are described as follows:

- **Erosion Hazard.** This property is similar to the NRCS Erosion Hazard from Off-Road Areas rating system. The TES erosion hazard is generally defined as the relative susceptibility to erosion following removal of vegetative cover and is based on soil loss from sheet/rill erosion as estimated by the Universal Soil Loss Equation (Brewer et al. 1991). Soil loss by water from other processes, such as gully erosion and mass wasting, are not considered. Soil losses are predicted for the four following categories: 1) the potential soil loss (PSL) is the rate of soil loss that would occur under conditions of complete removal of groundcover (i.e., maximum rate), 2) tolerance soil loss (TSL) is the highest rate of soil loss that can occur while sustaining inherent site productivity (i.e., threshold rate), 3) current loss is the rate of soil loss occurring under existing conditions of groundcover, and 4) natural loss is the rate of soil loss that would occur under conditions associated with a climax plant community (i.e., minimum rate).

  TES erosion hazard ratings are slight, moderate, and severe (Forest Service 1986b). A rating of slight is assigned where the PSL rate does not exceed the TSL rate. Degradation of soil productivity is of low probability, and areas within this erosion hazard class generally stabilize under natural conditions. Areas rated moderate exhibit PSL rates that exceed TSL rates, and loss of soil productivity is probable; reasonable and economically feasible mitigation measures are required to prevent significant losses in productivity. Severe hazard ratings are assigned to areas where PSL rates exceed TSL rates and where loss of productivity is inevitable. Areas with severe erosion hazards require significant mitigation measures to be applied to prevent irreversible loss in soil productivity, and there is a high probability of some productivity loss before mitigation can be applied.

  - **South Parcel.** Erosion hazard ratings range from slight to moderate for most of the parcel (Brewer et al. 1991). Significant areas rated moderate are located in the western, northwestern, and northeastern portions of the parcel. Severe ratings occur primarily along the Coconino Rim (Grandview Monocline, see Figure 3.4-13), the Red Butte area, and other steep areas in the northeastern part of the parcel. Severe ratings also occur locally in many small canyons throughout the parcel.

- **Unsurfaced Road Limitations.** Although the TES has no comparable measure to the NRCS road erosion hazard ratings, the TES unsurfaced road limitation property could be applied in a similar manner for the general analyses in this EIS. The TES unsurfaced road category pertains to the suitability for the use of native soils for unsurfaced roads in terms of construction and maintenance requirements (Brewer et al. 1991). These roads would be of low design and minimum construction cost (such as haul roads and for most exploratory drilling). A rating of slight indicates that there are few limitations or risks associated with unsurfaced roads. A rating of moderate or severe indicates that there would be problems in construction and maintenance of unsurfaced roads. Since most of these roads would be expected to receive little maintenance, alternative routes may be considered to avoid mitigation limitations and significant damage to soils rated moderate or severe.
  - **South Parcel.** Most soils in South Parcel are rated as having severe limitations for use as unsurfaced roads (Brewer et al. 1991). Localized areas, mostly valley floors, are rated moderate. The area at the base of the Coconino Rim in the northeastern part of the parcel is rated slight to moderate.

- **Wind Erodibility.** There is no soil property related to wind erosion defined in the TES. However, except in areas subject to severe wildfire damage, erosion from wind action is expected to be minimal throughout the parcel because of the significant level of vegetative cover present (personal communication, Christopher MacDonald, Forest Service 2010b).

### *Existing Soil Contamination*

The chemical quality of soil and stream sediments in the vicinity of new uranium mine sites may be subject to alteration from the dispersal and subsequent deposition of uranium and other trace metals from mine waste and ore exposed to wind and water action at land surface. Containment of mine drainage in surface impoundments presents an additional risk to soil at mine sites in the event of liner failure. Uranium and, to a lesser extent, arsenic were identified as the most abundant trace elements of concern at the mine sites (Otton et al. 2010). ADEQ has established SRLs for soil in a non-residential setting (ADEQ 2007). SRLs were generally developed as risk-based screening criteria for the remediation of soils; the risk-based SRL for uranium is 200 ppm. The SRL for arsenic is 10 ppm, which is based on estimated background levels for Arizona rather than risk-based criteria.

This section evaluates available reports and data to establish regional and local (study area) background levels of uranium and arsenic in soil and sediment, as well as background concentrations associated with soils developed on uranium-bearing breccia pipes. To address current impacts on soil chemistry, the following summarizes the recent USGS study (Otton et al. 2010), which examined historic effects from mining in the North Parcel in detail.

## NATURALLY OCCURRING CONCENTRATIONS OF URANIUM AND ARSENIC IN SOIL AND SEDIMENT

Otton et al. (2010) reviewed existing data and collected new analytical data from soil and sediment samples to determine background levels of uranium and trace metals for the study area. Geochemical data obtained from the National Uranium Resource Evaluation (NURE) database were analyzed for the twelve 7.5-minute quadrangles surrounding the mine sites in the North Parcel to determine background levels for uranium. The NURE samples in this area were collected in 1979, prior to the majority of mining activities in the North Parcel (Otton et al. 2010). This analysis indicated that samples from undisturbed soil in the study area contained uranium ranging from 1.4 to 3.4 ppm, with an average of 2.4 ppm (106 samples). No arsenic results were available from NURE. Otton et al. (2010) collected nine samples of stream alluvium from the nearby unmined, unmineralized Jumpup Canyon to determine background levels for the study area in stream sediments. The results of these stream sediment analyses were as follows: uranium ranged from 1.6 to 1.9 ppm and averaged 1.7 ppm; arsenic ranged from 4 to 5 ppm and averaged 4.6 ppm.

A regional survey was conducted by the USGS from 1961 to 1975 across the conterminous United States to determine the elemental concentrations present in unaltered surficial material and soil (Shacklette and Boerngen 1984). The samples analyzed for this survey were collected from a depth of 20 cm (or about 8 inches). For the Western United States, concentrations reported by Shacklette and Boerngen (1984) for uranium ranged from 0.68 to 7.9 ppm and averaged 2.5 ppm; concentrations for arsenic ranged from <0.10 to 97 ppm and averaged 5.5 ppm. These regional average values are generally consistent with the results from Otton et al. (2010) for average uranium content of soils samples in the study area (i.e., 2.4 ppm). The slightly higher regional arsenic estimate reported by Shacklette and Boerngen (1984) could be because of the small sample size, small area, or difference in media (sediment rather than soil) of the Otton et al. (2010) sample set obtained from Jumpup Canyon.

The results for soil and alluvium background concentrations by Otton et al. (2010) are consistent with an earlier USGS study conducted in the Snake Gulch area prior to development of the Pigeon Mine (Hopkins et al. 1984b). The Hopkins et al. (1984b) survey showed that uranium ranged from 0.4 to 1.4 ppm for soils (six samples) and from 0.2 to 2.0 ppm for sediment (31 samples) in the Snake Gulch area. Arsenic results for all samples analyzed by Hopkins et al. (1984b) were below the detection limit of 200 ppm. Another study conducted in 1999 investigated the geochemical impact on sediments in Hack Canyon from the mining activities at the Hack Canyon Mine complex: sediment samples obtained upstream of the Hack Canyon Mine complex contained uranium ranging from 0.6 to 1.5 ppm and arsenic ranging from 1.2 to 11.5 ppm (Carver 1999).

In addition to the study area and regional background concentrations described in the previous paragraphs, Otton et al. (2010) also reviewed available results for samples obtained across the surface expression of known mineralized breccia pipes. Hopkins et al. (1984b) obtained three soil samples from the surface of the Pigeon Pipe prior to initiation of mining: uranium ranged from 2.2 to 5.6 ppm, and arsenic was below the detection limit of 200 ppm for these samples. The Canyon Pipe, located in the South Parcel, was surveyed by Van Gosen and Wenrich (1991) prior to development of the site for mining. The investigation of the Canyon Pipe surface expression conducted by Van Gosen and Wenrich (1991) consisted of 14 soil samples outside the perimeter of the pipe and 18 soil samples within the pipe surface. Results indicated that uranium and arsenic concentrations are similar, regardless of whether samples were obtained within or beyond the pipe surface expression. The Canyon Pipe soil sample results are as follows: uranium concentrations ranged from 2.6 to 4.3 ppm, with an average of 3.2 ppm; arsenic concentrations ranged from less than 10 to 20 ppm, with an average of less than 10 ppm. Van Gosen and Wenrich (1991) investigated another mineralized breccia pipe, the SBF Pipe, located adjacent to the Hualapai Reservation, about 45 miles southwest of the Canyon Pipe. The surface expression of the SBF Pipe is characterized by a 7-foot-high rim consisting of Kaibab Formation encompassing a soil-filled, circular basin floored by Moenkopi Formation sandstone and siltstone. Similar geological conditions occur for other pipes located on the Coconino and Kaibab plateaus and for pipes on much of the Kanab Plateau (see Figures 3.4-5 and 3.4-8). Results from the SBF Pipe indicated that, although there was little difference in soil uranium concentrations inside and outside the pipe surface area, arsenic concentrations were much higher within the pipe area. Average uranium concentrations for the SBF Pipe were about 2.9 ppm inside the pipe surface area (20 samples) and about 2.6 ppm outside the pipe (16 samples); maximum uranium concentration detected was 3.7 ppm and was for a sample from inside the surface area of the pipe. Arsenic concentrations within the SBF Pipe surface area ranged from 10 to 110 ppm; average concentration was 33 ppm. Arsenic concentrations outside the pipe ranged from 4.2 to 32 ppm; average concentration was 12 ppm (Van Gosen and Wenrich 1991).

The regional survey of undisturbed soil reported by Shacklette and Boerngen (1984) provides a reasonable approximation of overall ambient conditions and is generally consistent with the analysis of conditions in the study area presented by Otton et al. (2010). However, naturally occurring levels of uranium and arsenic in the vicinity of specific uranium-bearing breccia pipes are likely to vary from site to site because of variability in surface rock compositions and environmental conditions (reduction-oxidation potential). Site-specific concentrations may be lower or higher than the regional levels reported by (Shacklette and Boerngen 1984). This conclusion is supported by the somewhat variable sample results for undisturbed soils at the Pigeon, Canyon, and SBF pipes (Hopkins et al. 1984b; Van Gosen and Wenrich 1991) and by results for sediment samples obtained upstream of the Hack Canyon mines (mineralized, unmined area) and Jumpup Canyon (unmineralized, unmined area) (Carver 1999; Otton et al. 2010). Thus, concentrations of contaminants of concern at specific sites should be considered in light of both average and maximum naturally occurring concentrations when evaluating the magnitude of a potential impact. The range and average naturally occurring concentrations for the primary constituents of concern are listed in Table 3.5-2. Ideally, background conditions and their variability at each mine site prior to initiation of mining should be known to infer that an impact has likely occurred. However, in many cases described in the next section, impacts can be inferred without pre-mining data because concentrations of contaminants of concern are well above background levels and approximated background conditions at unmined sites in the study area.

**Table 3.5-2.** Concentrations of Naturally Occurring Uranium and Arsenic in Undisturbed Soil and Sediment

| | Regional Range (ppm)* | Regional Average (ppm)* | Breccia Pipe Range (ppm)† |
|---|---|---|---|
| Uranium | 0.68–7.9 | 2.5 | 2.2–5.6 |
| Arsenic | <0.10–97 | 5.5 | 4.2–110 |

Note: ppm = parts per million.

* From Shacklette and Boerngen (1984) for the western United States; values reported as geometric means.

† Range of sample results at unmined uranium-bearing breccia pipes. Source for uranium range is Hopkins et al. (1984b). Source for arsenic is Van Gosen and Wenrich (1991).

## EFFECTS FROM HISTORIC (1980s) MINING

A study of existing mine sites in the North Parcel was conducted by the USGS in 2009 to characterize current impacts of historic uranium mining activities on soil and sediment near former and inactive mine and exploration sites (Otton et al. 2010). Reclaimed mine sites, including Pigeon Mine, the Hack Canyon Mine complex, and Hermit Mine, and the inactive Kanab North Mine, were evaluated for the study. The Kanab South Pipe drill site was also investigated. Assessment included sampling and geochemical analysis of surface soils, stream sediments, rock, and mine wastes for uranium and trace elements. Samples were generally taken inside and outside reclaimed/disturbed areas; most samples were collected within about 500 feet of the reclaimed areas. All samples were obtained from a depth of 0 to 2 inches; the study did not include investigation of subsurface materials, such as mine waste or drill cuttings potentially buried during reclamation.

In addition to the soil and sediment samples collected for the USGS study, radioactivity surveys were conducted at each site, including measurements at each sample location and at some unsampled areas (Otton et al. 2010). These surveys were conducted using Ludlum Model 19 MicroR exposure meters. MicroR meters measure radiation exposure from gamma-ray and x-ray emissions. MicroR measurements are reported in microrads per hour (μR/h).

Findings of Otton et al. (2010) are summarized as follows.

- **Pigeon Mine.** The Pigeon Mine was operational for 5 years and was reclaimed in 1989. The mine facilities consisted of the mine site (at the pipe), operations site, and wastewater surface impoundment. The operations and impoundment sites were both located about 1,000 feet northwest of the mine site. In 26 soil samples collected inside the reclaimed mine site area, median uranium concentration was 4.4 ppm, and median arsenic concentration was 41 ppm (Table 3.5-3). These results are believed to represent cover materials used to reclaim the site. Two samples obtained within the reclaimed area were much higher in uranium (68 and 79.1 ppm) and arsenic (377 and 407 ppm). These two samples were believed to represent soil impacted by exposed waste rock, hence the reporting of median results for this site rather than the numeric averages reported for the other sites investigated. Excluding these two anomalously high soil sample results, uranium concentrations within the reclaimed area ranged from 2.2 to 8.1 ppm, and arsenic concentrations ranged from 6 to 93 ppm.

  Of 16 soil samples collected within about 500 feet beyond the reclaimed area, the median uranium concentration detected was 6.3 ppm, and the median arsenic concentration was 25 ppm (see Table 3.5-3). Concentrations detected for two samples obtained on a hillslope about 200 feet northeast from the disturbed area were 26.5 and 36.6 ppm for uranium and 62 and 66 ppm for arsenic. These anomalously high sample results were thought to possibly be the result of off-site dispersion of mine-waste constituents from wind erosion. Concentrations detected for a third sample collected on a hillslope southeast of the reclaimed area were 11.1 ppm for uranium and 393 ppm for arsenic. Both wind-dispersed mine waste rock and weakly mineralized limonite-cemented sandstone (parent material) in the area may be the source of these elevated concentrations. Excluding the three anomalously high concentrations, uranium concentrations for soil samples collected outside the reclaimed area ranged from 3.2 to 12.9 ppm, and arsenic concentrations ranged from 7 to 46 ppm. Uranium levels in the five samples collected farthest from the site, about 500 feet or more north, northeast, and northwest of the site, ranged from 3.2 to 10.6 ppm (average 5.1 ppm); arsenic levels detected in these five samples ranged from 10 to 31 ppm (average 23 ppm) (see Table 3.5-3).

  Ephemeral stream sediment samples obtained downstream of the reclaimed Pigeon Mine appear to be slightly elevated in uranium and arsenic, compared with samples obtained upstream of the site. The source of these elevated concentrations may be distribution of mine-related contaminants and/or mineralized bedrock in the area.

  The average concentration of 15 soil samples obtained in the vicinity of the operations area was about 11.9 ppm for uranium and about 29 ppm for arsenic (excluding one anomalously high sample result with a uranium concentration of 206 ppm, and an arsenic concentration of 455 ppm). Several isolated deposits of mine waste remaining on-site, primarily in the operations area, were sampled; uranium concentrations as high as 1,230 ppm and arsenic concentrations as high as 1,980 ppm were detected in these samples.

  Otton et al. (2010) concluded that some soils at the Pigeon Mine reclaimed site are impacted to levels above cited background averages by off-site dispersion of trace elements in dust and by transport, via slope wash, of constituents related to exposed waste-rock fragments within the reclaimed area.

**Table 3.5-3.** Summary of Soil and Sediment Sample Results from Mines

| | Pigeon (reclaimed) | Kanab North (unreclaimed) | Hermit (reclaimed) | Hack Canyon[‡] (reclaimed) |
|---|---|---|---|---|
| **Inside Mine Site** | | | | |
| Number of Samples | 26 | 13 | 22 | N/A |
| Uranium, Range of Results (ppm)* | 2.2–8.1 | 6.4–2,840 | 1.6–19.9 | N/A |
| Uranium, Average of Results (ppm)[†] | 4.4 | 1,135 | 4.6 | N/A |
| Uranium, Outliers (ppm) | 68 and 79.1 | N/A | N/A | N/A |
| Arsenic, Range of Results (ppm)* | 6–93 | 4–1,980 | 4–27 | N/A |
| Arsenic, Average of Results (ppm)[†] | 41 | 380 | 8 | N/A |
| Arsenic, Outliers (ppm) | 377 and 407 | N/A | N/A | N/A |
| **Outside Mine Site** | | | | **(up to 0.8 mile downstream)** |
| Number of Samples | 16 | 22 | 35 | 4 |
| Uranium, Range of Results (ppm)* | 3.2–12.9 | 2.9–80.2 | 1.1–5.9 | 4.8–10.2 |
| Uranium, Average of Results (ppm)[†] | 6.3 | 27.8 | 1.9 | 6.6 |
| Uranium, Outliers (ppm) | 26.5 and 36.6 | N/A | N/A | N/A |
| Arsenic, Range of Results (ppm)* | 7–46 | 3–27 | 3–10 | 10–17 |
| Arsenic, Average of Results (ppm)[†] | 25 | 12 | 5 | 13 |
| Arsenic, Outliers (ppm) | 62, 66, and 393 | N/A | N/A | N/A |
| Approximate Distance of Farthest Samples | ≥ 500 feet | 300 and 420 feet | ≥ 325 feet | 1.6 and 4.0 miles |
| Uranium Concentration of Farthest Samples (ppm) | 3.2–10.6 | 10.3 and 6.9 | 1.2–1.9 | 3.2 and 2.4 |
| Arsenic Concentration of Farthest Samples (ppm) | 10–31 | 9 and 8 | 3–5 | 11 and 9 |

Source: Otton et al. (2010). Results for Pigeon Mine are for the mine site only, as summarized in Otton et al (2010); see text for discussion of sample results from the operations area.

Note: ppm = parts per million; N/A = not applicable.

* Excluding outliers at Pigeon Mine.

[†] Median values reported for Pigeon Mine; includes outliers.

[‡] Sediment samples. Concentrations detected in four sediment samples collected upstream from the Hack Canyon mines ranged from 2.1 to 3.9 ppm for uranium (2.9 ppm average) and ranged from 10 to 14 ppm for arsenic (12 ppm average).

- **Kanab North Mine.** Extraction of ore at the Kanab North Mine occurred between 1988 and 1990; the mine has been under interim management since 1992. The Kanab North Mine consists of a single fully bermed (except at the main gate) surface facility; the facility houses the mine access, management offices, a lined wastewater surface impoundment, and waste and ore stockpiling areas. The site is situated about 150 feet (closest edge) west from the edge of the canyon of Kanab Creek, which is approximately 1,200 feet below the plateau surface at this location. Mined waste rock and uranium ore have been exposed at the surface of the unreclaimed mine site for the duration of the interim management period. Investigation of the Kanab North Mine included sampling within the mine perimeter for disturbed soil, graded surfaces, and sediment in the surface impoundment, as well as undisturbed soils adjacent to the site. Results for 13 samples obtained within the mine site indicated that uranium concentrations ranged from 6.4 to 2,840 ppm (average 1,135 ppm), and arsenic concentrations ranged from 4 to 1,980 ppm (average 380 ppm) (see Table 3.5-3).

Results for 22 soil samples obtained up to 420 feet outside the mine site perimeter indicated that uranium concentrations ranged from 2.9 to 80.2 ppm (average 27.8 ppm), and arsenic concentrations ranged from 3 to 27 ppm (average was 12 ppm) (see Table 3.5-3). These samples were generally collected within about 250 feet of the site perimeter; two of these samples were collected about 300 and 420 feet northwest of the site. Uranium concentrations detected in these two farthest samples were 10.3 and 6.9 ppm, respectively; arsenic concentrations were 9 and 8 ppm, respectively (see Table 3.5-3). Results of the samples taken outside the perimeter indicate that concentrations are greatest to the east from the site, which is likely the prevailing wind direction. Thus, wind is believed to be the likely transport mechanism of constituent dispersion outside the site perimeter. On the basis that only one sample collected outside the site approximated the NURE uranium background average of 2.4 ppm, Otton et al. (2010) further concluded that mine-related materials may have dispersed beyond the limit of sampling (420 feet). It is unlikely that waterborne sediment migrated off-site because the containment berm surrounding the site was intact when the Otton et al. (2010) investigation was conducted in 2009.

- **Kanab South Pipe.** The Kanab South Pipe is located about 3,700 feet south of the Kanab North Mine. Erosion of the pipe surface has led to widening of a small wash that crosses the pipe surface and enters the canyon of Kanab Creek about 500 feet to the northeast. Six soil samples were obtained from low hills adjacent to the disturbed drill site area; concentrations detected in these samples ranged from 1.3 to 2.7 ppm for uranium and from 5 to 23 ppm for arsenic. Stream sediment samples were also collected upstream of and on the site; concentrations detected in these six samples ranged from 1.5 to 3.6 ppm for uranium and from 4 to 20 ppm for arsenic. Limonite-cemented sandstone bedrock occurring along the drainage pathway upstream of the site was also sampled; the results indicate that bedrock in the area may contain up to 54.9 ppm of uranium and 896 ppm of arsenic. Genetically similar sandstones were noted at the Pigeon Mine site; it was postulated that such mineralized zones in these sandstones may have formed by fluids circulating near the pipes during deposition of uranium ore. Results for soil and sediment samples at the Kanab South Pipe were thought to possibly represent background conditions at the Kanab North Mine because physiographic and geological conditions are similar.

- **Hermit Mine.** The Hermit Mine was operational for less than 1 year and was reclaimed in 1989. The Hermit Mine had a single surface facility with components that were similar to the Kanab North Mine. The mine was located in a relatively flat area about 8 miles west of the Kanab North Mine; surface water drainage at the site appears to flow to the north into a small stock tank. Concentrations of uranium in 22 soil samples collected within the reclaimed area ranged from 1.6 to 19.9 ppm (average 4.6 ppm), and arsenic concentrations ranged from 4 to 27 ppm (average 8 ppm) (see Table 3.5-3). Concentrations of uranium in 35 soil samples collected outside the reclaimed area ranged from 1.1 to 5.9 ppm (average 1.9 ppm), and arsenic concentrations ranged from 3 to 10 ppm (average 5 ppm) (see Table 3.5-3). All arsenic samples with concentrations greater than 6 ppm were obtained in the reclaimed area, the access road, and the stock tank. Otton et al. (2010) concluded that limited off-site dispersion of mine-related constituents had occurred at the Hermit Mine. Uranium and trace element concentrations in soil were determined to be at or below the background levels cited by Otton et al. (2010) within a few hundred feet outside the reclaimed edge of the Hermit Mine site.

- **Hack Canyon Mine Complex.** The Hack Canyon Mine complex includes the Hack Canyon Mine, which was operational for uranium production in the 1950s and 1960s, and Hack Canyon Mines 1, 2, and 3, which operated from 1981 to 1987. The first Hack Canyon Mine was developed for copper in the 1920s (Energy Fuels Nuclear, Inc. 1988b). Reclamation of all four Hack Canyon mines was completed in 1988. During mine operations, a significant flood event occurred on August 19, 1984, in the tributary that was occupied by Hack 1; radioactive materials were reported to have been recovered by mine personnel up to 1 mile downstream following the flood. All four of these mines were situated in canyon bottoms—either Robinson Canyon (Hack

3), an unnamed tributary canyon (Hack 1), or Hack Canyon Mine itself (Hack Canyon and Hack 2 mines). A total of 10 ephemeral stream sediment samples were obtained during the investigations. Four of these samples were obtained upstream of the mine sites, one sample was collected between Hack 2 and Hack 1, and five samples were obtained downstream of the mine sites. Concentrations detected in all stream sediment samples ranged between 2.1 and 10.2 ppm for uranium and between 9 and 17 ppm for arsenic. The upstream samples, which were said to represent background conditions for this area, ranged from 2.1 to 3.9 ppm for uranium (2.9 ppm average) and from 10 to 14 ppm for arsenic (12 ppm average). Concentrations of trace elements in the stream samples obtained about 2 to 3 miles downstream of the Hack Canyon Mine complex were determined to be about the same as those upstream of the complex; this result is consistent with conclusions made by Carver (1999) that "mean concentrations above the mine are equal to the mean concentrations below the mine." Uranium concentration detected in a sediment sample collected several miles downstream, near Willow Spring, was 2.4 ppm.

Flood events were determined to be the likely transport mechanism for several isolated fragments of mineralized rock, believed to be mine waste, found up to 0.5 mile downstream of the reclaimed sites by Otton et al. (2010). The rock fragments ranged between 2 and 18 inches in diameter. Five of the fragments were sampled, and analyses detected uranium concentrations ranging from 122 ppm to greater than 10,000 ppm, and arsenic concentrations ranging from 547 ppm to greater than 10,000 ppm. The presence of these fragments was attributed to flood events that transported waste rock off-site during mining or that eroded cover material in reclaimed areas, exposing and transporting buried mine wastes off-site after reclamation. The source of many of these fragments was believed to be the reclaimed terrace near Hack 1, which consists of several feet of waste rock covered by gravel that has been eroded by the ephemeral stream to expose the deposits. Although discrete fragments of rock containing large concentrations of mine-related constituents were identified by Otton et al. (2010), much lower concentrations of constituents were detected in fine-grained sediments (discussed in the previous paragraph), which shows limited dispersion of contaminants downstream. It was concluded that mine-derived particulates in stream sediments are diluted by large quantities of native fine-grained sediments during flooding, thus limiting the effects of these contaminants on the overall chemical quality of the sediment.

- **MicroR Meter Surveys.** The radioactivity surveys conducted indicated that radiation exposure detected at all of the sites was elevated, compared with readings obtained from the Jumpup Canyon area. The survey of the Jumpup Canyon area showed a narrow range of activity from 4 to 5 microrads per hour (μR/hr). The highest readings were obtained at the Kanab North Mine, followed by the Pigeon Mine and then the Hack Canyon mines. Radiation levels decreased rapidly within 400 feet of the Kanab North Mine perimeter. At the Pigeon and Hack Canyon mines, field surveying indicated that radioactivity decreased significantly within a few feet of the anomalous point sources, such as isolated ore and waste-rock fragments. Considerably lower levels of radiation were detected at the Hermit Mine. During traverses beyond the disturbed area at the Hermit site, activity levels generally ranged from 6 to 7 μR/hr (with a maximum value of 10 μR/hr). The traverses at the Hermit site were all at least 250 feet long. Results at the Kanab South site were considered by Otton et al (2010) to potentially be indicative of background conditions for the Kanab North Mine; these results showed a range of activity levels from 3 to 7 μR/hr.

Soil and sediment analyses conducted by Otton et al. (2010) detected uranium concentrations at all of the reclaimed, inactive (unreclaimed) mine sites that ranged from below regional average levels to above regional average levels (see Table 3.5-2). The degree to which soil is affected at each mine site varies, based on physiographic setting, the length of time mine rock was exposed at the surface, and the effectiveness of reclamation efforts. The effects from historic mining discussed above reflect the reclamation practices that were conducted under the regulatory framework that existed during the 1980s. Reclamation activities undertaken at that time may differ from the reclamation activities reasonably foreseen to be implemented under current requirements related to future plans of operation but are anticipated to be generally comparable. This is particularly true with respect to the later mines, such as Hermit and Pigeon, that were reclaimed near the end of the period of mining in the 1980s. Expected reclamation techniques, including those for long- or short-term interim management, are discussed in Section 4.5.2.

Salient conclusions made for this EIS regarding the potential distribution and accumulation of mine-related contaminants in soil and alluvium are as follows:

- Assessment of existing mine sites by Otton et al. (2010) indicates that significant changes in soil conditions as a result of past uranium mining are generally localized to within a few hundred feet of the areas of operation, except where mine sites may be subject to significant flash flooding (Hack Canyon mines). Soil samples collected 500 feet or more from the reclaimed area at the Pigeon Mine averaged 5.1 ppm for uranium and 23 ppm for arsenic, which are 2.5 and 17.5 ppm above the respective regional averages listed in Table 3.5-2 but are generally within the upper range of naturally occurring concentrations for uranium (5.6 ppm) and arsenic (110 ppm) associated with unmined uranium-bearing breccia pipes. Similarly, the farthest two samples collected about 300 and 420 feet from the Kanab North site contained uranium concentrations of 10.3 and 6.9 ppm, which are respectively about 5 and 1 ppm above the high end of the range of estimates for naturally occurring uranium (see Table 3.5-2). Results from the Hermit Mine site, which was more compact and operated for a much shorter duration than the Pigeon Mine, indicate that concentrations of mine-related constituents are generally at or below regional averages about 100 feet beyond the reclaimed area. The primary mechanism of off-site dispersion of mine-related constituents at sites removed from major drainage channels is fugitive dust generated at ore and waste-rock stockpiles during mining operations; a potential, but limited, secondary mechanism is slope wash transport of exposed waste materials remaining on-site after reclamation. This potential secondary mechanism is supported by a few samples collected at the Pigeon Mine site; however, there is little evidence of significant off-site movement of contaminants from slope wash.

  Where mine sites are located within drainage channels subject to flash flooding or are adjacent to steep areas or canyons, mine-related constituents have the potential to be dispersed more than a few hundred feet from the mine site. Evidence collected at the Hack Canyon Mine complex indicates that waste materials have been transported up to 0.5 mile downstream from the sites. Some of these ore/waste-rock deposits observed downstream of the Hack Canyon Mine complex could be the result of mining activities at the Hack Canyon Mine, rather than 1980s-era mining. Although trace element concentrations may be very high in mine waste fragments displaced by flooding, evidence collected by Otton et al. (2010) and Carver (1999) indicates that the overall impact to the fine-grained stream sediments is limited. An example of a mine site located adjacent to steep topography is provided by the Kanab North Mine. Samples collected within about 200 feet northeast from the Kanab North site perimeter contained up to 77.7 ppm more than the regional average background concentration for uranium (see Table 3.5-2). These samples were obtained in the prevailing downwind direction and immediately adjacent to the canyon of Kanab Creek, which suggests that mine-related contaminants may have dispersed off-site into the canyon. The total potential distance that sediment could be transported would be larger for a mine adjacent to a canyon, compared with a mine located away from a canyon, because particles would be expected to maintain their trajectory longer as they descend into the canyon. Similarly, waterborne sediments that enter a canyon or other steep area have the potential to move farther away from their source than sediments that remain in relatively level areas.

- Duration and scale of mining operations directly correlate to the magnitude and extent of contamination (e.g., compare Pigeon Mine effects with Hermit Mine effects). The area outside mine sites at reclaimed mines are also generally less impacted (at present)–than mine sites under very long-term interim management.

- This investigation was conducted at least 20 years after completion of reclamation efforts at the mines and about 20 years after the Kanab North Mine was deactivated. At reclaimed mines where significant amounts of erosion have not occurred, such as the Hermit Mine, surface conditions reported in Otton et al. (2010) are likely similar to conditions immediately after reclamation was completed. At mine sites where erosion may have exposed buried mine waste, such as the Hack Canyon mines, recently observed concentrations may be lower than conditions that may have existed immediately following the first significant erosive event, which would have removed cover materials, eroded buried waste, and re-deposited waste immediately downstream. This could occur because subsequent events may have dispersed contaminants to the extent that they were not detectable or diluted them to the levels observed in Otton et al. (2010). Effects on soils at inactive mines, such as Kanab North, are likely to be at their greatest because continual wind dispersion of materials off-site would be expected to generate a cumulative effect on the chemistry of downwind surface soils (assuming the soils themselves have not been subject to significant erosion).
- In general, Otton et al. (2010) compared average sample results at given sites with average regional background concentrations, which may not be appropriate for all locations because natural conditions may vary from site to site. Given that most samples were collected within a few hundred feet of reclaimed areas, particularly at the Kanab North Mine, the areal extent of sample collection may not have been large enough to clearly establish site-specific background conditions or the range of concentrations for naturally occurring elements present in the vicinity of the site. Thus, some comparisons presented by Otton et al. (2010) may over estimate or under estimate actual impacts.
- In some cases, particularly the Pigeon and Kanab North mines, samples collected outside reclaimed or disturbed areas may represent variability in natural conditions for the specific site, rather than elevated concentrations of trace elements as a result of mining activities. For example, mineralized bedrock noted at some sites (Pigeon Mine and Kanab South Pipe), which could be the parent materials for soil or source material for alluvium, may contribute to the apparently elevated concentrations of uranium and arsenic measured near mine sites in the area.
- Uranium concentrations reported in soil samples collected at all sites ranged from below to above the average regional background concentration (2.5 ppm); however, the concentrations were generally below the ADEQ non-residential SRL of 200 ppm.
- The arsenic non-residential SRL of 10 ppm was exceeded in many samples at each site. Because the arsenic SRL is based on background levels, 10 ppm may not be appropriate for all sites; arsenic concentrations in soils were generally below the maximum reported concentration in an undisturbed mineralized pipe (110 ppm at the SBF Pipe) but were generally above the average regional background of 5.5 ppm.
- Isolated waste-rock and ore fragments that contain significantly elevated levels of uranium and arsenic were identified at the Pigeon Mine and in the vicinity of the Hack Canyon Mine complex. Such fragments could contribute to localized contamination of soils in the immediate vicinity of the fragments as a result of leaching processes.
- The primary mechanism for dispersion of mine-related contaminants appears to be wind erosion of waste-rock and ore stockpiles during mining operations. A secondary mechanism for dispersion is water erosion of cover materials and buried waste rock after reclamation. Waste materials exposed by erosion of cover materials might result in minor contaminant dispersion by wind. Also, for mines located in large drainage channels or canyons, floods could disperse mine-related constituents from stockpiles during operations.

- The potential effect on subsurface soils (greater than 2 inches deep) is not known. Leaching of buried mine wastes could result in accumulation of contaminants in materials beneath or downslope of such mine-waste deposits. Although such impacts are conceivable, if cover materials remain intact, leaching from buried mine waste would be expected to be minimal.

# 3.6 VEGETATION RESOURCES

The Colorado Plateau ecoregion contains diverse flora and fauna. The isolation, complex geological features, and substantial climate change from glacial to postglacial times have led to the existence of many relict populations of endemic species that are exclusively native to this region. More than 300 plant species are endemic to the Colorado Plateau (Tuhy et al. 2002), and the Colorado Plateau provides habitat for numerous vertebrates, many of which are identified as "species of greatest conservation need" by the Southwest Regional Gap Analysis Project (Boykin et al. 2007). Several plant species are listed as federally protected species and are discussed in more detail in Section 3.8. Additionally, there are ACECs within and near the proposed withdrawal area, some of which were designated to protect threatened plant species (see Section 3.1.2), shown in Figure 3.6-1.

## 3.6.1 Vegetation Communities

The Colorado Plateau ecoregion contains a variety of vegetation communities. In the proposed withdrawal area, the communities include riparian, Great Basin Grassland, Great Basin Desertscrub, Great Basin Conifer Woodland, and Petran Montane Conifer Forest. Table 3.6-1 lists dominant plant species for each of these eight communities. Figure 3.6-2 illustrates the distribution of these major vegetation types. Digital representation of these communities was developed by the Nature Conservancy in Arizona based on the map "Biotic Communities of the Southwest" by Brown and Lowe (1980) in order to provide for easier interagency discussion of the vegetation types. These areas have been mapped in more detail as "ecological zones" in the Arizona Strip FEIS (BLM 2007). Detailed community descriptions of the vegetation communities found in the proposed withdrawal area are based on BLM (2008b) and Forest Service (2009a), unless indicated otherwise.

**Table 3.6-1.** Vegetation Communities and Dominant Plant Species on the Colorado Plateau within the Proposed Withdrawal Analysis Area

| Vegetation Community | Dominant Plant Species |
|---|---|
| Riparian | Cottonwood (*Populus* spp.), willow (*Salix* spp.), saltcedar (*Tamarix* spp.) |
| Great Basin Grassland | Grasses, including wheatgrass (*Pascopyrum smithii*), grama (*Bouteloua* spp.), galleta (*Pleuraphis jamesii*), three-awn (*Aristida* spp.), muhly (*Muhlenbergia* spp.), needlegrass (*Achnatherum* spp.), fescue (*Festuca* spp.), dropseed (*Sporobolus* spp.) |
| Great Basin Desertscrub | Sagebrush (*Artemesia* spp.), shadscale (*Atriplex confertifolid*), saltbush (*Atriplex* spp.), winterfat (*Krascheninnikovia lanata*), blackbrush (*Coleogyne ramosissima*), greasewood (*Sarcobatus vermiculatus*) |
| Great Basin Conifer Woodland | Pinyon pine (*Pinus* spp.), juniper (*Juniperus* spp.) |
| Petran Montane Conifer Forest | Ponderosa pine (*Pinus ponderosa*), Gambel oak (*Quercus gambelii*) |

Sources: BLM (2008b, 2010e).

## *Riparian*

The only major riparian vegetation community in the proposed withdrawal area occurs along Kanab Creek in the North Parcel. In the vicinity of the proposed withdrawal area, riparian communities are associated with surface water habitats such as rivers, streams, seeps, and springs, primarily along the Colorado River and its many side canyons and include resources such as Vasey's Paradise. At seeps and springs, natural conditions may include small wetland and/or riparian zones along short reaches of the drainages in which the springs and seeps occur. Riparian areas are a transition between permanently saturated areas and upland areas with visible vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Native riparian vegetation in these areas includes cottonwood (*Populus* spp.), willow (*Salix* spp.), seep willow (*Baccharis salicifolia*), arrowweed (*Pluchea sericea*), ash (*Fraxinus* spp.), cattail (*Typha* spp.), rush (*Juncus* spp.), and sedge (*Carex* spp.), as well as a variety of grasses and forbs (BLM 2008b). However, in many of the riparian areas, including Kanab Creek and associated side canyons, native vegetation is being displaced by invasive species such as saltcedar (*Tamarix* spp.). Saltcedar is now a dominant riparian shrubby tree in the Colorado River basin below 6,000 feet amsl. Kanab Creek also hosts populations of tree of heaven (*Ailanthus altissima*) and pampus grass (*Cortaderia* sp.). Other nonnative species occurring in these riparian communities are Russian olive (*Elaeagnus angustifolia*), rabbit foot grass (*Polypogon monspeliensis*), dallisgrass (*Paspalum dilatatum*), Bermuda grass (*Cynodon dactylon*), cocklebur (*Xanthium* spp.), and thistles (Family Asteraceae) (BLM 2007). Brome grasses (*Bromus* spp.) and knapweeds (*Centaurea* spp.) are also common.

Human diversion or impoundment of free-flowing water by dams, diversions, irrigation, or channelization has been a major factor in the degradation of the natural functions of riparian areas on the Colorado Plateau (BLM 2008b). Without natural hydrologic systems, water tables have lowered, and surface sediments have dried out. Cottonwood and willow are particularly susceptible to water stress and may decline as groundwater becomes less available. With less flooding, there is less channel shifting and less suitable habitat for cottonwood and willow seedlings, which are dependent on recently inundated sediments to become established. Historically, fire was probably uncommon in this vegetation community (BLM 2008b). However, flammable fuel loads have increased dramatically in riparian areas because of drought, limited flooding that ordinarily would remove litter and woody debris, and dense buildup of saltcedar, which is highly flammable.

## *Great Basin Grassland*

Portions of the North and South parcels contain Great Basin Grassland vegetation communities that extend beyond the boundaries of this study. These grasslands occur on nearly level, wind-desiccated geomorphic surfaces of sedimentary and igneous origin. There are few trees in the ecological zone, consisting mostly of scattered pinyon and juniper. Occasionally, cacti or shrubs may also be present, usually along the edge of the grassland or in microhabitats. Dominant grass species include western wheatgrass (*Pascopyrum smithii*), needle and thread (*Hesperostipa comata*), blue grama (*Bouteloua gracilis*), galleta (*Pleuraphis jamesii*), New Mexico feathergrass (*Hesperostipa neomexicana*), and various species of three-awn (*Aristida* spp.). Common shrubs include big sagebrush (*Artemisia tridentata*), black sagebrush (*Artemisia nova*), fourwing saltbush (*Atriplex canescens*), and Mormon tea (*Ephedra trifurca*). One-seed juniper (*Juniperus monosperma*) and Utah juniper (*Juniperus osteosperma*) woodlands and savannas are adjacent to Colorado Plateau grasslands.

Historically, perennial and annual grasses covered much of this vegetation community in a clumpy, relatively continuous carpet interspersed with shrubs and forbs. The natural fire regime for this zone involves frequent fires, which occur an average of 10 years apart, nearly all of which have stand replacement fire severity. Frequent fires are limited to woody species with a varied vegetation pattern across the landscape. Changes in fuel continuity from past management practices and fire suppression activities essentially eliminated fire from this ecological zone, resulting in increased shrub densities, the loss of perennial grasses, and the spread of non-native, invasive species (BLM 2008b).

## Great Basin Desertscrub

Great Basin Desertscrub occurs in the North and East parcels. Most of the mid- to lower-elevation basins and benchlands along major canyon systems are covered by this vegetation type, the majority of which is managed by the BLM and NPS (AGFD 2006a). This vegetation community is shrub dominated. Species diversity is low, with dominant shrubs occupying large tracts of land. Characteristic vegetation is low-growing, widely spaced hemispherical, non-sprouting shrubs with widely spaced bunchgrasses. Dominant shrubs include big sagebrush, black sagebrush, Bigelow sagebrush (*Artemisia bigelovii*), shadscale (*Atriplex confertifolia*), fourwing saltbush, rabbitbrush (*Chrysothamnus* spp.), winterfat (*Krascheninnikovia lanata*), hopsage (*Grayia spinosa*), horsebrush (*Tetradymia* spp.), blackbrush (*Coleogyne ramosissima*), and greasewood (*Sarcobatus vermiculatus*). Associated grasses may include blue grama, galleta, Indian ricegrass (*Achnatherum hymenoides*), western wheatgrass, junegrass (*Koeleria macrantha*), muttongrass (*Poa fendleriana*), and several muhleys (*Muhlenbergia* spp.) and dropseeds (*Sporobolus* spp.). Forbs include several gilia (*Gilia* spp.), buckwheat (*Eriogonum* spp.), penstemon (*Penstemon* spp.), lupine (*Lupinus* spp.), and globemallow (*Sphaeralcea* spp.) species. Cacti are poorly represented in Great Basin Desertscrub, compared with their occurrence in warm deserts. Cacti in the proposed withdrawal vicinity include several species of prickly pear (*Opuntia* spp.), hedgehog (*Echinocereus* spp.), and cholla (*Cylindropuntia* spp.).

## Great Basin Conifer Woodland

Great Basin Conifer Woodland is present in all three proposed withdrawal parcels but is best represented within the North and South parcels. This vegetation community is classified as evergreen woodland dominated by juniper (*Juniperus* spp.) and pinyon pine (*Pinus* spp.) trees. Juniper tends to dominate at elevations below 6,560 feet amsl, while pinyon pine dominates at higher elevations. These trees are low growing, rarely exceeding 40 feet in height. The understories of pinyon-juniper and dense mature juniper woodlands are very species-poor, containing only widely scattered shrubs, forbs, and small clumps of grass. Grasses are the most common understory component.

The species of pinyon most often present in the Great Basin Conifer Woodland is the common pinyon (*Pinus edulis*), with singleleaf pinyon (*Pinus monophylla*) occasionally being found. Utah juniper is the most common juniper present, with one-seed juniper occasionally found. The understory contains only widely scattered shrubs, forbs, and small clumps of grass. Grasses are the most common understory component. Dominant grass species include grama, Arizona fescue (*Festuca arizonica*), junegrass, Indian ricegrass, needlegrass (*Achnatherum* spp.), dropseed, and squirreltail (*Elymus elymoides*). Shrubs may include big sagebrush, cliffrose (*Purshia stansburiana*), broom snakeweed (*Gutierrezia sarothrae*), Utah serviceberry (*Amelanchier utahensis*), rabbitbrush, shadscale, and winterfat.

This habitat type has expanded in distribution and density predominantly on public lands managed by the Kaibab National Forest, Grand Canyon National Park, ASLD, and BLM (AGFD 2006a). The community is replacing grassland vegetation in many locations as a result of livestock grazing, fire suppression, introduction of nonnative species, and other activities, many of which cause changes in vegetative composition through the creation of conditions that favor woody species over perennial grasses and forbs. Much of the vegetative diversity provided by grassland communities is lost when pinyon-juniper vegetation becomes established in nearly monotypic stands (AGFD 2006a).

### *Petran Montane Conifer Forest*

Within the proposed withdrawal area, this vegetation community is found only on the South Parcel. It is dominated by ponderosa pine (*Pinus ponderosa*), with Gambel oak (*Quercus gambellii*) being the most common associate. Other species include New Mexican locust (*Robinia neomexicana*) and serviceberry, both usually growing as shrubs or small trees. At lower elevations, ponderosa pine may be found mixed with pinyon and juniper. The understory of more open stands supports abundant grasses and forbs. Shrubs present include those from adjoining communities, along with scattered individuals of mountain snowberry (*Symphoricarpos oreophilus*), Oregon grape (*Mahonia repens*), and Oregon boxleaf (*Paxistima myrsinites*).

Most of the Petran Montane Conifer Forest in the Colorado Plateau ecoregion is found on the Kaibab Plateau north and south of the Grand Canyon. This forested land is managed by the Forest Service and NPS. While disagreement exists in the academic and scientific communities regarding estimates of pre-settlement conditions, it remains obvious that the structure and makeup of the montane conifer forests are different, in many respects, from historic conditions (AGFD 2006a). The large, mature, “old-growth” forests of the ecoregion were replaced by dense stands of even-age ponderosa pine as a result of heavy commercial logging and associated fire-suppression activities. The more than 100 years of fire suppression has resulted in dense, closed-canopy ponderosa pine forests with abundant litter and limited herbaceous vegetation. Heavy fuel loads have caused stand replacement fires in large wildfire events over the past 25 to 30 years.

## 3.6.2 Invasive and Noxious Species

There are occurrences of invasive species in the proposed withdrawal area. Some of these have been designated as “noxious” weeds in the state of Arizona, meaning they have been determined to be detrimental to public health, agriculture, recreation, wildlife, or property (BLM 2009a). Although it appears that there are relatively fewer noxious weed infestations on the Kanab Plateau and House Rock Valley than in nearby areas, the North and East parcels are apparently susceptible to invasions from the north and the south (BLM 2008d). Nine noxious weed species are found on the Arizona Strip: Russian knapweed (*Acroptilon repens*), camelthorn (*Alhagi maurorum*), globed-podded hoary cress/whitetop (*Cardaria draba*), diffuse knapweed (*Centaureau diffusa*), spotted knapweed (*Centaureau maculosa*), halogeton (*Halogeton glomeratus*), three-lobed morning glory (*Ipomoea triloba*), puncturevine (*Tribulus terrestris*), and Scotch thistle (*Onopordum acanthium*). The locations of known noxious weeds on the Kanab Plateau and Kaibab National Forest are depicted on Map 3.12 in BLM (2007:Vol. 1, Ch. 3). There also are six additional invasive species on the Arizona Strip that have not been designated as noxious but that are non-native in this region: perennial pepperweed (*Lepidium latifolium*), saltcedar, Russian olive, cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and Malta star thistle (*Centaurea melitensis*). Medusahead (*Taeniatherum caput-medusae*), a non-native species, is established north of the proposed withdrawal area and may occur within the proposed withdrawal area in the future (BLM 2008b).

Noxious and invasive weeds found on the Kaibab National Forest include cheatgrass, Dalmatian toadflax (*Linaria dalmatica*), diffuse knapweed, Scotch thistle, bull thistle (*Cirsium vulgare*), and leafy spurge (*Euphorbia esula*) (Forest Service 2009a). Cheatgrass occurs throughout the Kaibab National Forest and Grand Canyon National Park. Dalmatian toadflax has been found on and around the Kaibab National Forest, including along SR 64, and along roadsides in Grand Canyon National Park. Diffuse knapweed has been found on the Kaibab National Forest and along SR 64, crossing the eastern boundary of Grand Canyon National Park to the Navajo Nation boundary. Scotch thistle has been found along SR 64 at the eastern boundary with Grand Canyon National Park and on many forest roads on the Kaibab National Forest. A few scattered bull thistle plants have been found in the interior of the Kaibab National Forest and in scattered locations in Grand Canyon National Park. Leafy spurge has been found within the Hull Cabin Historic District on the Kaibab National Forest. Most of these populations have been treated using manual, chemical, or biological control methods. Invasive non-native weed monitoring, new treatments, and re-treatments occur annually on the Arizona Strip and in Grand Canyon National Park. Currently, the Kaibab National Forest, Grand Canyon National Park, and several field offices of the BLM are engaged with multiple other parties as part of a Memorandum of Understanding to manage noxious weeds as the Washington County Cooperative Weed Management Area (CWMA). This memorandum outlines a formal agreement to "promote an integrated weeds management program throughout the Washington County CWMA that includes public relations, education and training in the noxious weed arena, as well as coordination of weed control efforts and methods, sharing of resources and designing other desirable resource protection measures relative to weed management."

### 3.6.3 Resource Condition Indicators

For vegetation resources, condition indicators include the

- amount of disturbance that would result in loss of vegetation;
- change in productivity;
- loss of diversity;
- degree of infestation of invasive species;
- degree and amount of fragmentation;
- degree and amount of contamination and loss of water resources for vegetation.

For a more detailed description of changes in vegetation spatial pattern and area occupied, see the habitat fragmentation discussion in the Fish and Wildlife section (Section 3.7).

## 3.7 FISH AND WILDLIFE

The proposed withdrawal area is located within the greater Colorado Plateau ecoregion, which supports a wide variety of terrestrial and aquatic wildlife species. With the exception of Kanab Creek on the Kaibab Plateau, perennial aquatic systems and associated riparian habitats are extremely rare within the proposed withdrawal area; therefore, fish and riparian-dependent wildlife species are naturally limited. However, aquatic and riparian habitats are relatively abundant, adjacent to the proposed withdrawal area along the Colorado River, seeps and springs, and associated drainages in Grand Canyon National Park.

The USGS reviewed historical hydrologic data and analyzed water samples to determine uranium levels in Northern Arizona (Bills et al. 2010). Preliminary results suggest that dissolved uranium concentrations in areas without mining were generally similar to those with active or reclaimed mines, except for Horn Creek, which has high levels of uranium, arsenic, and other toxic metals. Horn Creek is located within the Park and has been previously impacted from the Orphan Mine. Historical water-quality and water-chemistry data evaluated for approximately 1,000 water samples determined that approximately 16% have exceeded maximum contaminant levels for arsenic, iron, lead, manganese, radium, sulfate, and uranium (Bills et al. 2010). These data suggest that water recharged from the surface or from perched water-bearing zones may contain dissolved gypsum from overlying rock units or may have been in contact with sulfide-rich ore. The USGS summarize that a few springs and wells in the region contain concentrations of dissolved uranium greater than the EPA MCL of 30 µg/L (Bills et al. 2010). These springs and seeps are in close proximity to or in direct contact with orebodies. Sixty-six percent of natural water sample concentrations of dissolved uranium in the dataset were 5 µg/L or less, and they may be subjectively be classified as low concentrations for human consumption within the study area (Bills et al. 2010).

The USGS also performed a literature review and analysis (Hinck et al. 2010) to document taxa-specific (i.e., birds, fish, amphibians, reptiles, small mammals, large mammals, etc.) plant and wildlife threshold levels for uranium or other metals. Based on the finding of this report, it is apparent that many plant and wildlife species are susceptible at levels below the EPA drinking water standards for humans. Impacts include reproductive issues, added pressure from more uranium tolerant species, and mortality.

General wildlife species associated with northern Arizona and the proposed withdrawal area are discussed in Table 3.7-1 and within various subsections of Section 3.7. Federally protected species, resource agency management indicator species (MIS), and agency-listed sensitive species are addressed in Section 3.8. The term ‘possible’ is defined as being when a species has a high probability of occurring because documented habitat components are present, the species may exist in close proximity to the proposed withdrawal area, or the species may be affected by actions proposed in one or more of the alternatives.

## 3.7.1 Wildlife Linkages

Establishing linkages between natural lands has long been recognized as important for sustaining natural ecological processes and biological diversity. For any linkage analysis, it is important to identify a suite of species on which recommendations will be focused, as the concept of focal species in reserve design and wildlife connectivity is a central theme in local and regional conservation planning (Miller et al. 1998; Soulé and Terborgh 1999). Focal species are typically identified to symbolize ecological conditions that are critical to healthy, functioning ecosystems (Lambeck 1997). The proposed withdrawal area overlaps with or is located immediately adjacent to five linkages identified by the Arizona Wildlife Linkages Workgroup (2006) (Figure 3.7-1). Focal species identified for these five linkages by the Arizona Wildlife Linkages Workgroup (2006) include large-game species, BLM and Forest Service Sensitive species, and NPS Species of Concern. No federally listed threatened or endangered species were included among the focal species identified for these linkages.

- **Linkage 3: Cedar Rim–Fredonia Pronghorn Crossing**. Linkage 3 consists of private, State Trust land, tribal, and BLM lands (although BLM lands make up only 9% of the linkage). Focal species associated with this linkage include mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), mountain lion (*Puma concolor*), and a variety of bats. Primary threats to this linkage include urbanization and SR 389.
- **Linkage 5: Kaibab Plateau North Rim.** Linkage 5 consists primarily of National Forest System land, with small amounts in private ownership or managed by NPS and BLM. Among the focal species associated with this linkage are mule deer, mountain lion, and wild turkey (*Meleagris gallopavo*). The major threat to this linkage is SR 67.
- **Linkage 6: Paria Plateau–Kaibab Plateau.** Linkage 6 consists primarily of BLM land, with small amounts of Forest Service, NPS, ASLD State Trust, tribal, and private land. Among the focal species associated with this linkage are pronghorn, mule deer, desert bighorn sheep (*Ovis canadensis nelsoni*), chisel-toothed kangaroo rat (*Dipodomys microps*), and western burrowing owl (*Athene cunicularia hypugea*). Threats to this linkage are listed as U.S. 89A, BLM Road 1065, and recreational traffic.
- **Linkage 12: Coconino Plateau–Kaibab National Forest.** Linkage 12 consists primarily of private and State Trust land, with small amounts of Forest Service and NPS land. Focal species include elk (*Cervus canadensis*), mule deer, mountain lion, northern goshawk (*Accipiter gentilis*

*atricapillus*), and pronghorn. Threats to this linkage include SR 64, the Grand Canyon railroad, and urbanization.

- **Linkage 13: South Rim Grand Canyon.** Linkage 13 consists primarily of tribal and Forest Service land, with a small amount of private land. Focal species include mule deer, elk, desert bighorn sheep, and mountain lion. Threats include SR 64, urbanization, and recreational traffic.

**Table 3.7-1.** General Wildlife Species Summary

| Species | Documented in the Proposed Withdrawal Area? | Documented in Close Proximity to the Proposed Withdrawal Area? | ESA status | Forest Service Management Indicator Species? | General Wildlife (per BLM and Forest Service)? | AGFD Species of Greatest Conservation Need in Arizona? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Mammals** | | | | | | | |
| Desert bighorn sheep (*Ovis canadensis nelsoni*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Mule deer (*Odocoileus hemionus*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Pronghorn (*Antilocapra americana*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Elk (*Cervus canadensis*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Mountain lion (*Puma concolor*) | Yes | Yes | No | No | Yes | Yes | Yes |
| Bison (*Bison bison*) | Yes | Yes | No | No | Yes | No | Yes |
| **Birds** | | | | | | | |
| Merriam's turkey (*Meleagris gallopavo merriami*) | Yes | Yes | No | Yes | No | No | Yes |
| Plain (Juniper) titmouse (*Baeolophus ridgwayi*) | Yes | Yes | No | Yes | No | No | Yes |
| Pygmy nuthatch (*Sitta pygmaea*) | Yes | Yes | No | Yes | No | No | Yes |
| Lucy's warbler (*Vermivora luciae*) | Yes | Yes | No | Yes | No | No | Yes |
| Yellow-breasted chat (*Icteria virens*) | Possible | Yes | No | Yes | No | No | Yes |
| American three-toed woodpecker (*Picoides tridactylus*) | Possible | Possible | No | No | No | Yes | Yes |
| Western purple martin (*Progne subis*) | Possible | Possible | No | No | No | Yes | Yes |
| Red-naped sapsucker (*Sphyrapicus nuchalis*) | Possible | Possible | No | No | No | Yes | Yes |
| Lewis's woodpecker (*Melanerpes lewis*) | Possible | Possible | No | No | No | Yes | Yes |
| Lincoln's sparrow (*Melospiza lincolnii*) | Possible | Possible | No | No | No | Yes | Yes |
| MacGillivray's warbler (*Oporornis tolmiei*) | Possible | Possible | No | No | No | Yes | Yes |
| Downy woodpecker (*Picoides pubescens*) | Possible | Yes | No | No | No | Yes | Yes |
| Green-tailed towhee (*Pipilo chlorurus*) | Possible | Possible | No | No | No | Yes | Yes |
| Ruby-crowned kinglet (*Regulus satrapa*) | Possible | Yes | No | No | No | Yes | Yes |
| Golden-crowned kinglet (*R. Calendula*) | Possible | Yes | No | No | No | Yes | Yes |
| **Aquatics** | | | | | | | |
| Bluehead sucker (*Catostomus discobolus*) | Possible | Yes | No | No | No | Yes | Yes |
| Aquatic invertebrates | Yes | Yes | No | Yes | No | No | Yes |

## 3.7.2 Fish and Aquatic Resources

The majority of standing surface waters in the Colorado Plateau ecoregion was created by impoundment of major river systems. The exception being the Colorado River and several small lakes associated with seeps and springs located both north and south of the Grand Canyon, including within the proposed withdrawal area. Human-made flood-control impoundments can significantly influence the flows, sediment transport, water quality, and aquatic habitat characteristics. Loss of natural flow, temperature, and nutrient cycling regimes can occur and have associated impacts on native aquatic species. This is compounded in most instances by the introduction of non-native fish, crustacean, and amphibian species for sport fishing. Unnatural conditions can also be created on the stream banks as well with the rapid expansion of invasive non-native plant species such as saltcedar. For a more detailed description of water resources associated with the proposed withdrawal area, see Section 3.4 and Figures 3.4-9, 3.4.10, 3.4-11, and 3.4.13.

Unique habitats that form a small part of the overall habitats represented in the proposed withdrawal area, or on adjacent lands, can be quite important to biota, as evidenced by the large number of endemic species in northern Arizona. Numerous springs and seeps associated with the Colorado River drainage support particularly rare or endemic species (NPS 2009a). With the exception of a short perennial stretch (less than 0.5 mile long) of Kanab Creek, where Clear Water Spring flows into Kanab Creek about 14 miles south of Fredonia on the Kanab Plateau, and within the North Parcel (BLM 2008b), there are no perennial stream reaches on the proposed withdrawal area. It should be noted that Kanab Creek, downstream of the North Parcel, is also perennial and has potential to be impacted by the Proposed Action. Springs and seeps also are rare features on the proposed withdrawal area (BLM 2008b; Forest Service 2009a). Consequently, there are no sizable wetlands within the proposed withdrawal area and few in the ecoregion (BLM 2008b). Water sources in the proposed withdrawal area consist of small, ephemeral water bodies that develop in low-lying areas where seasonal runoff collects and water developments such as earthen tanks for livestock exist.

## 3.7.3 General Wildlife Species

Species representative of aquatic/riparian, grassland, desertscrub, pinyon-juniper woodland, and ponderosa pine forest are listed in Table 3.7-2. Descriptions and species listed are from Brown and Lowe (1980). A variety of game species (including mule deer, elk, pronghorn, and turkey) and non-game wildlife species are discussed below under MIS. Two additional game species—desert bighorn sheep, a Forest Service Sensitive species, and bison (*Bison bison*), no special status—are not included in the MIS section. Desert bighorn sheep is discussed in Section 3.8.3, below. Bison is included in the discussion of the Grand Canyon Game Preserve, below.

**Table 3.7-2.** Representative Wildlife by Vegetation Community

| Vegetation Community | Representative Wildlife Species |
|---|---|
| Aquatic/Riparian | Birds characteristic of well-developed riparian communities include Bell's vireo (*Vireo belli*). Spring habitats are important for distinct populations of invertebrates (e.g., springsnails [*Pyrgulopsis* spp.] and ambersnails [*Oxyloma* spp.]). Aquatic habitats are important for amphibians and fish (e.g., speckled dace [*Rhinichthys osculus*]). |
| Great Basin Grassland | The most well-known Great Basin Grassland mammal representative is the pronghorn (*Antilocapra americana*). Associated smaller mammals found in this community include pocket gopher (*Geomys* spp.), harvest mouse (*Reithrodontomys* spp.), and chisel-toothed kangaroo rat (*Dipodomys microps*). Grassland birds may include Brewer's sparrow (*Spizella breweri*), western meadowlark (*Sturnella neglecta*), prairie falcon (*Falco mexicanus*), and western burrowing owl (*Athene cunicularia hypugaea*). |

**Table 3.7-2.** Representative Wildlife by Vegetation Community (Continued)

| Vegetation Community | Representative Wildlife Species |
|---|---|
| Great Basin Desertscrub | A distinctive fauna is centered in the Great Basin Desertscrub vegetation community in northern Arizona. Mammals such as Townsend's ground squirrel (*Spermophilus townsendi*), long-tailed pocket mouse (*Perognathus formosus*), and northern grasshopper mouse (*Onychomys leucogaster*) are closely associated with sagebrush in the Great Basin Desertscrub. Large ungulates are poorly represented here, but mule deer and bighorn sheep are known to use this vegetation community. Birds characteristic of this community include sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), and Vesper sparrow (*Pooecetes gramineus*). Characteristic reptile and amphibian species include sagebrush lizard (*Sceloporus graciosus*) and Great Basin spadefoot toad (*Spea intermontanus*), respectively. A number of reptile subspecies such as desert horned lizard (*Phrynosomo platyrhihnos platyrhinos*) and Great Basin and Plateau tiger whiptails (*Aspidoscelis tigris tigris* and *A. tigris septentrionalis,* respectively) are indicative of Great Basin Desertscrub. |
| Great Basin Conifer Woodland | Vertebrate species closely tied to or centered within this vegetation community in northern Arizona include pinyon mouse (*Peromyscus truei*), pinyon jay (*Gymnorhinus cyanocephalus*), gray flycatcher (*Empidonax wrightii*), bushy-tailed woodrat (*Neotoma cinerea*), gray vireo (*Vireo vicinior*), juniper titmouse (*Baeolophus ridgwayi*), black-throated gray warbler (*Dendroica nigrescens*), Scott's oriole (*Icterus parisorum*), and Plateau striped whiptail (*A. velox*) (Brown 1994). Pinyon-juniper woodlands are also seasonal habitats for a number of montane animals; as such, they are often of great importance as winter range for elk and mule deer. |
| Petran Montane Conifer Forest | Several species of wildlife are dependent on ponderosa pine, including Kaibab and Abert's squirrel (*Sciurus aberti kaibabensis* and *S. aberti,* respectively), northern goshawk, and Merriam's turkey. The list of characteristic nesting avifauna includes flammulated owl (*Otus flammeolus*), white-breasted nuthatch (*Sitta carolinensis*), pygmy nuthatch (*S. pygmaea*), brown creeper (*Certhis familiaris*), western bluebird (*Sialia mexicana*), yellow-rumped warbler (*Dendroica coronata*), western tanager (*Piranga ludoviciana*), pine siskin (*Carduelis pinus*), and chipping sparrow (*Spizella passerine*). Ponderosa pine forests support a wide variety of neotropical migratory songbirds. |

## Grand Canyon Game Preserve

The Grand Canyon Game Preserve is located between the Kanab Plateau and House Rock Valley on the Kaibab Plateau, a portion of which is within the northern reaches of the South Parcel. The Grand Canyon Game Preserve was established through presidential proclamation in 1906 by Theodore Roosevelt and specifically designated within the Grand Canyon Forest Reserve (now the Kaibab National Forest). The reason for establishment of the preserve was related to concerns about the extirpation of game species through unregulated hunting. In order to maximize populations of game species, government-sanctioned hunters virtually eliminated predators in the preserve, leading to overpopulation by the Kaibab deer herd in the 1920s. Management of the game preserve now falls under the Kaibab Land Management Plan (Forest Service 1996), which incorporates management directed toward ecosystem enhancement preserve for a broad range of habitat types and variety of wildlife species. Numerous cooperating agencies work to achieve the management goals and objectives specified in the Arizona wildlife and fisheries comprehensive plan (AGFD 2007a) and cooperative agreement for the management of the Grand Canyon Game Preserve.

Prior to the establishment of the game preserve, a herd of bison was introduced into House Rock Valley in 1906 (BLM 2008b). A portion of the herd still uses this area during the winter months and is managed as part of the Houserock Valley Wildlife Area. During the warm season, however, most of the bison move upslope to graze in the game preserve and Grand Canyon National Park. On the game preserve, the bison are managed under a Memorandum of Understanding between the Forest Service and AGFD, initially signed on August 8, 1950.

## Management Indicator Species

The role of MIS in National Forest System planning is described in the 1982 implementing regulations for the National Forest Management Act of 1976. Forest Service Manual 2620.5 defines management indicators as "plant and animal species, communities or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management

activities on their populations and the populations of other species with similar habitat needs which they may represent" (Forest Service 1991). These regulations require that certain vertebrate and/or invertebrate species present in the area be identified as MIS and that these species be monitored, as "their population changes are believed to indicate the effects of management activities" [36 CFR 219.19(a)(1)].
Table 3.7-3 is a list of MIS species for National Forest System lands associated with the proposed withdrawal area. The list is based on MIS of the Kaibab National Forest, as described in Foster et al. (2010), and input from Kaibab National Forest biologists. Included in the table are the habitat types or habitat components for which these MIS species are indicators. MIS species information is from Foster et al. (2010) and Forest Service (2008d), unless indicated otherwise.

**Table 3.7-3.** Wildlife Management Indicator Species on the Proposed Withdrawal Areas

| Common Name | Scientific Name | Habitat or Habitat Component | Proposed Withdrawal Parcel |
|---|---|---|---|
| **Invertebrates** | | | |
| Aquatic macroinvertebrates | Includes mayflies, stoneflies, and caddisflies | Riparian | North |
| **Birds** | | | |
| Northern goshawk | *Accipiter gentilis atricapillus* | Late-seral ponderosa pine | South |
| Merriam's turkey | *Meleagris gallopavo merriami* | Late-seral ponderosa pine | South, East |
| Hairy woodpecker | *Picoides villosus* | Snags in ponderosa pine, mixed-conifer, and mixed-conifer with aspen habitats | South |
| Juniper titmouse | *Baeolophus ridgwayi* | Late-seral pinyon-juniper and snags in pinyon-juniper | All three parcels |
| Pygmy nuthatch | *Sitta pygmaea* | Late-seral ponderosa pine | South, East |
| Lucy's warbler | *Vermivora luciae* | Late-seral low-elevation riparian | North |
| Yellow-breasted chat | *Icteria virens* | Late-seral low-elevation riparian | North |
| **Mammals** | | | |
| Elk | *Cervus canadensis* | Early-seral ponderosa pine, mixed conifer, spruce-fir | South |
| Mule deer | *Odocoileus hemionus* | Early-seral aspen and pinyon-juniper | All three parcels |
| Pronghorn | *Antilocapra americana* | Early- and late-seral grassland | South, East |
| Abert's squirrel | *Sciurus aberti* | Early-seral ponderosa pine | South |

Although northern goshawk is addressed in the Special Status Species section of this chapter, management recommendations developed for goshawk by Reynolds et al. (1992) are a major driver of forest management in the southwestern United States, including the Kaibab National Forest in the proposed withdrawal area, and are therefore described briefly here. The Kaibab LRMP/ROD (Forest Service 1988) prescribes the goshawk guidelines to all forest and woodland habitats on the Kaibab National Forest, with the exception of Mexican spotted owl (*Strix occidentalis lucida*) protected, restricted, and designated critical habitat, all of which have their own guidelines, which take precedence.

Goshawk management recommendations describe desired forest conditions for nesting, post-fledging, and foraging habitat while emphasizing conditions that support diverse prey populations (Foster et al. 2008). Fire, forest thinning, and snag retention are important components of the plan. The Kaibab LMP/ROD prescribes leaving snags in forested habitats to support goshawk prey species (Forest Service 1996).

## PINYON-JUNIPER WOODLAND

The two MIS associated with pinyon-juniper woodland in the proposed withdrawal vicinity are juniper titmouse (*Baeolophus ridgwayi*) and mule deer.

### Juniper titmouse (*Baeolophus ridgwayi*)

Juniper titmouse is an obligate secondary cavity nester. They typically nest in natural cavities such as knotholes or broken branches but will also use woodpecker-excavated cavities or stump holes as well as nest boxes. They are most abundant where juniper is dominant and where large, mature trees provide natural cavities for nesting. They are non-migratory and reside mainly in pinyon-juniper woodlands throughout the year. Juniper titmice occasionally wander into other habitats that are adjacent to or near pinyon-juniper woodlands, including cottonwood, willow, buffaloberry (*Shepherdia argentea*), and sagebrush shrublands, during the nonbreeding season.

Changes in historic fire regimes and habitat conversion resulting from livestock grazing are two major potential management impacts on the juniper titmouse.

### Mule deer (*Odocoileus hemionus*)

Mule deer are generalists that use ponderosa pine, mixed-conifer, woodland, and chaparral habitats. Forage items mostly consist of a variety of woody browse, but they feed more on grasses and forbs during the spring and summer months. Important forage plants include mountain-mahogany (*Cercocarpus ledifolius*), buckbrush (*Ceanothus cuneatus*), cliffrose, sagebrush, buckthorn (*Rhamnus* spp.), juniper, and oak.

Mule deer apparently were not common on BLM Arizona Strip lands prior to the arrival of early settlers (BLM 2008b). Populations began increasing during the early 1900s and peaked during the 1960s following decades of intensive predator control measures. The AGFD considers the current mule deer population on the Arizona Strip to be low but stable (BLM 2008b). Numerous water sources have been developed to make more habitats accessible to deer.

## PONDEROSA PINE FOREST

The five MIS associated with ponderosa pine forest in the proposed withdrawal area are Merriam's turkey (*Meleagris gallopavo merriami*), hairy woodpecker (*Picoides villosus*), pygmy nuthatch (*Sitta pygmaea*), elk, and Abert's squirrel (*Sciurus aberti*).

### Merriam's turkey (*Meleagris gallopavo merriami*)

National forests contain the majority of turkey habitat in Arizona. Merriam's turkeys are found primarily in ponderosa pine forests with a mix of meadows, oak, and juniper. Roosting and nesting habitat consists of large, open-crowned trees, often on steep slopes. Good brood-rearing habitats include natural or created openings, riparian areas, abundant herbaceous vegetation adjacent to forest cover, and mid-day loafing and roosting areas. Turkeys are migratory in parts of their range, moving to lower elevations during winter. Timing of movements can differ annually, depending on snowfall. Current conditions on National Forest System lands provide suitable habitat for turkeys. Small-scale thinning and prescribed burning create open areas for foraging while preserving denser areas for nesting.

### Hairy woodpecker (*Picoides villosus*)

Hairy woodpecker is one of the most abundant primary cavity nesters in northern Arizona. It is widely distributed wherever there are mature forests with substantial snags. Hairy woodpeckers occur in both deciduous and coniferous forests but may show preference for open pine forests in the Southwest. Although it is more abundant in Arizona pine forests, hairy woodpeckers are also found in pinyon-juniper woodland in the north and some Upper Sonoran deciduous woodlands and riparian areas in the south. Hairy woodpeckers are strongly associated with burned areas, an important historical component of northern Arizona forests resulting from frequent intervals of fire.

As primary cavity nesters, hairy woodpeckers are dependent on dead or dying portions of live trees and snags. They excavate their nests in both live and dead conifers and deciduous trees such as quaking aspen (*Populus tremuloides*) with fungal heart rot. The primary conifer species used for nesting in northern Arizona is ponderosa pine. Hairy woodpeckers prefer to drill their cavities on the underside of a curved limb in a somewhat open location.

Hairy woodpeckers primarily eat insects from the surface and subsurface of trees but also consume a diversity of fruits and seeds. In the western United States, they prefer to forage on conifers. In northern Arizona, they forage on ponderosa pine and are found in greater densities in burned areas. In turn, they are an important prey resource to many raptors, including the northern goshawk, Cooper's hawk (*Accipiter cooperi*), sharp-shinned hawk (*Accipiter striatus*), and great-horned owl (*Bubo virginianus*).

Hairy woodpecker populations are believed to be stable on the Kaibab National Forest. Based on the existing snag policy, guidelines for habitat manipulations, and the increasing severity of forest fires and number of acres burned in the Southwest, it is likely that hairy woodpecker populations will increase in the future.

## Pygmy nuthatch (*Sitta pygmaea*)

Pygmy nuthatch is one of the most abundant species in ponderosa pine forests. It is virtually limited to long-leaf pine systems, including ponderosa pine and Jeffrey pine (*Pinus jeffreyi*). In northern Arizona, pygmy nuthatches breed and feed in ponderosa pine communities and also in shallow ravines that contain white fir (*Abies concolor*), Douglas-fir, Arizona white pine (*P. monticola*), quaking aspen, and an understory of maple (*Acer* spp.). Pygmy nuthatches prefer old-growth, mature forests. However, this species can also be found in densely forested areas with smaller-diameter trees as long as there is nesting and roosting sites available, such as snags or trees with dead portions suitable for excavation. Ponderosa pine foliage volume positively correlates with pygmy nuthatch abundance, but abundance inversely correlates with trunk volume, which suggests that the species prefers heterogeneous stands of well-spaced, old pines and vigorous trees of intermediate age.

Pygmy nuthatches are both primary and secondary cavity-nesters, excavating dead or well-rotted wood, but also using existing cavities in northern Arizona. They nest primarily in ponderosa pine but occasionally use other conifers and quaking aspen if cavities are present. Pygmy nuthatches are primarily insectivorous. They forage in needle clusters and on cones, twigs, branches, and trunks. Pygmy nuthatches are assumed to be stable to declining on the Kaibab National Forest.

## Elk (*Cervus canadensis*)

Elk are currently considered common on the Kaibab National Forest (South Parcel) but apparently only occur intermittently on the Kanab Plateau (North Parcel) and House Rock Valley (East Parcel). In addition to occupying ponderosa pine forests, elk graze grassland and woodland habitats within the Kaibab National Forest. Although they prefer grasses over forbs, they are associated with deciduous thickets and early-seral stages that contain an interspersion of grasses and forbs. Elk occupy mountain meadows and forests in summer and move to lower-elevation pinyon-juniper woodland, conifer forest, and grasslands in winter, where they will browse woody shrubs. The population trend for elk has been stable to increasing on the Kaibab National Forest.

## Mountain lion (*Puma concolor*)

Mountain lions in Arizona use desert mountains with broken terrain and steep slopes, along with dense vegetation, caves, and rocky crevices that provide shelter. Stream courses and ridgetops are frequently used as travel corridors and hunting routes. Riparian vegetation along streams provides cover for lions traveling in open areas (AGFD 2007b). Mountain lions are active throughout the year, any time, day or night, but most hunting occurs at dawn or dusk. They are essentially solitary animals, with the exception for a few days during mating and periods of juvenile dependence. In Arizona, both whitetail (*Odocoileus virginianus*) and mule deer are the principal prey species, while in other areas, javelina (*Pecari tajacu*), elk, pronghorn, bighorn sheep, and/or livestock can be major components of their diets (AGFD 2007b). Population densities vary, depending on habitat components and density of prey items. Home range size for adult males is approximately 20 to 150 square miles, while for females it is approximately 10 to 50 square miles, both of which probably vary seasonally (AGFD 2007b). Territories of males and females may overlap, but males tend to avoid other males. Loss of habitat is probably the greatest threat to mountain lion populations throughout its range. Large tracts of roadless habitat are necessary to maintain individual populations, and the corridors that connect these tracts are required for dispersal of lions between populations. In addition, any loss of habitat of their prey species (deer) may cause a reduction in the mountain lion population.

### Abert's squirrel (*Sciurus aberti*)

Abert's squirrel is a tassel-eared squirrel occurring south of the Grand Canyon. The species lives, nests, and forages in ponderosa pine forests. Preferred habitat structure is intermediate-aged ponderosa pine forest intermixed with larger trees, where groups of trees have crowns that are interlocking or in close proximity. Thickets of medium-sized trees, with fewer large trees per acre, also can provide favorable habitat for Abert's squirrel. Nests are typically built in the branches of large ponderosa pines. Other nest sites include cavities in Gambel oak and in dwarf mistletoe (*Arceuthobium* spp.). Abert's squirrels depend on the interspersion of habitat types within the forest to provide arboreal travel routes and food both on the ground and in the trees. Closed canopies and abundant snags represent forest conditions favorable for Abert's squirrels. Abert's squirrel populations are currently considered stable on the Kaibab National Forest.

## GRASSLAND

The one MIS associated with grassland habitat in the proposed withdrawal area is pronghorn.

### Pronghorn (*Antilocapra americana*)

Pronghorn are associated with grasslands and savannahs with scattered shrubs and rolling hills. It prefers forbs and grasses as forage but will browse on woody shrubs when forbs and grasses are not available. Rangeland with a low vegetative structure, averaging 15 to 24 inches in height, is considered prime pronghorn habitat. Pronghorn movements vary seasonally. Animals using habitat on the Tusayan Ranger District (South Parcel), for example, spend time on different game management units (GMUs), including areas south of the Kaibab National Forest.

Pronghorn are native to the proposed withdrawal area. However, they apparently were eliminated from the Arizona Strip in the early 1900s and reintroduced beginning in the 1960s (BLM 2008b). Much of the pronghorn habitat on the Arizona Strip is found in the Clayhole area (North Parcel) and House Rock Valley area (East Parcel). On the Kaibab National Forest, pronghorn occur primarily in the Upper Basin in the northeastern portion of the Tusayan Ranger District, the southeastern portion of the Tusayan Ranger District, and small grasslands and sagebrush-grass communities (Forest Service 2009b).

The development of private lands, fence lines, railroads, roads, and highways has resulted in the fragmentation of pronghorn habitat. On the Arizona Strip, pronghorn populations since the 1980s have been low but stable (BLM 2008b). Management actions to help restore pronghorn to their former ranges within the Arizona Strip include modifying fences to allow pronghorn movement, improving forage species composition and diversity, and developing or making other water sources available for pronghorns (BLM 2008b).

## RIPARIAN

The three MIS associated with riparian habitat in the proposed withdrawal area are Lucy's warbler (*Vermivora luciae*), yellow-breasted chat (*Icteria virens*), and aquatic macroinvertebrates.

### Lucy's warbler (*Vermivora luciae*)

The species is only one of two warblers in the United States that nest regularly in cavities. In Arizona, it is a common resident of low-elevation mesquite (*Prosopis* spp.) bosques, cottonwood-willow forests, and densely vegetated xeric-riparian washes. They are also found in mid-elevation ash-walnut-sycamore-live oak associations. Although considered a generalist, the preferred habitat for Lucy's warbler is dense mesquite. It has also recently begun breeding in saltcedar communities in the Grand Canyon region.

Within the proposed withdrawal area, only Kanab Creek is considered suitable habitat for Lucy's warbler. Because Lucy's warbler can nest in saltcedar, it is likely this species will persist on the Kaibab National Forest in Kanab Creek. Bird surveys conducted in Kanab Creek in 2001 failed to detect any Lucy's warblers. Lucy's warblers are likely stable within the limited habitat available on the Kaibab National Forest.

### Yellow-breasted chat (*Icteria virens*)

The species prefers early-seral, shrubby thickets that are composed of low, dense vegetation with sparse canopy cover. This habitat type is found along forest edges, the margins of riparian or wetland habitat, regenerating burned areas, partially clearcut forests, and fencerows and thickets on abandoned farmland. In the arid western United States, chats are mainly confined to riparian and shrubby habitats. In Arizona, chats occur primarily in cottonwood-willow associations with a dense understory of mesquite and saltcedar along major rivers and ponds.

In the arid West, yellow-breasted chats build cup nests in dense, brushy, low-lying trees and shrubs, including Arizona alder (*Alnus oblongifolia*), Arizona ash (*Fraxinus velutina*), Russian olive, Siberian elm (*Ulmus pumila*), box-elder (*Acer negundo*), Goodding's willow (*Salix gooddingii*), coyote willow, blue-stem willow (*S. irrorata*), seep willow, canyon grape (*Vitis arizonica*), Virginia creeper (*Parthenocissus quinqurfolia*), net-leaf hackberry (*Celtis reticulata*), sumac (*Rhus trilobata*), and New Mexico forestiera (*Forestiera neomexicana*). In early successional shrubby habitats, where chats were more abundant, the preferred nesting substrates were seep willow, coyote willow (*S. exigua*), and canyon grape.

Very little riparian habitat suitable for this species is available within or adjacent to the proposed withdrawal area. What does occur consists primarily of dense, nonnative saltcedar and other native shrubs along Kanab Creek. The sometimes extensive saltcedar stands do not provide good foraging habitat and are increasing in distribution.

## AQUATIC MACROINVERTEBRATES

Aquatic macroinvertebrates live in a variety of riparian habitats where water is present. As a group, they provide a vital link in the food chain between primary producers (algae and macrophytes) and fish and amphibians. Many species are useful indicators of aquatic habitat conditions. Within the proposed withdrawal area, MIS aquatic macroinvertebrates include mayflies (Order Ephemeroptera), stoneflies (Order Plecoptera), caddisflies (Order Trichoptera), and true flies (Order Diptera). Aquatic macroinvertebrates were selected for monitoring the health of late-seral, riparian habitats because a diverse and abundant array of these species is indicative of healthy riparian habitats on the Kaibab National Forest. Aquatic macroinvertebrates are sensitive to changes resulting from forest practices, such as timber harvest, grazing, and road building (NPS 2009a).

Aquatic macroinvertebrates are not considered an effective MIS on the proposed withdrawal area because of the absence of well-developed riparian areas. They are not effective management indicators when stream courses have cycles of spring runoff that subside into slow or stagnant reaches of warm, isolated, receding waters, as in Kanab Creek, although some reaches within the North Parcel are not stagnant.

## 3.7.4 Migratory Birds

The Migratory Bird Treaty Act of 1918 gives federal protection to all migratory birds, including nests and eggs. Under the MBTA [16 USC 703–711], it is unlawful to take, kill, or possess migratory birds except as permitted by regulations [50 CFR Subpart B]. EO 13186 of January 10, 2001 (*Federal Register* 66[11]:3853–3856), directs federal agencies to support migratory bird conservation and to "ensure that environmental analyses . . . evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern" [50 CFR Section 3d(6)]. Species of concern are defined as "those species listed in the periodic report 'Migratory Nongame Birds of Management Concern in the United States,' priority migratory bird species as documented by established plans (such as Bird Conservation Regions in the North American Bird Conservation Initiative or Partners in Flight physiographic areas), and those species listed in 50 C.F.R. 17.1" [50 CFR Section 2i].

The Bald and Golden Eagle Protection Act [16 USC 668–668c], enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles (*Haliaeetus leucocephalus*), including their parts, nests, or eggs. This law provides for the protection of the bald eagle and the golden eagle (*Aquila chrysaetos*) by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. Amendments were made in 1972 and 1978 and a 1994 Memorandum (*Federal Register* 59:22953, April 29, 1994) from President William J. Clinton to the heads of Executive Agencies and Departments sets out the policy concerning collection and distribution of eagle feathers for Native American religious purposes.

The USFWS has the legal mandate and the trust responsibility to maintain healthy migratory bird populations for the benefit of the American public. Management recommendations for migratory birds can be found in the *USFWS Migratory Bird Program Strategic Plan 2004–2014* (USFWS 2010a). A list of species protected as migratory birds can be found in USFWS (2010b) and Appendix 2.G of the Arizona Strip ROD/RMP (2008b). Latta et al. (1999) describe priority bird species of concern by vegetation type in Arizona. These vegetation types are in turn grouped into the pertinent physiographic areas at the Partners in Flight (2010) website. The following vegetation (habitat) types are found in the proposed withdrawal area: Great Basin Woodland, Great Basin Desertscrub, Petran Montane Conifer Forest, Great Basin Grassland, Riparian Wetland, and Cliff/Rock.

Numerous migratory bird species occur within the boundaries of the proposed withdrawal area. Many of the species classified as MIS also are classified as migratory (e.g., northern goshawk, Lucy's warbler, yellow-breasted chat), as are many of the species analyzed in the Section 3.8 (e.g., northern goshawk, bald eagle, and peregrine falcon [*Falco peregrinus*]). In addition, bald eagle and golden eagle, which are both migratory species, have been observed within the proposed withdrawal area. Both are afforded added protection under the Bald and Golden Eagle Protection Act [16 USC 668–668c]. Vegetation (habitat) types and associated priority bird species of concern that may potentially occur in or adjacent to the proposed withdrawal area are listed in Table 3.7-4 and described based on information in Latta et al. (1999).

**Table 3.7-4.** Arizona Priority Bird Species by Vegetation Type

| Vegetation Type | Species | Important Habitat Components |
|---|---|---|
| **Great Basin Woodland** | | |
| Pinyon pine and/or juniper (may include several species) | Gray flycatcher (*Empidonax wrightii*) | Breeds in semi-arid woodlands and brushy areas that include pinyon pine and/or juniper woodlands, tall sagebrush/greasewood plains, and open ponderosa or Jeffrey pine forests with pinyon and/or juniper understory. |
| | Pinyon jay (*Gymnorhinus cyanocephalus*) | Pinyon pine seeds provide the primary source of reproductive energy for nesting. Food availability seems to be the most important factor determining colony breeding site selection. Open cup nests (usually one nest/tree) are placed in ponderosa pine, pinyon pine, Gambel oak, juniper, and occasionally blue spruce (*Picea pungens*). |
| | Gray vireo (*Vireo vicinior*) | Breeds in Arizona in open mature pinyon-juniper woodlands on canyon and mesa slopes from 3,200–6,800 feet amsl. A broadleaf shrub component is typically present, often composed of Utah serviceberry and single-leaf ash (*Fraxinus anomala*). |
| | Black-throated gray warbler (*Dendroica nigrescens*) | Primarily associated with pinyon pine and juniper woodlands (occasionally with scattered ponderosa pine) and mixed oak-pine woodlands. Breeding habitat is frequently characterized by a brushy undergrowth of scrub oak (*Quercus turbinella*), ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), or mountain mohagany (*Cercocarpus montanus*). |
| | Juniper titmouse (*Baeolophus ridgwayi*) | Highly restricted to pinyon-juniper woodlands. It occasionally wanders into other habitats (usually riparian) within its range that are adjacent to or near pinyon-juniper woodlands during the nonbreeding season. |
| **Great Basin Desertscrub** | | |
| Sagebrush, blackbrush, shadscale, and greasewood | Sage thrasher (*Oreoscoptes montanus*) | In Arizona, primarily occupies big sagebrush but occurs in areas of sandsage (*Artemisia filifolia*), saltbush, and greasewood. |
| | Sage sparrow (*Amphispiza belli*) | Closely associated with pure stands of big sagebrush throughout their range or stands intermingled with bitterbrush (*Purshia* sp.), saltbush, shadscale, rabbitbrush, or greasewood. |
| | Brewer's sparrow (*Spizella breweri*) | Breeds exclusively in cold desertscrub, primarily sagebrush, but also in saltbush, shadscale, and greasewood. |
| **Petran Montane Conifer Forest** | | |
| Ponderosa pine matrix (may include some Douglas-fir, Gambel oak, pinyon pine and/or juniper, aspen, and white fir) | Northern goshawk (*Accipiter gentilis atricapillus*) | Generally, nest sites are in mature and old-growth forest stands with relatively high canopy closure. In Arizona, primarily use ponderosa pine and mixed-conifer forests. In ponderosa pine habitat in Arizona, selected nest sites with higher canopy density, larger-diameter stems, and a higher frequency of large stems. |
| | Purple martin (*Progne subis*) | In Arizona ponderosa pine forests, prefers areas with a high snag density adjacent to or in open areas. |
| **Great Basin Grassland** | | |
| Includes Great Basin grassland (with scattered pinyon-juniper) | Ferruginous hawk (*Buteo regalis*) | In Arizona, uses the open scrublands, woodlands, and grasslands in the northern and southeastern parts of the state. Most occupied areas include nearby slopes or knolls of widely scattered junipers. |
| | Burrowing owl (*Athene cunicularia hypugea*) | Found in open, dry grasslands, agricultural and range lands, and desert. Also inhabits grass, forb, and open shrub stages of pinyon pine and ponderosa pine habitats. In Arizona, predominantly associated with prairie dog (*Cynomys* spp.) towns and round-tailed ground squirrel (*Spermophilus tereticaudus*) populations. |
| **Riparian Wetland** | | |
| Cottonwood, willow, ash, seepwillow, some saltcedar, and arrowweed | Western yellow-billed cuckoo (Cocc*yzus americanus occidentalis*) | A riparian obligate species found to be most abundant in cottonwood/willow associations. Breeds in riparian habitats, primarily below the Mogollon Rim in the Colorado and Gila river drainages. |

**Table 3.7-4.** Arizona Priority Bird Species by Vegetation Type (Continued)

| Vegetation Type | Species | Important Habitat Components |
|---|---|---|
| **Riparian Wetland, continued** | | |
| | Southwestern willow flycatcher (*Strix occidentalis lucida*) | A riparian obligate species that requires dense habitats along rivers, streams, or other wetland areas, usually with surface water, where 10- to 30-foot-tall willows, seepwillow, arrowweed, buttonbush (*Cephalanthus occidentalis*), alder, or other shrubs and trees are present, often with a scattered overstory of cottonwood. Nests in thickets dominated by saltcedar and Russian olive. |
| | Lucy's warbler (*Vermivora luciae*) | Although classified as a generalist, the preferred habitat is dense mesquite. Will also use saltcedar, screwbean mesquite (*Prosopis pubescens*), and cottonwood willow (non-gallery). |
| **Cliff/Rock** | | |
| Cliff, canyon wall, rock outcrop, talus slope | White-throated swift (*Aeronautes saxatalis*) | Occupies a wide variety of habitats, with the common attribute being the availability of nearby cliffs. |
| | Peregrine falcon (*Falco peregrinus*) | Occupies cliffs, canyon walls, and rock spires, usually near rivers or other water sources where prey is more abundant. |
| | Canyon wren (*Catherpes mexicanus*) | Found where topography provides appropriate substrates for foraging and nesting; steep slopes and canyons. |

Source: Latta et al. (1999).

## 3.7.5 Resource Condition Indicators

For fish and wildlife resources, resource condition indicators include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites), and the influence of these habitat changes on the reproductive success, population size, health, and diversity of organisms (Table 3.7-5). Many of these changes in habitat are similar to the condition indicators for vegetation. The concept of MIS was developed by the Forest Service to monitor selected ecological conditions (e.g., habitat quality) on National Forest System lands. The MIS concept is described in greater detail in Section 3.7.3, above.

Recognized threats to wildlife in the region include habitat loss and alteration, disturbance, introduction of non-native species, and increases to exposure of radiation and toxicity. The loss of habitat contiguity (i.e., fragmentation) is considered a particularly important reason for regional declines in native species and has been targeted as the most serious threat to biological diversity worldwide (Saunders et al. 1991; Wilcox and Murphy 1985). Countering this threat requires a systematic approach to identifying, protecting, and restoring functional connections across the landscape to allow essential ecological processes to continue operating. Habitat fragmentation typically leads to the isolation of populations, thus creating local subpopulations scattered across a landscape (Dobson et al. 1999). Isolation of these subpopulations may lead to local extinctions because, over time, populations restricted to isolated patches may experience a reduction in genetic diversity as a result of increased inbreeding, increased risk of local extinction from population dynamics and catastrophic events, and decreased ability to recolonize (Hanski 1999; Hanski and Simberloff 1997; Yanes et al. 1995).

**Table 3.7-5.** Fish and Wildlife Resource Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Wildlife habitat | Issues associated with wildlife habitat include fragmentation of habitat by roads, noise from exploration or development activities that is disruptive to wildlife, wildlife being disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species. | *Indicator:* Acres and type of habitat lost and duration of loss.<br>*Indicator:* Changes in migratory or foraging behavior.<br>*Indicator:* Changes in road densities in migration corridors.<br>*Indicator:* Avoidance or adaptation of species to noise source/visual intrusion.<br>*Indicator:* Acres of habitat loss or degradation as a result of establishment of invasive species caused by mineral exploration or development activities. |
| Wildlife populations | Potential loss of critical wildlife winter range. Potential for exploration or development to occur in critical calving or fawning areas, disruption of nesting habitat, etc. | *Indicator:* Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time. |
| Wildlife mortality and reproductive success | The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle-wildlife accidents and associated wildlife mortality.<br>In addition to vehicle wildlife accidents; increased uranium levels in surface and groundwater and soil contamination has potential to cause increased mortality and decreased reproductive success due to exposure of chemicals and radiation. | *Indicator:* Estimated number of vehicle-wildlife collisions associated with exploration or production activity.<br>*Indicator:* Changes in uranium and other heavy metal levels in soils as well as on the surface and in surface waters such as rivers, streams and seeps, springs, and stock tanks fed by wells. |

# 3.8 SPECIAL STATUS SPECIES

Special status species addressed below include 1) species listed or being considered for listing by the USFWS under the ESA; 2) BLM Sensitive species; 3) Forest Service Sensitive species; 4) NPS species of concern; and 5) AGFD Species of Greatest Conservation Need (SGCN). Figures depicting plant and animal locations are based on BLM (2008b) and data files provided by the BLM, Forest Service, and NPS. Table 3.8-1 summarizes species status and potential occurrence within the proposed withdrawal area and adjacent lands. It should be noted that some species are listed as special status species by multiple agencies. For those species that are listed as special status species by multiple agencies, the species description is included only once within Section 3.8.

Wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion (soil, food, and water), inhalation, and various cell absorption processes. In addition to the resource condition indicators discussed in Section 3.7, Fish and Wildlife, resource condition indicators for special status species include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and quantity at aquatic sites), that affect overall species health and abundance, as well as potential impacts (modify or destroy) to designated critical habitat. It should be noted that several species discussed in this report, are associated with the Virgin River, which is located more than 30 miles from the proposed withdrawal area. Species that are associated with the Virgin River are included in analysis because they are listed on the USFWS Mohave County Species threatened and endangered species list and groundwater (R-aquifer) from portions of the North Parcel are associated with the Virgin River watershed (see Section 3.4, Water Resources).

## 3.8.1 Threatened, Endangered, and Candidate Species

The Endangered Species Act of 1973, as amended, provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The law requires federal agencies, in consultation with the USFWS and/or the U.S. National Oceanic and Atmospheric Administration Fisheries Service, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. Table 3.8-1 summarizes general information on special status species and agency involvement and documents whether that species is analyzed in detail in Chapter 4.

In addition to threatened, endangered, and candidate species, this section also addresses species proposed for listing, species undergoing status review as potential candidates for listing, species covered under Conservation Agreements, and recently delisted species. The species listed in Table 3.8-2 and discussed below were based on review of the most recent USFWS species lists for Mohave and Coconino counties, Arizona, a search of the Arizona Heritage Data Management System and pertinent literature, correspondence with the USFWS, and meetings with the USFWS, NPS, Forest Service, and BLM. Table 3.8-2 contains 36 species that may be found within the proposed withdrawal area or adjacent to the proposed withdrawal area. Information on species trends (when available) and proximity to mining claims (when applicable) is included. The term ‘possible’ is defined as when a species has a high probability of occurring because documented habitat components are present or the species may exist in close proximity to the proposed withdrawal area.

### *Plants*

#### BRADY PINCUSHION CACTUS (*PEDIOCACTUS BRADYI*)

The species is known to occur at several locations in House Rock Valley (Figure 3.8-1). Within House Rock Valley, the BLM currently administers the Marble Canyon ACEC (see Figure 3.6-1) for protection of the species (BLM 2008b). The Marble Canyon ACEC includes one of only two populations known to occur on public lands (BLM 2007). It is also the only area where the species overlaps Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*) (see below). The soils where Brady pincushion cactus occurs are derived from the Moenkopi Formation and characterized by overlying limestone chips. Trend studies have been conducted yearly since 1986 and show a stable population, with some fluctuations related to rodent depredation and precipitation (BLM 2007).

#### SENTRY MILKVETCH (*ASTRAGALUS CREMNOPHYLAX* VAR. *CREMNOPHYLAX*)

The plant is not known to occur within the proposed withdrawal area. *Astragalus* is the largest genus of flowering plants in Arizona. *Astragalus cremnophylax* and three other species are in the subsection *Humillimi* of *Astragalus* (Maschinski 1993). Sentry milk-vetch is a rare endemic plant known from only three locations on the South Rim of the Grand Canyon. All locations are within Grand Canyon National Park and are referred to as: Maricopa Point, Grandview, and Lollipop Point. Sentry milk-vetch is found where Kaibab limestone forms large flat platforms with shallow soils near pinyon-juniper woodlands. The species' habitat specificity, reduced number, vigor of plants, and small habitat size make it vulnerable to extinction. Given these conditions, the major threats to the species include limited number, distribution, and size of the populations; low reproduction; stochastic environmental or demographic events; and habitat destruction and modification (AGFD 2005a; USFWS 2006a).

**Table 3.8-1.** Special Status Species Summary

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | |
| Bald eagle (*Haliaeetus leucocephalus*) | Yes | Yes | Delisted | Yes | Yes | No | Yes |
| California condor (*Gymnogyps californianus*) | Yes | Yes | Endangered with nonessential experimental 10(j) population within proposed withdrawal area | No | No | No | Yes |
| Mexican spotted owl (*Strix occidentalis lucida*) | Yes | Yes | Threatened w/CH in North Parcel | No | No | No | Yes |
| Southwestern willow flycatcher (*Empidonax traillii extimus*) | Possible | Yes | Endangered w/CH | No | No | No | Yes |
| Yuma clapper rail (*Rallus longirostrus yumanensis*) | No | Yes | Endangered w/o CH | No | No | No | Yes |
| American peregrine falcon (*Falco peregrinus anatum*) | Yes | Yes | Delisted | Yes | Yes | No | Yes |
| Yellow-billed cuckoo (*Coccyzus americanus occidentalis*) | Possible | Yes | Candidate | No | Yes | No | Yes |
| California least tern (*Sterna antillarum browni*) | No | No | Endangered w/CH | No | No | No | No See Table 4.8-1 |
| Northern goshawk (*Accipiter gentilis atricapillus*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Western burrowing owl (*Athene cunicularia hypugea*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Ferruginous Hawk (*Buteo regalis*) | Yes | Yes | No | No | Yes | No | Yes |
| Golden Eagle (*Aquila chrysaetos*) | Yes | Yes | No | No | Yes | No | Yes |
| Pinyon Jay (*Gymnorphinus cyanocephalus*) | Yes | Yes | No | No | Yes | No | Yes |
| **Mammals** | | | | | | | |
| Greater western mastiff bat (*Eumops perotis californicus*) | Possible | Yes | No | Yes | Yes | Yes | Yes |

**Table 3.8-1.** Special Status Species Summary (Continued)

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Mammals, continued** | | | | | | | |
| Desert bighorn sheep (*Ovis canadensis nelsoni*) | Yes | Yes | No | Yes | No | No | Yes |
| Western red bat (*Lasiurus blossevillii*) | Possible | Yes | No | Yes | No | No | Yes |
| Spotted bat (*Euderma maculatum*) | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Allen's lappet-browed bat (*Idionycteris phyllotis*) | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*) | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Long-legged myotis (*Myotis volans*) | Yes | Yes | No | No | No | Yes | Yes |
| Big free-tailed bat (*Nyctinomops macrotis*) | Yes | Yes | No | No | No | Yes | Yes |
| Pocketed free-tailed bat (*Nyctinomops femorosaccus*) | Possible | Yes | No | No | No | Yes | Yes |
| Mexican long-tongued bat (*Choeronycteris mexicana*) | Possible | Yes | No | No | Yes | Yes | Yes |
| Southwestern myotis (*Myotis auriculus*) | No | Yes | No | No | No | Yes | Yes |
| Black-footed ferret (*Mustela nigripes*) | No | Yes | Endangered w/o CH | No | No | No | No<br>See Table 4.8-1 |
| Southwestern river otter (*Lontra canadensis sonora*) | No | Yes | No | No | No | Yes | No<br>See Table 4.8-1 |
| House Rock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*) | Yes | Yes | No | Yes | Yes | No | Yes |
| Merriam's shrew (*Sorex merriami*) | Yes | Yes | No | Yes | No | No | Yes |
| Mogollon vole (*Microtus mogollonensis*) | Yes | Yes | No | Yes | No | No | Yes |

**Table 3.8-1.** Special Status Species Summary (Continued)

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Mammals, continued** | | | | | | | |
| Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)* | No | No | Endangered w/o CH | No | No | No | No<br>See Table 4.8-1 |
| Arizona myotis (*Myotis occultus)* | No | Yes | No | No | Yes | No | Yes |
| Gunnison's prairie dog (*Cynomys gunnisoni*) | No | Yes | No | No | Yes | No | Yes |
| **Plants** | | | | | | | |
| Brady pincushion cactus (*Pediocactus bradyi*) | Yes | Yes | Endangered w/o CH | No | No | No | Yes |
| Jones cycladenia (*Cycladenia humilis* var. *jonesii*) | No | Yes | Threatened w/o CH | No | No | No | No<br>See Table 4.8-1 |
| Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*) | No | Yes | Endangered w/o CH | No | No | No | Yes |
| Siler pincushion cactus (*Pediocactus sileri*) | Yes | Yes | Threatened w/o CH | No | No | No | Yes |
| Welsh's milkweed (*Asclepia welshii*) | No | Yes | Threatened w/CH in Utah | No | No | No | No<br>See Table 4.8-1 |
| Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*) | Yes | Yes | Candidate | No | Yes | No | Yes |
| Paradine (Kaibab) plains cactus (*Pediocactus paradinei*) | Yes | Yes | Conservation Agreement | No | Yes | No | Yes |
| Pipe Springs cryptantha (*Cryptantha semiglabra*) | Possible | Yes | No | No | Yes | No | No<br>See Table 4.8-1 |
| San Francisco Peaks groundsel (*Packera franciscana*) | No | No | Threatened w/CH | No | No | No | No<br>See Table 4.8-1 |
| Navajo Sedge (*Carex specuicola*) | No | No | Threatened w/CH | No | No | No | No<br>See Table 4.8-1 |
| Arizona cliffrose (*Purshia subintegra*) | No | No | Endangered w/o CH | No | No | No | No<br>See Table 4.8-1 |

**Table 3.8-1.** Special Status Species Summary (Continued)

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Plants, continued** | | | | | | | |
| Arizona bugbane (*Cimicifuga arizonica*) | No | No | Conservation Agreement | No | No | No | No See Table 4.8-1 |
| Morton wild buckwheat (*Eriogonum mortonianum)* | Possible | Yes | No | Yes | No | No | Yes |
| Grand Canyon rose (*Rosa stellata* var. *abyssa*) | Yes | Yes | No | No | Yes | Yes | Yes |
| Marble Canyon milkvetch (*Astragalus cremnohylax* var. *hevronii*) | Yes | Yes | No | No | Yes | No | Yes |
| Mt. Trumbull beardtongue (*Penstemon distans*) | No | Yes | No | No | Yes | No | No See Table 4.8-1 |
| Paria Plateau fishhook cactus (*Sclerocactus sileri*) | Yes | Yes | No | No | Yes | No | Yes |
| September 11 stickleaf (*Mentzelia memorabilis*) | No | Yes | No | No | Yes | No | No See Table 4.8-1 |
| Silverleaf sunray (*Enceliopsis argophylla*) | No | Yes | No | No | Yes | No | No See Table 4.8-1 |
| Sticky wild buckwheat (*Eriogonum viscidulum*) | No | Yes | No | No | Yes | No | No See Table 4.8-1 |
| Gierisch mallow (*Sphaeralcea gierischii*) | No | Yes | Candidate | No | Yes | No | No See Table 4.8-1 |
| Holmgren milkvetch (*Astragalus holmgreniorum*) | No | Yes | Endangered w/CH in Arizona and Utah | No | No | No | No See Table 4.8-1 |
| Grand Canyon beavertail cactus (*Opuntia basilaris* var. *longiareolata*) | No | Yes | No | No | No | Yes | Yes |
| Kaibab agave (*Agave utahensis* ssp. *kaibabensis*) | No | Yes | No | No | No | Yes | Yes |
| McDougall's yellowtops (*Flaveria mcdougallii*) | No | Yes | No | No | No | Yes | Yes |
| Grand Canyon cave-dwelling primrose (*Primula specuicola*) | No | Yes | No | No | No | Yes | Yes |

**Table 3.8-1.** Special Status Species Summary (Continued)

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Plants, continued** | | | | | | | |
| Kaibab suncup (Grand Canyon evening-primrose) (*Camissonia specuicola* ssp. *hesperia*) | No | Yes | No | No | No | Yes | Yes |
| Arizona leatherflower (*Clematis hirsutissima* var. *hirsutissima*) | Yes | Yes | No | Yes | No | No | Yes |
| Tusayan flameflower (*Talinum validulum*) | Yes | Yes | No | No, but tracked as a rare species | No | No | Yes |
| Tusayan rabbitbrush (*Chrysothamnus molestus*) | Yes | Yes | No | Yes | No | No | Yes |
| Marble Canyon indigo bush (*Psorothamnus arborescens* var. *pubescens*) | Possible | Yes | No | No | Yes | No | Yes |
| Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*) | No | Yes | No | No | Yes | No | Yes |
| Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*) | No | No | No | No | Yes | No | No See Table 4.8-1 |
| **Fish** | | | | | | | |
| Apache trout (*Oncorhyncus gilae apache*) | No | No | Threatened w/o CH | No | No | No | No See Table 4.8-1 |
| Humpback chub (*Gila cypha*) | No | Yes | Endangered w/CH–Colorado River | No | No | No | Yes |
| Razorback sucker (*Xyrauchen texanus*) | No | No | Endangered w/CH | No | No | No | Yes |
| Little Colorado spinedace (*Lepidomeda vittata*) | No | No | Threatened w/ CH | No | No | No | No See Table 4.8-1 |
| Bonytail chub (*Gila elegans*) | No | No | Endangered w/ CH | No | No | No | No See Table 4.8-1 |
| Roundtail chub (*Gila robusta*) | No | No | Candidate | No | Yes | No | Yes |

**Table 3.8-1.** Special Status Species Summary (Continued)

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Fish, continued** | | | | | | | |
| Flannelmouth sucker (*Catostomus latipinnis*) | No | Yes | No | No | Yes | Yes | Yes |
| Desert sucker (*Catostomus* [*Pantosteus*] *clarki*) | No | Yes | No | No | Yes | Yes | Yes |
| Speckled dace (*Rhinichthys osculus*) | Possible | Yes | No | No | Yes | No | Yes |
| Woundfin (*Plagopterus argentissimus*) | No | Yes | Endangered, w/CH along the Virgin River in Utah, Arizona, and Nevada | No | No | No | Yes |
| Virgin River chub (*Gila seminuda*) | No | Yes | Endangered w/CH along the Virgin River in Utah, Arizona, and Nevada | No | Yes | No | Yes |
| Virgin spinedace (*Lepidomeda mollispinis mollispinis*) | No | Yes | Conservation Agreement | No | Yes | No | Yes |
| Bluehead Sucker (*Catostomus discobolus*) | | | No | No | Yes | No | |
| **Reptiles and Amphibians** | | | | | | | |
| Relict leopard frog (*Lithobates* [*Rana*] *onca*) | No | No | Candidate with Conservation Agreement and Strategy | No | Yes | No | Yes |
| Northern leopard frog (*Lithobates* [*Rana*] *pipiens*) | Possible | Yes | No | Yes | Yes | No | Yes |
| Lowland leopard frog *(Lithobates* [*Rana*] *yavapaiensis* | No | Yes | No | Yes | Yes | No | Yes |
| Chiricahua leopard frog (*Lithobates* [*Rana*] *chiricahuensis*) | No | No | Threatened w/o CH | No | No | No | No<br>See Table 4.8-1 |
| Northern Mexican gartersnake (*Thamnophis eques megalops*) | No | No | Candidate | No | Yes | No | No<br>See Table 4.8-1 |
| Grand Canyon rattlesnake (*Crotalus oreganus abyssus*) | Possible | Yes | No | Yes | No | No | Yes |

**Table 3.8-1.** Special Status Species Summary (Continued)

| Species | Documented in any of the Three Proposed Withdrawal Parcels? | Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels? | USFWS Listed Species/Critical Habitat Information | Forest Service Sensitive Species? | BLM Sensitive Species? | Grand Canyon National Park Species of Concern? | Potentially Impacted by Proposed Withdrawal? |
|---|---|---|---|---|---|---|---|
| **Reptiles and Amphibians, continued** | | | | | | | |
| Desert tortoise (*Gopherus agassizii*) (Mohave population) | No | No | Threatened w/CH | No | No | No | No<br>See Table 4.8-1 |
| Desert tortoise (*Gopherus agassizii*) (Sonoran population) | No | Yes | Candidate | No | Yes | Yes | No<br>See Table 4.8-1 |
| **Invertebrates** | | | | | | | |
| Kanab ambersnail (*Oxyloma. h. kanabensis* ) | Possible | Yes | Endangered w/o CH | No | No | No | Yes |
| Grand Canyon cave pseudoscorpion (*Archeolarca cavicola*) | No | Yes | No | No | No | Yes | Yes |
| Hydrobiid spring snails<br>Grand Wash springsnail (*Pyrgulopsis bacchus*)<br>Desert springsnail (*Pyrgulopsis deserta*) | No | Yes | No | No | Yes | No | Yes |
| Succineid snails (all species in Family Succineidae), including Niobrara ambersnail (*Oxyloma haydeni haydeni*); | No | Yes | No | No | Yes | No | Yes |

Sources: USFWS Species list for Coconino and Mohave counties was accessed on January 15, 2010, and again on August 15, 2010. Arizona Heritage Data Management System accessed on January 15, 2010; received data on January 20, 2010 (buffer set for proposed withdrawal area only); BLM (2010) list.

Note: CH = Critical habitat.

**Table 3.8-2.** Federally Listed Species and Their Potential for Occurrence in the Proposed Withdrawal Area

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Plants** | | | | |
| Brady pincushion cactus (*Pediocactus bradyi*) | USFWS E | No | Yes | No |
| Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*) | USFWS E | No | No | Yes |
| Holmgren milkvetch (*Astragalus holmgreniorum*) | USFWS E | No | No | No |
| Welsh's milkweed (*Asclepias welshii*) | USFWS T with Critical Habitat | No | No | No |
| Siler pincushion cactus (*Pediocactus sileri*) | USFWS T | Yes | No | No |
| Jones' cycladenia (*Cycladenia humilis* var. *jonesii*) | USFWS T | No | No | No |
| Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*) | USFWS C<br>BLM S | Yes | Yes | Possible |
| Paradine (Kaibab) plains cactus (*Pediocactus paradinei*) | USFWS CA<br>BLM S | No | Yes | No* |
| Gierisch mallow (*Sphaeralcea gierischii*) | USFWS C<br>BLM S | No | No | No |
| San Francisco Peaks groundsel (*Packera franciscana*) | USFWS T with Critical Habitat | No | No | No |
| Navajo Sedge (*Carex specuicola*) | USFWS T with Critical Habitat | No | No | No |
| Arizona cliffrose (*Purshia subintegra*) | USFWS E | No | No | No |
| Arizona bugbane (*Cimicifuga arizonica*) | USFWS Conservation Agreement | No | No | No |
| **Wildlife** | | | | |
| Black-footed ferret (*Mustela nigripes*) | USFWS E | No | No | No |
| California condor (*Gymnogyps californianus*) | USFWS E | Yes | Yes | Yes |
| Southwestern willow flycatcher (*Empidonax traillii extimus*) | USFWS E with Critical Habitat | Possible | No | No |
| Yuma clapper rail (*Rallus longirostrus yumanensis*) | USFWS E | No | No | No |
| Mexican spotted owl (*Strix occidentalis lucida*) | USFWS T with Critical Habitat | Yes | Possible | Possible |
| Yellow-billed cuckoo (*Coccyzus americanus occidentalis*) | USFWS C<br>BLM S | Possible | No | No |
| California least tern (*Sterna antillarum browni*) | USFWS E | No | No | No |
| Desert tortoise (*Gopherus agassizii*) (Mojave population) | USFWS T with Critical Habitat | No | No | No |
| Desert tortoise (*Gopherus agassizii*) (Sonoran population) | USFWS C<br>BLM S | No | No | No |
| Chiricahua leopard frog (*Lithobates* [Rana] *chiricahuensis*) | USFWS T | No | No | No |

**Table 3.8-2.** Federally Listed Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Wildlife, continued** | | | | |
| Northern Mexican gartersnake (*Thamnophis eques megalops*) | USFWS C<br>BLM S | No | No | No |
| Relict leopard frog (*Lithobates* [Rana] *onca*) | USFWS C with CA<br>BLM S | No | No | No |
| Humpback chub (*Gila cypha*) | USFWS E with Critical Habitat | No | No | No |
| Razorback sucker (*Xyrauchen texanus*) | USFWS E with Critical Habitat | No | No | No |
| Virgin River chub (*Gila seminuda*) | USFWS E with Critical Habitat | No | No | No |
| Woundfin (*Plagopterus argentissimus*) | USFWS E with Critical Habitat | No | No | No |
| Apache trout (*Oncorhyncus gilae apache*) | USFWS T | No | No | No |
| Little Colorado spinedace (*Lepidomeda vittata*) | USFWS T with Critical Habitat | No | No | No |
| Bonytail chub (*Gila elegans*) | USFWS T with Critical Habitat | No | No | No |
| Roundtail Chub (*Gila robusta*) | USFWS C<br>BLM S | No | No | No |
| Virgin spinedace (*Lepidomeda mollispinis mollispinis*) | CA<br>BLM S | No | No | No |
| Kanab ambersnail (*Oxyloma haydeni kanabensis*) | USFWS E | No | Possible | No |
| Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)* | USFWS E | No | No | No |

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

USFWS

C = Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

CA = Conservation Agreement. Formal agreement between the Forest Service and one or more parties to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened.

E = Listed Endangered: imminent jeopardy of extinction under ESA.

T = Listed Threatened: imminent jeopardy of becoming endangered under ESA.

* Adapted from Forest Service (2009a).

## HOLMGREN MILKVETCH (*ASTRAGALUS HOLMGRENIORUM*)

The species does not occur within the proposed withdrawal area. Only three populations are known: one in Arizona and two in Washington County, Utah (USFWS 2010c). The primary population is in Mohave County, Arizona (see Figure 3.8-1), near the Virgin River Gorge. All populations are within 9 miles of St. George, Utah. Habitat for the species is shallow, sparsely vegetated soils derived primarily from the Virgin Limestone member of the Moenkopi Formation at 2,700 to 2,800 feet amsl. The number of living plants may not exceed 10,000 (Van Buren and Harper 2003). In drought years, populations are as much as 95% smaller than in years with adequate water.

## WELSH'S MILKWEED (*ASCLEPIAS WELSHII*)

The species is not known to occur within the proposed withdrawal area. In Arizona, it occurs north of House Rock Valley along BLM Road 1065 (see Figure 3.8-1); it is also found in Utah north of the Kanab Plateau. It grows on open, sparsely vegetated, semi-stabilized sand dunes and on the lee slopes of actively drifting sand dunes. It is found in small numbers in Vermilion, scattered in the Navajo Sandstone derived Aeolian sand dunes of Coyote Buttes (BLM 2007). In the past, OHV activity was the main threat to this species, but it is now well protected as a result of the designation and management of the Paria Canyon–Vermilion Cliffs Wilderness Area, which encompasses the Coyote Buttes. Critical habitat is located entirely in Utah around Coral Pink Sand Dunes State Park. As denoted with designated critical habitat, this species is found on open, sparsely vegetated semi-stabilized coral pink sand dunes, in sagebrush, juniper, pine and oak communities of the Great Basin desertscrub, at 1,700–1,900 m amsl (AGFD 2005b). Populations of Welsh's milkweed apparently are stable. It is known from four locations, with a total of approximately 20,000 aboveground stems (AGFD 2005b).

## SILER PINCUSHION CACTUS (*PEDIOCACTUS SILERI*)

Siler pincushion cactus occurs at several locations on the Kanab Plateau within the proposed withdrawal area (see Figure 3.8-1). Within the North Parcel, both the Johnson Spring and Moonshine Ridge ACECs (see Figure 3.6-1) were established in part to protect this cactus. Several of the known populations occur outside these two ACECs, including along BLM Road 5. The species is found exclusively on gypsiferous clay to sandy soils and appears to be strongly related to the Shnabkaib and middle red members of the Moenkopi Formation (BLM 2007). These soils are high in soluble salts.

Trend studies, first undertaken in the 1980s, demonstrate a relatively stable population with some fluctuations caused by precipitation and rodent depredations (BLM 2007). The species was downlisted to threatened in 1993 because it was later determined to be more abundant and widespread than was believed at the time of listing. Two mining claims are within the boundaries of known populations, and another 25 mining claims are within about 1,300 feet of known populations (Payne et al. 2010).

## JONES' CYCLADENIA (*CYCLADENIA HUMILIS* VAR. *JONESII*)

The species is not known to occur within the proposed withdrawal area. Although its range is mostly in Utah, the species occurs in Arizona a few miles north of the Kanab Plateau (see Figure 3.8-1), just west of the Kaibab Indian Reservation in Potter Canyon and an adjacent canyon. The Lone Butte ACEC (see Figure 3.6-1) was established in part to protect this plant. In Arizona, it is found on gypsiferous, saline soils of the Chinle Formation (BLM 2007).

The population in Arizona appears to be well protected from threats resulting from private land and rugged terrain, which limit access. Trend studies have been undertaken at two plots and have shown a stable population with some precipitation-related fluctuations (BLM 2007).

## FICKEISEN PLAINS CACTUS (*PEDIOCACTUS PEEBLESIANUS* VAR. *FICKEISENIAE*)

Fickeisen plains cactus occurs within the proposed withdrawal area (see Figure 3.8-1) (Forest Service 2009a). On the North Parcel, it occurs in areas between the canyon draining Kanab Creek, particularly on plateaus between Chamberlain, Hack, and Grama canyons, as well as along the Toroweap Road (BLM Road 109). On the East Parcel, the species occurs within the Marble Canyon ACEC, as well as along the western portion of House Rock Valley within and along the edge of Kaibab National Forest. The Coconino Rim portion of the Kaibab National Forest may contain habitat for the plant, but surveys of this habitat have not been conducted. It tends to occur in shallow soils derived from exposed layers of Kaibab Limestone (BLM 2007). After flowering and fruiting, the cactus retracts into the soil, making it difficult to locate. This cactus occurs in very small populations at several locations on the Arizona Strip.

Trend studies have been ongoing since the middle 1980s and show populations are relatively stable, with occasional fluctuations from precipitation and rodent depredation (BLM 2007). There are no mining claims within known Fickeisen plains cactus populations, but there are four claims within 1,300 feet of known plants (Payne et al. 2010).

## PARADINE (KAIBAB) PLAINS CACTUS (*PEDIOCACTUS PARADINEI*)

The species is found within the proposed withdrawal area (see Figure 3.8-1) (Forest Service 2009a). Management considerations for this species is addressed through a Conservation Agreement dated February 11, 1998, and signed by the Forest Service, BLM, and USFWS. It occurs in fairly open, mostly level sites on alluvial fans, valley bottoms, and ridge tops where plants are preferentially associated with grass (blue grama) (AGFD 1999). It prefers soils with coarse fragments in conjunction with the Kaibab Limestone Formation (BLM 2007).

Populations were reported as declining on both BLM and Forest Service land (BLM 2007). A.M. Phillips. III and others (Phillips et al. 2001) conducted surveys on the North Kaibab Ranger District in 1992–1994 and found a fairly substantial population of scattered individuals in pinyon-juniper woodland. Field surveys in 2000–2001 (Frey 2001; Phillips et al. 2001) showed an apparent sharp decrease in the numbers of cacti since 1994, probably as a result of conditions caused by a drought from 1998 to the summer of 2000. In 2010 after a wet winter, Frye, B.G. Phillips, and others observed abundant flowering and fruiting in the monitoring plots that have been inventoried for over 20 years; recruitment was evident in 2011. Other observations at various locations in the spring of 2011 revealed numerous cacti, including young and old plants, where they have not been seen in abundance for over 10 years.

## GIERISCH MALLOW (*SPHAERALCEA GIERISCHII*)

The species does not occur within any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County near the vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon (AGFD 2005c). Habitat includes warm desert shrub community, mainly on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation as well as on the Moenkopi Formation (AGFD 2005c). Population trends are unknown (AGFD 2005c).

## SAN FRANCISCO PEAKS GROUNDSEL (*PACKERA FRANCISCANA*)

The species does not occur within the proposed withdrawal area. This species is found in alpine tundra above southwestern spruce-fir or bristlecone pine (*Pinus aristata*) forests on talus slopes above 3,300 m (10,900 feet) amsl. The current range of this species includes San Francisco Peaks, Coconino County. Critical habitat has been established for this species and includes three alpine areas of Coconino National Forest (USFWS 2008).

### NAVAJO SEDGE (*CAREX SPECUICOLA*)

This species does not occur within the proposed withdrawal area. This species is endemic to the Navajo Nation, Coconino, Navajo, Apache counties in Arizona and San Juan County in Utah (AGFD 2005d). Within northern Arizona, this species is known to occur from the Navajo Creek drainage in Coconino County, east to the Tsegi Canyon Watershed and the east side of Shonto Wash south of Shonto in Navajo County, south to the Rock Point/Mexican Water and Canyon de Chelly National Monument, Apache County (AGFD 2005d).

### ARIZONA CLIFFROSE (*PURSHIA SUBINTEGRA*)

This species does not occur within the proposed withdrawal area. This species is endemic to Arizona. Within Arizona this species is found in Central Arizona near Horseshoe Lake, Maricopa County; near Cottonwood, Yavapai County; near Burro Creek, Mohave County; and near Bylas, Graham County (AGFD 2001a). Habitat includes rolling, rocky, limestone hills and slopes within Sonoran Desertscrub. This species requires white Tertiary (Miocene and Pliocene) limestone lakebed deposits high in lithium, nitrates, and magnesium (AGFD 2001a).

### ARIZONA BUGBANE (*CIMICIFUGA ARIZONICA*)

This species does not occur within the proposed withdrawal area. This species is endemic to Arizona (AGFD 2008a). Within Arizona this species is found in Central Arizona near Bill Williams Mountain (Kaibab National Forest), tributaries to Oak Creek, and West Clear Creek (Coconino National Forest), Coconino County; Workman Creek and Cold Springs Canyon in the Sierra Ancha Mountains (Tonto National Forest), Gila County (AGFD 2008a).

## *Animals*

### BLACK-FOOTED FERRET (*MUSTELA NIGRIPES*)

The species does not occur within the proposed withdrawal area. In Arizona, it has been reintroduced into the Aubrey Valley in Coconino County (AGFD 2001b), where there are currently two populations: an experimental, nonessential population [10(j) status]; and a fully protected population located approximately 10 miles southwest of the Kaibab National Forest (Figure 3.8-2). There are no known colonies of Gunnison's prairie dogs (*Cynomys gunnisoni*), their main prey species, on the Kaibab National Forest large enough to support black-footed ferrets (Forest Service 2009a). Habitat includes arid prairies, the same habitat used by prairie dogs, the principal food source of the species.

### HUALAPAI MEXICAN VOLE (*MICROTUS MEXICANUS HUALPAIENSIS*)

The species does not occur within the proposed withdrawal area and is endemic to Arizona. This species is known from Mohave County (Hualapai and Music Mountains, Grand Wash Cliffs, Wabayuma Peak vicinity, and upper Blue Tank Wash drainage), Coconino County (Prospect Valley, Laguna Valley, Aubrey Cliffs, Round Mountain, and Trinity Mountain), Yavapai County (Santa Maria and Santa Prieta mountains, and Walnut Creek vicinity, north of Bald Mountain) (AGFD 2003a). The Hualapai Mexican vole is primarily associated with woodland forest types containing grasses and grass-sedge associates and occurs in moist, grass-sedge habitats along permanent or semipermanent waters (such as springs or seeps), but may be able to occupy drier areas when grass/forb habitats are available, particularly during wetter years (AGFD 2003a). This species diet consists mainly of grasses, forbs, and other plants (AGFD 2003a).

## CALIFORNIA CONDOR (*GYMNOGYPS CALIFORNIANUS*)

As of March 31, 2011, there are a total of 196 condors in the wild population, 68 of them in Arizona. Birds have only been released at Vermilion Cliffs (no releases at Hurricane Cliffs). Breeding activity has occurred at the locations mentioned, but not all these nests have been successful. Lead contamination from hunter-killed carcasses continues to be a major factor affecting the reintroduction program (personal communication, Brenda Smith, USFWS 2011). Critical habitat for this species occurs in California only. A reintroduction program began on the BLM's Arizona Strip District in 1996, with release sites on both the Vermilion Cliffs and the Hurricane Cliffs. This reintroduced population has been designated experimental, non-essential, as defined under Section 10(j) of the ESA. For ESA Section 7 purposes, the species is treated as a proposed species on BLM and Forest Service lands and as a threatened species on NPS lands. As of July 2009, there were 180 free-flying condors, 75 of which are found in Arizona (Payne et al. 2010). This species is a carrion feeder, usually on mammalian carcasses. Foraging for carrion occurs over long distances, as a condor can travel 80 to 160 km (48–96 miles) per day in search of food (USFWS 2001). It is highly attracted to human activity. Condors have been documented having successful breeding in the vicinity of the Vermilion Cliffs and east side of the Kaibab Plateau and within the Grand Canyon (Figure 3.8-3). The designated experimental population area in Arizona includes portions of Apache, Coconino, Mohave, Navajo, and Yavapai counties (USFWS 2001). Condors' diet consists of large, terrestrial mammalian carcasses such as deer, goats, sheep, donkeys, horses, pigs, cougars, bears, or cattle. Alternatively, they may feed on the bodies of smaller mammals, such as rabbits or coyotes (USFWS 2001).

## SOUTHWESTERN WILLOW FLYCATCHER (*EMPIDONAX TRAILLII EXTIMUS*)

Southwestern willow flycatchers occur along the Colorado River in the Grand Canyon. The species is not known to occur in the proposed withdrawal area (Figure 3.8-4), and there is no critical habitat on the proposed withdrawal area (Figure 3.8-5). Critical habitat is located along the Virgin River and includes riparian areas dominated by native plants which can vary from single-species, single-layer patches to multi-species, multilayered strata with complex canopy and subcanopy structure. The southwestern willow flycatcher diet primarily consists of insects.

Habitat along Kanab Creek may be used during migration by flycatchers for resting and feeding. The BLM has identified two patches of suitable habitat along Kanab Creek (one at Clearwater Spring and the other 0.5 mile downstream from the spring) and several areas of potentially suitable habitat adjacent to Gunsight Point, but no willow flycatchers have been documented at any of these locations (BLM 2007). Willow-cottonwood habitat along Kanab Creek has been replaced largely by saltcedar which is also used by southwestern willow flycatchers. The Kanab Creek ACEC (see Figure 3.6-1), designated at 13,148 acres, was in part established for protection of the species (BLM 2008b).

Nesting sites have been identified in upper Grand Canyon near RMs 24, 28, 50, and 71 (Payne et al. 2010), as well as along the river corridor from Spencer Canyon/RM 246 (Payne et al. 2010) to Lake Mead National Recreation Area (RM 285.3) (McLeod et al. 2008). The locations of the canyon nesting areas are depicted in Figure 3.8.4.

The north-central limit of the breeding range for the species is southern Utah. Historically, it was recorded in southern Utah along the Virgin River (Phillips 1948; Wauer and Carter 1965), Colorado River and Kanab Creek (Behle 1985; Behle et al. 1958; Behle and Higgins 1959; Browning 1993), and perhaps the Paria River (BLM unpublished data, as cited in USFWS 2002b). Recent studies along the Virgin River in St. George have located resident and breeding individuals (Langridge and Sogge 1998; McLeod and Koronkiewicz 2010). According to the range-wide willow flycatcher database, Kanab Creek, in the town of Kanab, has been surveyed from 2000 to 2007, with two territories recorded in 2002 and none in other years (personal communication, S. Durst, USFWS 2010).

## YUMA CLAPPER RAIL (*RALLUS LONGIROSTRUS YUMANENSIS*)

Yuma clapper rail is not known to occur within the proposed withdrawal area. The Yuma clapper rail occurs within the Virgin River drainage above Lake Mead (personal communication, Brenda Smith, USFWS 2011). It may also occur along the Virgin and Muddy rivers in Nevada near Lake Mead. Large populations are present on Bill Williams River, the lower Gila River from near Phoenix to the Colorado River, and along the lower Salt and Verde rivers. It prefers the tallest, densest cattail and bulrush (*Scirpus* sp.) marshes available (AGFD 2006b). Yuma clapper rail primarily eats crustaceans and mollusks.

## MEXICAN SPOTTED OWL (*STRIX OCCIDENTALIS LUCIDA*)

There are no known Mexican spotted owl nesting records for any of the proposed withdrawal parcels; however, a portion of Kanab Creek, which has been included as critical habitat for this species, is located within the North Parcel. A total of 41 Protected Activity Centers (PACs) have been recorded in Grand Canyon National Park within the upper reaches of several large, steep-walled tributary side canyons (Payne et al. 2010). A PAC is delineated at known owl sites to encompass a minimum of 600 acres of the best nesting and roosting habitat at the site. One PAC, along Kanab Creek in Grand Canyon National Park, is immediately south of the Kanab Plateau, and numerous PACs in Grand Canyon National Park are immediately north of the Kaibab National Forest. Because of the proximity of known PACs and the fact that in Grand Canyon National Park the species forage in pinyon-juniper woodland and home ranges (n = 5 adult males) were larger than the PAC sizes recommended in the Recovery Plan (Bowden 2008), the species is considered likely to occur on all of the proposed withdrawal parcels while foraging or during post-nesting dispersal. According to Payne et al. (2010), the Grand Canyon National Park population may serve a critical role in connecting populations via juvenile dispersal. Based on habitat modeling in the canyon, the Park originally estimated that another 40 potential PACs could possibly be delineated. Most of those potential territories would probably be found in the lower gorge west of Powell Plateau.

Mexican spotted owl critical habitat includes dense old growth mixed-conifer forests located on steep slopes, especially deep, shady ravines (AGFD 2005e). These sites have high canopy closure, high basal area, many snags, and many downed logs. For foraging, multistoried forest with many potential patches is desirable. Mexican spotted owls nest and roost primarily in closed-canopy forests or rocky canyons. In the northern portion of the range (southern Utah and Colorado), most nests are in caves or on cliff ledges in steep-walled canyons (AGFD 2005e). The owl's diet consists of rodents, birds, lizards, insects, and occasionally bats (AGFD 2005e).

In the Colorado Plateau Recovery Unit, the ponderosa pine and pine-oak habitat are not considered nesting habitat for the species; only the mixed-conifer and riparian habitat types are considered nesting or roosting habitat, according to the *Mexican Spotted Owl Recovery Plan* (USFWS 1995a). The Forest Service has informed the BLM that there is no mixed-conifer habitat on the South Parcel. However, the USFWS considers the forested "canyon-like" habitat in the northeastern portion of the North Kaibab Ranger District to be potential nesting habitat unless surveys demonstrate otherwise. On the Kanab Plateau, there are 9,600 acres of designated critical habitat in the North Parcel (within Grama, Hack, Chamberlain, and Water canyons). The BLM considers upper Kanab Creek and the Hack Canyon area (including Grama, Water, and Chamberlain canyons) to be occupied, high-priority areas for the species (BLM 2008b:Appendix A). This determination is based entirely on the presence of habitat components; the area has not been surveyed. This habitat is within Critical Habitat Unit CP-10, which includes portions of the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park (see Figure 3.8-5) (USFWS 2004).

The southeast corner of the Kanab Plateau is within Critical Habitat Unit CP-10, which includes portions of the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park (see Figure 3.8-5) (USFWS 2004). All three proposed withdrawal parcels are within the Colorado Plateau Recovery Unit, one of six recovery units recognized in the United States (USFWS 1995a). The Colorado Plateau Recovery Unit coincides with the Colorado Plateau physiographic province and includes most of south-central and southern Utah, plus portions of northern Arizona, northwestern New Mexico, and southwestern Colorado.

## YELLOW-BILLED CUCKOO (*COCCYZUS AMERICANUS OCCIDENTALIS*)

There are no yellow-billed cuckoo nesting records from within the proposed withdrawal area, but cuckoos have been recorded in Grand Canyon National Park (Payne et al. 2010) and may occur along Kanab Creek on the Kanab Plateau. The breeding range of the species is currently restricted to southern and central Arizona and the extreme northeast corner of the state (AGFD 2002a; Corman 2005). It has been observed in the Arizona Strip in the cottonwood/willow galleries at the confluence of Beaver Dam Wash and the Virgin River (BLM 2007). In Arizona, the species prefers streamside cottonwood, willow groves, and larger mesquite bosques for migrating and breeding (AGFD 2002a). Yellow-billed cuckoos feed almost entirely on large insects that they glean from tree and shrub foliage. They feed primarily on caterpillars, including tent caterpillars. They also feed frequently on grasshoppers, cicadas, beetles, and katydids, occasionally on lizards, frogs, and eggs of other birds, and rarely on berries and fruits.

## CALIFORNIA LEAST TERN (*STERNA ANTILLARUM BROWNI*)

There are no occurrences of California least tern within the proposed withdrawal area, and the proposed withdrawal area does not fall within designated critical habitat for this species. The California least tern is primarily a resident of California but may occur in different parts of Arizona where habitat components are adequate for nesting or feeding such as large lakes, recharge basins, or wetland areas (USFWS 2009a). Breeding has been documented in Maricopa County. Transient migrants occur more frequently and have recently been documented in Mohave and Pima counties. This species forms nesting colonies on barren to sparsely vegetated areas and in shallow depressions on open sandy beaches, sandbars, gravel pits, or exposed flats along shorelines of inland rivers, lakes, reservoirs, and drainage systems (USFWS 2009a). The California least tern is diet is primarily a fish-eater, feeding in shallow waters of rivers, streams, and lakes (USFWS 2009a).

## DESERT TORTOISE (*GOPHERUS AGASSIZII*) (MOJAVE POPULATION)

The proposed withdrawal area does not include desert tortoise habitat and does not fall within designated critical habitat for the species. There are no occurrences of desert tortoise within the proposed withdrawal area. In Arizona, tortoises and critical habitat are located north of the Colorado River, approximately 40 miles west of the North Parcel (see Figure 3.8-5). The Arizona Strip is within the Northeast Mojave Recovery Unit and includes two areas of critical habitat for the species: one along the western slope of the Beaver Dam Mountains (Beaver Dam Slope), the other along the northern slope of the Virgin Mountains (Gold Butte-Pakoon) (BLM 2007). Habitat for the species includes sandy 13 loam and rocky soils in valleys, bajadas, and rocky slopes and hills in the Mojave Desert at elevations ranging from 500 to 5,100 feet amsl (BLM 2007). The desert tortoise is an herbivore. Desert annuals, particularly forbs, are the primary food source for Mojave desert tortoise, and grasses are considered to be secondary in importance (Ernst and Lovich 2009).

## DESERT TORTOISE (*GOPHERUS AGASSIZII*) (SONORAN POPULATION)

The Sonoran desert tortoise does not occur within the proposed withdrawal area. The distribution in the United States is considered to be east and south of the Colorado River, extending south and east from northwestern Mohave County (near Perce Ferry) in Arizona, and covers roughly the western portion of the state (AGFD 2001c). The distribution in the United States is likely bounded to the northeast and east by habitat changes imposed by the Mogollon Rim. Habitat consists primarily of rocky slopes and bajadas of the Mojave and Sonoran desertscrub vegetation communities (AGFD 2001c). The desert tortoise is an herbivore. Grasses form the bulk of its diet, but it also eats herbs, annual wildflowers, and new growth of cacti, as well as their fruit and flowers (AGFD 2001c).

## RELICT LEOPARD FROG (*LITHOBATES* [RANA] *ONCA*)

The species does not occur within the proposed withdrawal area. In Arizona, extant populations apparently are restricted to two general areas: Surprise Canyon in lower Grand Canyon National Park and Sycamore Spring, both in Mohave County (USFWS 2009b). However, according to USFWS (personal communication, Brian Wooldridge, U.S. Fish and Wildlife Service 2009), the frogs in Surprise Canyon originally thought to be this species are actually lowland leopard frogs (*Rana yavapaiensis*). Relict leopard frog was introduced to Sycamore Spring in 2003. It also is present in Nevada at springs near the Overton Arm of Lake Mead and springs in Black Canyon below Hoover Dam (USFWS 2009b). No relict leopard frogs are known from BLM lands on the Arizona Strip (BLM 2007). A historic population was found at a privately owned spring adjacent to the Virgin River at Littlefield, Arizona, but that population has since been extirpated (BLM 2007). Adult frogs inhabit permanent streams, springs, and spring-fed wetlands below approximately 2,000 feet amsl (USFWS 2009b). Relict leopard frog presumably feed on a wide variety of invertebrates (USFWS 2009b).

In August 2009, 17 springs in Grand Canyon National Park considered at risk from uranium extraction activities were sampled for relict leopard frogs and other aquatic organisms by USGS and NPS personnel (Museum of Northern Arizona 2009). Relict leopard frogs were not found during this survey.

## CHIRICAHUA LEOPARD FROG (*LITHOBATES* [RANA] *CHIRICAHUENSIS)*

This species does not occur within the proposed withdrawal area. This species inhabits mountain regions of central and southeastern Arizona, southwestern New Mexico, south in the Sierra Madre Occidental to Western Jalisco, Mexico, from 1,066–2,408 m (3,500–7,900 feet) amsl (AGFD 2006c). Within Arizona, this species' range is divided into two areas. The first (northern population) extends from montane central Arizona east and south along the Mogollon Rim to montane parts of west-southwestern New Mexico. The second is located in the mountains and valleys south of the Gila River in southeastern Arizona and southwestern New Mexico and extends into Mexico (adjacent Sonora) along the eastern slopes of the Sierra Madre Occidental (AGFD 2006c). The primary habitat type of Chiricahua leopard frog is oak, mixed oak, and pine woodlands. Other habitat types range into areas of chaparral, grassland, and even desert.

Chiricahua leopard frogs are habitat generalists that live and breed in lentic and lotic habitats in natural and man-made systems (AGFD 2006c). The Chiricahua leopard frog presumably feeds on a wide variety of invertebrates as well as some small vertebrates (including juveniles of their own kind) (AGFD 2006c).

## NORTHERN MEXICO GARTERSNAKE (*THAMNOPHIS EQUES MEGALOPS*)

This species does not occur within the proposed withdrawal area. Northern Mexico gartersnake ranges from southeastern Arizona and extreme southwestern New Mexico, southward into the highlands of western and southern Mexico, to Oaxaca (AGFD 2001d). Within Arizona, this species occurs in the southeast corner of state from the Santa Cruz Valley east and generally south of the Gila River. Recent valid records (post 1980) occur from the San Rafael and Sonoita grasslands area and from Arivaca. It is also known from the Agua Fria River, Oak Creek, the Verde River, and from several upper Salt/Black River sites, including smaller tributaries (AGFD 2001d). The gartersnake eats frogs, toads, fish, lizards, and small mammals (AGFD 2001d).

## HUMPBACK CHUB (*GILA CYPHA*)

Humpback chub does not occur within the proposed withdrawal area, and there is no critical habitat for the species within the proposed withdrawal area; however, the Colorado River, which is adjacent to the proposed withdrawal area, has been designated critical habitat. Humpback chubs feed predominantly on small aquatic insects, diatoms and filamentous algae. According to USFWS biologist Glen Knowles (personal communication 2009), this species occurs in the lower 12 miles of the Little Colorado River, and from about RMs 30 to 240 in the main stem Colorado River; the vast majority of fish, however, are located in the lower 9 miles of the Little Colorado River and in the reach of the Colorado River around the Little Colorado River, from RMs 56 to 67 below Parker Dam and from the Paria River to Hoover Dam. Included in the critical habitat designation is the main stem Colorado River from the confluence of the Paria River to Hoover Dam, including Lake Mead, Lake Mohave, and Colorado River below Parker Dam. Critical habitat includes portions of the Colorado, Green, and Yampa rivers in the Upper Basin and the Colorado and Little Colorado rivers in the Lower Basin in Colorado, Utah, and Arizona (USFWS 2002a). Critical habitat relative to the proposed withdrawal area is depicted in Figure 3.8-5. According to NPS biologist Brian Healy (personal communication 2010), NPS is currently working on several translocation projects within the Grand Canyon. To date, Shinamu Creek has had two translocation efforts, with about 300 fish being released. Feasibility studies are underway to potentially translocate humpback chub to Bright Angel Creek and Havasu Creek, and long-range planning could translocate populations of humpback chub in Kanab Creek in later phases.

## RAZORBACK SUCKER (*XYRAUCHEN TEXANUS*)

Razorback sucker does not occur within the proposed withdrawal area, and there is no critical habitat designated on any of the proposed withdrawal parcels. Currently, natural adult populations occur only in Lakes Mohave, Mead, and Havasu (AGFD 2002b). Critical habitat includes parts of the Yampa, Greene, Duchesne, White, Colorado, San Juan, Gila, Salt, and Verde rivers (USFWS 2009c). Included in the designation are Lake Mohave, Lake Mead, and the Colorado River below Parker Dam (see Figure 3.8-5). This species uses a variety of habitat types from main stem channels to slow backwaters of medium-sized and large streams and rivers, sometimes around cover (AGFD 2002b). Recent data indicate that razorback suckers have been found upstream of Lake Mead in the main stem of the Colorado River (personal communication, Pam Sponholtz, USFWS 2010). These records are important because they open up the possibility of razorback suckers’ being found throughout the Colorado River, especially during the time frame of this proposed withdrawal. The USFWS considered the Colorado River occupied habitat.

Historical records from the Grand Canyon through 1990, as reported by Minckley et al. (1991), are Bright Angel Creek, 1944 (one fish); Lees Ferry, 1963 (one fish); Paria River, 1978 (one fish); Paria River, 1979 (three fish); Bass Rapid, 1986 (one fish; photographed); Bright Angel Creek, 1987 (three fish); and mouth of the Little Colorado River, 1989 and 1990 (three fish each year).

All recent records of the species are from the Little Colorado River. According to the Grand Canyon Monitoring and Research Center database, which includes records through 2006, there are several records from the Little Colorado from 1989 through 1995. The diet of this species generally is composed of insects and planktonic food sources.

## VIRGIN RIVER CHUB (*GILA SEMINUDA*)

The species does not occur within any of the proposed withdrawal parcels, and there is no critical habitat on any of the proposed withdrawal parcels (see Figure 3.8-5). It occurs in the Moapa River in Nevada and the main stem Virgin River in Arizona, Utah, and Nevada from Pah Tempe Springs downstream to the Mesquite Diversion in extreme northwestern Arizona (Mohave County) (USFWS 2009d). Only the Virgin River population is listed. Critical habitat includes the main stem Virgin River and its 100-year floodplain, extending from the confluence of La Verkin Creek, Utah, to Halfway Wash, Nevada (USFWS 2000). Habitat is deeper areas where waters are swift but not turbulent, generally where there are boulders or other cover (USFWS 2009d). The status of this fish is not well known at the present time, but it is likely to still occupy segments of the Virgin River. Virgin River chub are opportunistic feeders, consuming zooplankton, aquatic insect larvae, other invertebrates, debris, and algae.

## WOUNDFIN (*PLAGOPTERUS ARGENTISSIMUS*)

Woundfin does not occur within the proposed withdrawal area, and there is no critical habitat in any of the proposed withdrawal parcels (see Figure 3.8-5). Critical habitat is identical to the designation for the Virgin River chub (USFWS 2000). Woundfin has been extirpated from almost all of its historical range, except the main stem Virgin River from Pah Tempe Springs to Lake Mead in northwestern Arizona (Mohave County) (USFWS 2009e). Habitat is shallow, warm, turbid, fast-flowing water (USFWS 2009e). Numbers are thought to be low in the Arizona portion of the Virgin River as a result of competition with introduced species for resources and the absence of suitable habitat features (BLM 2007). Woundfin diets are quite varied and consist mainly of insects, insect larvae, other invertebrates, algae, and detritus.

## APACHE TROUT (*ONCORHYNCUS GILAE APACHE*)

The species does not occur within the proposed withdrawal area. The natural range is the headwater streams of the Salt (Black and White rivers), Little Colorado, and Blue rivers in the White Mountains of east-central Arizona (AGFD 2001e). It has been introduced and has become established outside its natural range in the Pinaleño Mountains, Coronado National Forest, and North Kaibab Ranger District of the Kaibab National Forest along North Canyon Creek (AGFD 2001e). In North Canyon Creek, records are all within the Saddle Mountain Wilderness (personal communication, Angela Gatto, Forest Service 2009). The Apache trout’s diet consists of both terrestrial and aquatic insects.

## LITTLE COLORADO SPINEDACE (*LEPIDOMEDA VITTATA*)

The species does not occur within the proposed withdrawal area and is endemic to the Little Colorado River and its north-flowing tributaries, including the Arizona counties of Coconino, Navajo, and Apache (AGFD 2001f). Historical distribution is similar to the current distribution but may have occurred in the Zuni River watershed south of Gallup, New Mexico (AGFD 2001f). This species appears to be quite capable of tolerating relatively harsh environments that undergo dramatic fluctuations in pH, dissolved gases, and water temperature. Predation occurs mainly from rainbow trout (*Oncorhynchus mykiss*) and green sunfish (*Lepomis cyanellus*) (AGFD 2001f). The diet of Little Colorado River spinedace varies seasonally and consists primarily of aquatic and terrestrial insects.

## BONYTAIL CHUB (*GILA ELEGANS*)

The species does not occur within the proposed withdrawal area. This species was once widely distributed throughout the Colorado River and its main tributaries, which include the Green River in Utah and Wyoming and the Colorado, Gila, Salt, and Verde rivers in Arizona (AGFD 2001g). Currently found only in isolated populations in the Yampa, Green, and Colorado rivers at the Colorado–Utah border and at the confluence of the Green and Colorado rivers. In the lower basin, found only in Lake Mohave with possible individuals between Parker and Davis dams. Critical habitat was established for bonytail chub in March, 1994 (AGFD 2001g), designating portions of the Colorado, Green, and Yampa rivers in the upper basin and the Colorado River from Hoover to Parker dams (including Lake Mohave and Lake Havasu) (AGFD 2001g). Bonytail chub are opportunistic feeders, eating insects, zooplankton, algae, and higher plant matter.

### ROUNDTAIL CHUB (*GILA ROBUSTA*)

This species does not occur within the proposed withdrawal area. Roundtail chubs are known from larger tributaries of the Colorado Basin from Wyoming south to Arizona and New Mexico, as well as the Rio Yaqui south to Rio Piaxtla, northwestern Mexico (AGFD 2002c). Within Arizona, this species currently occurs in two tributaries of the Little Colorado River (Chevelon and East Clear Creeks); several tributaries of the Bill Williams River basin (Boulder, Burro, Conger, Francis, Kirkland, Sycamore, Trout, and Wilder Creeks); the Salt River and four of its tributaries (Ash Creek, Black River, Cherry Creek and Salome Creek); the Verde River and five of its tributaries (Fossil, Oak, Roundtree Canyon, West Clear, and Wet Beaver Creeks); Aravaipa Creek (a tributary of the San Pedro River); and Eagle Creek (a tributary of the Gila River) (AGFD 2002c). Roundtail chub eat terrestrial and aquatic insects, mollusks, other invertebrates, fishes, and algae.

### VIRGIN SPINEDACE (*LEPIDOMEDA MOLLISPINIS MOLLISPINIS*)

This species does not occur within the proposed withdrawal area. Virgin spinedace is endemic to the Virgin River and its tributaries in Utah, Nevada, and Arizona (AGFD 2001h). Within Arizona, it is found in Mohave County, lower Beaver Dam Wash to its confluence with the Virgin River at Littlefield, Arizona. Historically present in the Virgin River from the Utah border to Littlefield, primarily in conjunction with clear water inflows of perennial tributaries (AGFD 2001h). Major factors affecting Virgin spinedace are water diversion, impoundment, channelization, degradation of water quality, and introduced species, both fishes and crayfish (AGFD 2001h). A Conservation Agreement between the USFWS, Utah Division of Wildlife Resources, Washington County Water Conservancy District, and others was finalized in 1995. The plan focuses on reducing threats to the Virgin spinedace and enhancing and/or stabilizing instream flow in specific reaches of occupied and unoccupied habitat. Virgin spinedace are opportunistic feeders, eating insects, insect larvae, other invertebrates, and plant matter.

### KANAB AMBERSNAIL (*OXYLOMA HAYDENI KANABENSIS*)

Kanab ambersnail does not occur within any of the proposed withdrawal parcels. There are two populations in Arizona: Vasey’s Paradise and Elves Chasm, both in Grand Canyon National Park (see Figure 3.8-4). There also are two populations in Utah along Kanab Creek (AGFD 2001j). The snails at Elves Chasm were introduced by AGFD. Vasey’s Paradise is a naturally occurring population located approximately 32 miles downstream of Lees Ferry (USFWS 1995b), just south of House Rock Valley. Preliminary estimates indicated a population of about 16,000 individuals at this site (USFWS 1995b). In August 2009, 15 springs (including Vasey’s Paradise) in Grand Canyon National Park were sampled for Kanab ambersnails by USGS and NPS personnel (Museum of Northern Arizona 2009). Kanab ambersnail was found at Vasey’s Paradise, but no Kanab or other *Oxyloma* ambersnail shells or live individuals were found at any of the other springs visited. The snail also occurs at two wetlands located about 1.3 miles apart near the Arizona border in Kane County, Utah: Three Lakes Canyon and Kanab Creek Canyon (USFWS 1995b). Survey records from approximately 10 years ago indicate that one of the two Kanab Creek populations may be lost, apparently from cattle grazing (AGFD 2001j). Habitat is marshes watered by springs and seeps at the base of sandstone cliffs or limestone at approximately 3,200 feet amsl (AGFD 2001j).

## 3.8.2 Bureau of Land Management Sensitive Species

The BLM Sensitive species are listed in Table 3.8-3. All federal candidate species are considered and managed as BLM sensitive species (BLM 2010). Information on species trends is included with the individual species accounts when available.

In addition to BLM Sensitive species, Table 3.8-3 also contains species that the Forest Service and NPS also consider Sensitive or MIS, which means some species are listed by multiple agencies. These species are addressed only once and not repeated in Sections 3.8.3 or 3.8.4. Species included on both Forest Service and BLM sensitive species lists include Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*), western burrowing owl (*Athene cunicularia hypugea*), bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrines anatum*), northern goshawk (*Accipiter gentilisatricapillus*), northern leopard frog (*Lithobates* [Rana] *pipiens*), and lowland leopard frog (*Lithobates* [Rana] *yavapaiensis*). Species included on BLM, Forest Service and NPS sensitive species lists include greater western mastiff bat (*Eumops perotis californicus*), spotted bat (*Euderma maculatum*), Allen's lappet-browed bat (*Idionycteris phyllotis*) and pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*). Species included on both BLM and NPS sensitive species lists include Grand Canyon rose (*Rosa stellata* var. *abyssa*), flannelmouth sucker (*Catostomus latipinnis*), desert sucker (*Catostomus* [Pantosteus] *clarki*) and Mexican long-tongued bat (*Choeronycteris Mexicana*).

**Table 3.8-3.** BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Plants** | | | | |
| Mt. Trumbull beardtongue (*Penstemon distans*) | BLM S | No | No | No |
| Grand Canyon rose (*Rosa stellata* ssp. *abyssa*) | BLM S<br>NPS SC | Yes | No | Possible* |
| Marble Canyon milkvetch (*Astragalus cremnohylax* var. *hevronii*) | BLM S | No | Yes | No |
| Paria Plateau fishhook cactus (*Sclerocactus sileri*) | BLM S | No | Yes | No |
| September 11 stickleaf (*Mentzelia memorabilis*) | BLM S | No | No | No |
| Silverleaf sunray (*Enceliopsis argophylla*) | BLM S | No | No | No |
| Sticky wild buckwheat (*Eriogonum viscidulum*) | BLM S | No | No | No |
| Pipe Springs cryptantha (*Cryptantha semiglabra*) | BLM S | Possible | No | No |
| Marble Canyon indigo bush (*Astragalus cremnophlax* var. *hevronii*) | BLM S | No | Possible | No |
| Toana milkvetch/Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*) | BLM S | Possible | No | No |
| Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus* | BLM S | No | No | No |
| **Animals** | | | | |
| Allen's lappet-browed bat (*Idionycteris phyllotis*) | BLM S<br>Forest Service S<br>NPS SC | Yes | Yes | Possible |
| Northern leopard frog (*Lithobates* [Rana] *pipiens*) | BLM<br>Forest Service S | Possible | Possible | No |

**Table 3.8-3.** BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Animals, continued** | | | | |
| Lowland leopard frog<br>*(Lithobates* [Rana] *yavapaiensis)* | BLM S<br>Forest Service S | Possible | No | No |
| Bald eagle<br>(*Haliaeetus leucocephalus*) | BLM S<br>Forest Service S | Yes | Yes | Yes |
| American peregrine falcon<br>(*Falco peregrinus anatum*) | BLM S<br>Forest Service S | Yes | Possible | Possible |
| Northern goshawk<br>(*Accipiter gentilis atricapillus*) | BLM S | Possible | Possible | Yes |
| Townsend’s big-eared bat<br>(*Corynorhinus townsendii*) | BLM S | Yes | Yes | Yes |
| Arizona myotis<br>(*Myotis occultus*) | BLM S | Possible | Possible | Possible |
| Spotted bat<br>(*Euderma maculatum*) | BLM S | Yes | Yes | Yes |
| Greater western mastiff bat<br>(*Eumops perotis californicus*) | BLM S | Possible | Possible | Possible |
| Mexican long-tongued bat<br>(*Choeronycteris mexicana*) | BLM S | Possible | Possible | Possible |
| Gunnison’s prairie dog<br>(*Cynomys gunnisoni*) | BLM S | No | No | Possible |
| Houserock Valley chisel-toothed kangaroo rat<br>(*Dipodomys microps leucotis*) | BLM S<br>Forest Service S | No | Yes | No |
| Western burrowing owl<br>(*Athene cunicularia hypugea*) | BLM S<br>Forest Service S | Yes | Yes | No |
| Ferriginous Hawk (*Buteo regalis*) | BLM S | Possible | Possible | Possible |
| Golden Eagle (*Aquila chrysoides*) | BLM S | Yes | Yes | Possible |
| Pinyon jay (*Gymnorhinus cyanocephalus*) | BLM S | Yes | Yes | Yes |
| Flannelmouth sucker<br>(*Catostomus latipinnis*) | BLM S<br>NPS SC | No | No | No |
| Desert sucker<br>(*Catostomus* [Pantosteus] *clarki*) | BLM S<br>NPS SC | No | No | No |
| Speckled dace<br>(*Rhinichthys osculus*) | BLM S | Possible | No | No |
| Bluehead sucker<br>(*Catostomus discobolus)* | BLM S | Yes | Yes | Yes |
| Hydrobiid spring snails<br>Grand Wash springsnail<br>(*Pyrgulopsis bacchus*)<br>Desert springsnail<br>(*Pyrgulopsis deserta*) | BLM S | No | No | No |
| Succineid snails (F. Succineidae),<br>Niobrara ambersnail<br>(*Oxyloma haydeni haydeni*) | BLM S | No | No | No |

Notes:

BLM
S = Sensitive: those taxa occurring on BLM Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service
S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)
SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

* Based on Forest Service (2009a).

## *Plants*

### MT. TRUMBULL BEARDTONGUE (*PENSTEMON DISTANS*)

Mt. Trumbull beardtongue does not occur within the proposed withdrawal area; however, it is known to occur approximately 20 miles southwest of the Kanab Plateau (see Figure 3.8-1). It is found at the southeastern edge of the Shivwits Plateau in Whitmore, Parashant, and Andrus canyons (AGFD 2001k). The species tends to be widely scattered in isolated populations that seem to be restricted to the relatively cool, moist microhabitats on north- and east-facing slopes of the Kaibab and Toroweap limestone formations (BLM 2007).

Population trends are unknown but apparently stable (AGFD 2001jk). The BLM initiated trend studies in 1987 and 1989 at two locations in Grand Canyon-Parashant National Monument (BLM 2007). By 1997, a large plot of 49 plants had increased in number to 80. The smaller count plot started with 21 plants in 1987, decreased to six in 1992, and increased to nine plants in 1997.

### GRAND CANYON ROSE (*ROSA STELLATA* SSP. *ABYSSA*)

This species is listed by both the BLM and NPS. The species occurs within the proposed withdrawal area (see Figure 3.8-1). It also occurs along the rim (mainly North Rim, Twin Point) of the Grand Canyon and at the junction of the Little Colorado River and Big Canyon (AGFD 2005f). All known populations are in the Timoweap member of the Moenkopi Formation, on or near canyon rims or the tops of cliffs at the edges of mesas or plateaus, as well as along low ledges at depressions caused by breccia pipes (BLM 2007; Brian 2000). The Kanab Canyon population is decreasing; trends at Twin Point are unknown (AGFD 2005f).

### TOANA MILKVETCH/DIAMOND BUTTE MILKVETCH (*ASTRAGALUS TOANUS* VAR. *SCIDULUS*)

The species is found outside the proposed withdrawal area approximately 10 miles west of the Kanab Plateau (see Figure 3.8-1). It is known only from the bases of Diamond Butte and Twin Buttes, where it grows on small outwash fans by small mesas on alluvium overlying the Shnabkaib member of the Moenkopi Formation (BLM 2007).

Population trends are unknown. Less than 12 plants were first discovered in 1999 at two Arizona Strip sites (BLM 2007). These sites have been subsequently monitored, but no plants have been located.

### MARBLE CANYON MILKVETCH (*ASTRAGALUS CREMNOHYLAX* VAR. *HEVRONII*)

The plant is found on the eastern edge of House Rock Valley (see Figure 3.8-1). It is endemic to the rim of Marble Canyon, where it occurs south of Shinumo Wash, north to Sheep Springs Wash (AGFD 2005g). Marble Canyon milkvetch occurs on rim-rock benches at the canyon edge in crevices and depressions with shallow soils on Kaibab Limestone at approximately 5,420 feet amsl (Arizona Rare Plant Committee 2001). Population trends are unknown (AGFD 2005g). In 1997, six sites with about 265 plants were located.

### PARIA PLATEAU FISHHOOK CACTUS (*SCLEROCACTUS SILERI*)

The species occurs in House Rock Valley (East Parcel) and the Paria Plateau (north of the East Parcel) (Arizona Rare Plant Committee 2001). Habitat is sandstone to sandy soil of the Moenave, Chinle, and Navajo formations, where it grows on pinyon-juniper mesa tops at 5,000 to 6,300 feet amsl (Arizona Rare

Plant Committee 2001). Population trends are not well known (AGFD 2003b). This plant is difficult to locate in the field; it appears to be quite rare.

## SEPTEMBER 11 STICKLEAF (*MENTZELIA MEMORABILIS*)

The species is found outside the proposed withdrawal area on the adjacent west lands (the Kanab Plateau) (see Figure 3.8-1). It is an Arizona endemic in northern Mohave County, in the Clayhole Wash drainage between Colorado City and Mount Trumbull (AGFD 2006d). September 11 stickleaf grows on dry gypsum-clay outcrops with sparse vegetation between 4,689 and 5,197 feet amsl (AGFD 2006d). Population trends are unknown (AGFD 2006d).

## SILVERLEAF SUNRAY (*ENCELIOPSIS ARGOPHYLLA*)

Silverleaf sunray is found outside the proposed withdrawal area on the adjacent west lands (the Kanab Plateau). It is found in Mohave County in the vicinity of Lake Mead, the Grapevine Mesa area, below Hurricane Cliffs, south of Hoover Dam, the Boulder Dam area, the Gyp Hills area, and east of Littlefield (AGFD 2005h). Habitat consists of warm desert shrub communities on dry clay and gypsum slopes and in sandy washes (AGFD 2005h). Population trends are unknown (AGFD 2005h).

## STICKY WILD BUCKWHEAT (*ERIOGONUM VISCIDULUM*)

The species does not occur within any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County (see Figure 3.8-1), north of the Virgin River (AGFD 2005i). Habitat includes low dunes, washes, and sandy flats and slopes in saltbush and creosote bush communities in Mohave Desertscrub (AGFD 2005i). Population trends are unknown (AGFD 2005i). There are reports of 29 occurrences in Nevada, with a total estimated population of at least 29,000 individuals.

## PIPE SPRINGS CRYPTANTHA (*CRYPTANTHA SEMIGLABRA*)

The species is found outside the proposed withdrawal area north of the Kanab Plateau in extreme northwestern Coconino County and adjacent extreme northeastern Mohave County, in the area surrounding the town of Fredonia, Arizona (AGFD 2004a). All known localities are within 7 miles of Fredonia, and the type location is 2 miles east of Fredonia. It is found in the arid red detrital clay soils and gray shales of the Moenkopi Formation in the Great Basin Desertscrub biotic community at elevations ranging from 4,600 to 4,900 feet amsl (AGFD 2004a). Trends in populations are unknown (AGFD 2004a). This species appears to be tolerant of disturbance. A positive 90-day finding was published in the *Federal Register* (74[158]:41649–41662) for the Pipe Springs cryptantha and a 12-month status review to determine whether or not to federally list the species will be published in the future.

## MARBLE CANYON INDIGO BUSH (*PSOROTHAMNUS ARBORESCENS VAR. PUBESCENS*)

The species is found outside the proposed withdrawal area but located on adjacent lands in the vicinity of Marble Canyon (Roth 2008). Marble Canyon indigo bush is endemic to Northern Coconino County, Arizona, in the vicinity of Marble Canyon and on the Navajo Nation (Roth 2008). This species is located on soils derived from the Moenkopi Formation in mixed desert shrub communities between 3,400 and 4,900 feet (Roth 2008).

## THREE-CORNERED MILKVETCH (*ASTRAGALUS GEYERI VAR. TRIQUETRUS*)

The species is found outside the proposed withdrawal area in northwestern Mohave County, Arizona. The total range of this species is northwestern Arizona and southeastern Nevada (AGFD 2004f). This species is an ephemeral annual that is not seen for years at a time and prefers average to above-average rainfall years to germinate (AGFD 2004f). This species is limited to washes and small pockets of wind-deposited sand, of the creosote bush scrub series, with sandy soils formed from sedimentary formations adjacent to Lake Mead and its tributary valleys (AGFD 2004f). Within Arizona, this species is known from Sand Hollow Wash, Horsethief Canyon, and Beaver Dam Wash, Mohave County and located within an elevation from 2,000 and 2,395 ft (AGFD 2004f).

## Animals

### ALLEN'S LAPPET-BROWED BAT (*IDIONYCTERIS PHYLLOTIS*)

This species is included on the BLM, Forest Service, and NPS species lists. This insectivorous bat species has been recorded within the Kanab Plateau and House Rock Valley (AGFD 2010a). It is considered likely to occur on the Kaibab National Forest. Population status along the Colorado River corridor is unknown, but individuals have been observed and collected in the river corridor in Grand Canyon National Park (Payne et al. 2010). Most Arizona specimens have been taken from the southern Colorado Plateau, the Mogollon Rim, and adjacent mountain ranges (AGFD 2001g). In Arizona, it has been taken most often in ponderosa pine, pinyon-juniper woodland, and riparian areas with sycamores, cottonwoods, and willows (AGFD 2001g). Population trends are very poorly known (AGFD 2001g).

### ARIZONA MYOTIS (*MYOTIS OCCULTUS*)

This insectivorous bat species is known to occur in Northern Arizona. Arizona distribution records do not contain information regarding whether this species is known to occur within the proposed withdrawal area (AGFD 2011). The total range for this species includes southern California, Arizona, New Mexico, and Colorado, south to Mexico and possibly into west Texas (AGFD 2011). This species has been observed at higher elevations in Apache, Coconino, Cochise, Gila, Greenlee, Mohave, Navajo, and Yavapai counties. Their elevation ranges from 3,200 to 8,620 feet; there are also records from much lower elevations between 150 and 1,000 feet along the lower Colorado River (AGFD 2011).The AGFD suggests this species may use manmade structures for roosting, but based on radio tracking studies performed in northern Arizona, maternity colonies were frequently observed in large ponderosa pine snags. They may use tree cavities, mines, or possibly caves for winter hibernation (AGFD 2011).

### GREATER WESTERN MASTIFF BAT (*EUMOPS PEROTIS CALIFORNICUS*)

The insectivorous bat species is known to occur on adjacent lands to the proposed withdrawal area (AGFD 2010a). It is considered likely to occur on the South Parcel. It has been recorded in Grand Canyon National Park (Payne et al. 2010); sonograms recorded at Point Sublime on the North Rim of the Grand Canyon were verified by D. Pearson (AGFD 2002d). In Arizona, where it is considered a year-round resident, the species been found in all Arizona counties except Yavapai, Navajo, Apache, and Santa Cruz (AGFD 2002d). Habitat includes lower and upper Sonoran Desertscrub vegetation zones near cliffs, where it prefers rugged, rocky canyons with abundant crevices (AGFD 2002d). Population trends are poorly known (AGFD 2002d).

### SPOTTED BAT (*EUDERMA MACULATUM*)

The insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 2008a, 2009c). The Kaibab National Forest records are from the Camp 36 Tank (Forest Service 2008a, 2009c). It has been recorded from the Kaibab Plateau, at a watershed southeast of Seligman, at a known roost near Marble Canyon (AGFD 2003h), and in Grand Canyon National Park (Payne et al. 2010). There appears to be a substantial population in the Fort Pierce Wash area on the

Utah–Arizona border (AGFD 2003h). In Arizona, it is mostly collected in dry, rough desertscrub, with a few captured or heard in ponderosa pine forest (AGFD 2003h).

Population abundance and densities are very poorly known, but spotted bat is now known to occupy a wider total range and to be more common than initially thought (AGFD 2003h). The Fort Pierce Wash area of southwestern Utah and northwestern Arizona is one of five areas in the western United States where it has been taken in some numbers or fairly regularly (AGFD 2003h).

### MEXICAN LONG-TONGUED BAT (*CHOERONYCTERIS MEXICANA*)

The species may occur on lands adjacent to the proposed withdrawal area. The AGFD documented one record along the Colorado River adjacent to East Parcel (AGFD 2006e). At Grand Canyon National Park, this species has also been documented living in caves and mines (Payne et al. 2010). The species prefers mesic areas in canyons of mixed oak-conifer forests in mountains rising from the desert (AGFD 2006e). Population trends are unknown (AGFD 2006e). This species of bat feed on fruits, pollen, nectar, and probably insects.

### PALE TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII PALLESCENS*)

The insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 1999, 2009c). Maternity colonies are located in the East and South parcels (AGFD 2010a). In the South Parcel, the species was identified during surveys of caves (Forest Service 2008b) and abandoned mine features (Forest Service 2008c). It is considered widespread in Arizona and has been found in Cochise, Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, and Yuma counties (AGFD 2003i). There is a maternity colony at Stanton's Cave in Grand Canyon National Park (Payne et al. 2010). Habitat includes desertscrub, oak woodlands, pinyon-juniper, and conifer forest types throughout the state in summer (AGFD 2003i).

### HOUSEROCK VALLEY CHISEL-TOOTHED KANGAROO RAT (*DIPODOMYS MICROPS LEUCOTIS*)

This species is included on both the BLM and Forest Service species lists. The species is known to occur within the proposed withdrawal area (see Figure 3.8-2). The range is restricted to the House Rock Valley (East Parcel), on the west side of the Colorado River, in Coconino County (AGFD 2001l). Habitat is shrub-dominated Great Basin Desertscrub with relatively high shrub cover and sparse grass cover at 3,500 to 6,500 feet amsl. The preferred soils have a rocky or gravelly component and are deep to moderately deep (AGFD 2001l). The diet of this species is generally dominated by leaves, but it will sometimes eat insects and fungi (AGFD 2001l).

The relative abundance of the species throughout the occupied portion of East Parcel appears to be low and generally patchy; approximately 73,624 acres of habitat are occupied out of a total of about 150,000 acres that are available (AGFD 2001l). It appears that this species is now absent from part of its former range (AGFD 2001l).

### WESTERN BURROWING OWL (*ATHENE CUNICULARIA HYPUGEA*)

This species is included on both the BLM and Forest Service sensitive species lists. The owl occurs on both the North and East parcels (AGFD 2001m). There are no known or historic records from the Kaibab National Forest. It occurs locally in open areas, generally year-round, with only a few winter records on the Colorado Plateau in the northeastern part of the state (AGFD 2001m).

Habitat includes open, well-drained grasslands, steppes, deserts, prairies, and agricultural lands, often associated with burrowing mammals. Burrowing owls feed on a wide variety of prey, changing food habits as location and time of year determine availability. Large arthropods, mainly beetles and grasshoppers, form a large portion of their diet. Small mammals, especially mice, rats, gophers, and ground squirrels, are also important food items. Other prey animals include reptiles and amphibians, scorpions, young cottontail rabbits, bats, and birds, such as sparrows and horned larks (AGFD 2001m).

## BALD EAGLE (*HALIAEETUS LEUCOCEPHALUS*) (DELISTED)

The species has been documented within all three proposed withdrawal area. According to Payne et al. (2010), it is frequently observed over the South Parcel and has been observed roosting near Boggy Tank. -Bald eagles arrive in northern Arizona as early as the last week of October and typically leave by the third week of March (Payne et al. 2010). Bald eagles are mostly fish eaters. Bald eagles do nest in northern Arizona but have not been recorded from within the proposed withdrawal area (Brown and Stevens 1992). The bald eagle has been delisted under the ESA, which means that is no longer listed as threatened or endangered under the ESA.

## AMERICAN PEREGRINE FALCON (*FALCO PEREGRINUS ANATUM*) (DELISTED)

Based on examination of the peregrine falcon nest map in the Arizona Heritage Data Management System (AGFD 2002e), the species appears to nest along Kanab Creek on the Kanab Plateau. There also are at least six peregrine falcon breeding territories along Marble Canyon (Payne et al. 2010), as well as breeding records along the Vermilion Cliffs immediately adjacent to the proposed withdrawal area (Figure 3.8-6) (AGFD 2002e). Currently, there are more than 50 nesting pairs in Grand Canyon National Park, from Lees Ferry to Lake Mead, and a monitoring program is in place (Payne et al. 2010). Optimum peregrine habitat is generally considered to be steep, sheer cliffs overlooking woodlands, riparian areas, or other habitats supporting abundant avian prey species (AGFD 2002e).

## FERRUGINOUS HAWK (*BUTEO REGALIS*)

Ferruginous hawk is considered likely to occur within the proposed withdrawal area. In Arizona, this species prefers open scrublands and woodlands, grasslands, and Semidesert Grassland (AGFD 2001n). In general, the Ferruginous hawk breeds in open areas with little topographic relief and avoids high elevation, forest interior and narrow canyons. Hunting areas are typically open grasslands, preferably those dotted with suitable low hills or short trees which serve as perches (AGFD 2001n).

This species is primarily found in the western states of North America, southern Canada and down into central Mexico. Breeds form western Canada south to northern Arizona and New Mexico. The winter range is primarily from central Mexico north through the southwestern and mid-western United States. As discussed by AGFD (2001n) within Arizona this species breeds in northern Arizona on the Colorado Plateau and can be seen in virtually any part of Arizona with open environs, particularly in agricultural fields and native grasslands.

## GOLDEN EAGLE (*AQUILA CHRYSAETOS*)

Golden eagle is considered likely to occur within the proposed withdrawal area. This species is usually found in open country, in prairies, arctic and alpine tundra, open wooded country and barren areas, especially in hilly or mountainous regions. They nest on rock ledges, cliffs or in large trees. In Arizona they are found in mountainous areas and are virtually vacant after breeding in some desert areas (AGFD 2002f). The Golden eagle's territory size in several areas of the western United States averaged 22 to 55 square miles (57–142 sq km). The Golden eagle is a carnivore that feeds mainly on small mammals like rabbits, marmots, and ground squirrels. They may also eat insects, snakes, birds, juvenile ungulates, and carrion (AGFD 2002f).

## NORTHERN GOSHAWK (*ACCIPITER GENTILIS ATRICAPILLUS*)

Northern goshawk is known to occur within the proposed withdrawal area (Figure 3.8-7).The Kaibab Plateau exhibits one of the highest breeding densities known (AGFD 2003k). In Arizona, the species nests most commonly in ponderosa pine forests along the Mogollon Rim and on the Kaibab Plateau and in ponderosa pine forests in the southeastern mountains (AGFD 2003k). Beier (1997) found that adult goshawks in Arizona wintered in ponderosa pine forest and pinyon-juniper woodlands during some winters. In general, females remained in ponderosa pine in the general vicinity of their nest, while most male goshawks moved 5 to 10 miles from the nesting area and generally into the closest pinyon-juniper woodlands.

Human disturbance is not considered a potential limiting factor (Reynolds et al. 2006). A number of the known goshawk nest sites on the Tusayan and Williams ranger districts of the Kaibab National Forest are located close to Level 2 forest roads, which are characterized by relatively low traffic volumes and speeds. Logging trucks passing within approximately 1,600 feet of two active nests on the Kaibab Plateau did not cause discernible behavioral responses from the individuals at the nests (Forest Service 2009d).

Little historical information on goshawk densities exists, but populations appear to have undergone dramatic declines over the past 50 years (AGFD 2003k). On the Kaibab National Forest, the species is assumed by the Forest Service to be declining (Forest Service 2008d). All ponderosa pine and ponderosa pine–Gambel oak habitat on the forest was surveyed by Forest Service personnel, following Forest Service regional northern goshawk protocol. A total of 107 nesting territories was identified on a 684-square-mile study area on the Kaibab Plateau from 1991 to 1996 (AGFD 2003k). Causes being investigated for the decline include a change in forest composition and structure resulting from intensive forest management between the 1960s and early 1990s, combined with catastrophic fire and wind throw and natural environmental variation in prey abundance (Bratland et al. 2008).

## PINYON JAY (*GYMNORHINUS CYANOCEPHALUS*)

The pinyon jay occurs throughout much of the western United States. The pinyon jay can be found from central Oregon and Montana south to central Arizona, New Mexico and northwestern Oklahoma (Utah Division of Wildlife Resources 2011). Pinyon jays do not migrate and are typically found on dry mountain slopes and foothills near pinyon-juniper forests. This species can also be found in sagebrush, scrub oak, and chaparral communities and in pine forests. Pinyon jays live in large flocks that can have as many as 500 birds. A pinyon jay may spend its entire life in the flock it was born into. The pinyon jay population varies depending on the availability of pinyon pine seeds. In years when there aren't many seeds, the jay population drops. Each flock has an established home range, but may become somewhat nomadic and move long distances when food is scarce. The diet of the pinyon jay consists primarily of pinyon and other pine seeds, but also includes berries, small seeds, grains, and insects. At times, pinyon jays may also eat bird eggs and hatchlings (Utah Division of Wildlife Resources 2011).

## FLANNELMOUTH SUCKER (*CATOSTOMUS LATIPINNIS*)

This species is included on both the BLM and NPS species lists. The flannelmouth sucker does not occur within the proposed withdrawal area; however, its range does include the Colorado River and its larger tributaries in Glen and Grand canyons, to include the Virgin River (AGFD 2001o). It is reportedly found in the Paria River at its confluence with the Colorado River (BLM 1987); however, this reference may no longer be accurate. Flannelmouth suckers are omnivorous, benthic foragers (they feed on the bottom) that are primarily restricted to large and moderately large rivers; larvae inhabit shallow, slow-flowing near-shore areas (AGFD 2001o).

## DESERT SUCKER (*CATOSTOMUS* [PANTOSTEUS] *CLARKI*)

This species is included on both the BLM and NPS species lists. The species does not occur within the proposed withdrawal area. The range of this sucker in Arizona includes the lower Colorado River downstream of Grand Canyon National Park, generally including the Bill Williams, Salt, Gila, and San Francisco river drainages, along with the Virgin River basin (AGFD 2002g). Habitat consists of the rapids and flowing pools of streams and rivers, primarily over bottoms of gravel-rubble, with sandy silt in the interstices (AGFD 2002g). Young desert suckers feed primarily on the larvae of aquatic insects. Adults feed mostly on aquatic plants and parts of plants present along the stream bottom. Feeding is performed predominantly by scraping plant materials off of rocks and small stones (AGFD 2002g).

## SPECKLED DACE (*RHINICHTHYS OSCULUS*)

Speckled dace is not known to occur within the proposed withdrawal area; however, it may occur in Kanab Creek on the Kanab Plateau (adjacent lands). In Arizona, it is found in the Colorado, Bill Williams, and Gila river drainages; it is not present in the slower and warmer portions of Colorado River main stem (AGFD 2002h). It is reportedly found in the Paria River at the confluence with the Colorado River (BLM 1987); however, this reference may no longer be accurate. The species is a bottom dweller, found in rocky riffles, runs, and pools of headwaters, creeks, and small to medium-sized rivers (AGFD 2002h). Populations of this species apparently are stable (AGFD 2002h). Speckled dace are benthic feeders, eating primarily insect larvae and other invertebrates, although algae and fish eggs are also consumed (AGFD 2002h).

## BLUEHEAD SUCKER (*CATOSTOMUS DISCOBOLUS*)

The bluehead sucker is found in high gradient streams of western North America (AGFD 2003l).
The bluehead sucker is a benthic (bottom dwelling) species with a mouth modified to scrape algae (the primary food of the bluehead sucker) from the surface of rocks. Members of the species spawn in streams during the spring and summer. Fast-flowing water in high-gradient reaches of mountain rivers has been identified as important habitat for bluehead sucker.

In Arizona, this species is found in the Colorado River main stem and Grand Canyon tributaries, including Little Colorado River, Clear Creek, Bright Angel Creek, Shinumo Creek, Kanab Creek, and Havasu Creeks; rare below Diamond Head. This species may also be found in a few areas on the Navajo Reservation and in the San Juan Drainage (AGFD 2003l). This species is located within the proposed withdrawal area (Kanab Creek).

## HYDROBIID SPRING SNAILS: GRAND WASH SPRINGSNAIL (*PYRGULOPSIS BACCHUS*); DESERT SPRINGSNAIL (*PYRGULOPSIS DESERTA*)

Neither of these *Pyrgulopsis* springsnails occurs within the proposed withdrawal area. Both species are associated with springs. The Grand Wash springsnail is known to occur in only three springs in the Grand Wash trough in Mohave County; the species possibly also occurs in the Virgin Mountains in Clark County, Nevada (BLM 2007). Desert springsnail is found in springs along the Virgin River in southwestern Utah and northwestern Arizona (BLM 2007). Population trends and food habits for these two snails are unknown (AGFD 2001p, 2004b).

## SUCCINEID SNAILS (FAMILY SUCCINEIDAE): NIOBRARA AMBERSNAIL (*OXYLOMA HAYDENI HAYDENI*)

Niobrara ambersnail does not occur within the proposed withdrawal area. In Arizona, there are two populations along the Colorado River (see Figure 3.8-4): within the Grand Canyon at Indian Gardens

(Bright Angel Trail); and a riverside marsh at 9 Mile in the Lees Ferry reach (AGFD 2004c). The latter site is immediately adjacent to the East Parcel. In August 2009, 17 springs in Grand Canyon National Park considered at risk from uranium extraction activities were sampled for ambersnails by USGS and NPS personnel (Museum of Northern Arizona 2009). No *Oxyloma* snails were found during this survey. A third population of Niobrara ambersnails is located in southern Utah in the Kanab Canyon area (AGFD 2004c). The Indian Gardens population is restricted to permanently wet areas fed by a small spring, and the Lees Ferry population is restricted to areas with damp or saturated soil (AGFD 2004c).

Because of the populations' great reliance on wetland habitat, de-watering is a common threat to all *Oxyloma* populations (AGFD 2004c). The population near Lees Ferry is subject to inundation from even moderate flows of the Colorado River (>25,000 cubic feet per second [708 cubic meters per second]), and more than 90% of the entire habitat is inundated at 45,000 cubic feet per second or more (AGFD 2004c). The Indian Gardens population is threatened by trampling from off-trail hikers, large flash floods, and possible habitat loss/degradation as a result of landscape maintenance (AGFD 2004c).

## 3.8.3 Forest Service Sensitive Species

The Forest Service Sensitive species listed in Table 3.8-4 and addressed below are based on correspondence from Kaibab National Forest biologists and on the Regional Forester's sensitive species list (Forest Service 2010a). Information on species trends is included when available. As noted in Table 3.8-4, several of these species are also listed as sensitive by BLM and as such are addressed in Section 3.8.3, above. Species included on both Forest Service and BLM sensitive species lists include Houserock Valley chisel-toothed kangaroo rat, western burrowing owl, bald eagle, American peregrine falcon, northern goshawk, northern leopard frog, and lowland leopard frog.

**Table 3.8-4.** Forest Service Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Plants** | | | | |
| Tusayan flameflower (*Phemeranthus validulum*) | Tracked as rare by Forest Service | No | No | Yes |
| Arizona leatherflower (*Clematis hirsutissima* var. *hirsutissima*) | Forest Service S | No | No | Yes |
| Tusayan rabbitbrush (*Chrysothamnus molestus*) | Forest Service S | No | No | Yes |
| Morton wild buckwheat (*Eriogonum mortonianum*) | Forest Service S | Possible | No | No |
| **Animals** | | | | |
| Bald eagle (*Haliaeetus leucocephalus*) | BLM S<br>Forest Service S<br>(see species account in Section 3.8.2) | Yes | Yes | Yes |
| American peregrine falcon (*Falco peregrinus anatum*) | BLM S<br>Forest Service S<br>(see species account in Section 3.8.2) | Yes | Possible | Possible |
| Greater western mastiff bat (*Eumops perotis californicus*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Yes | Possible |

**Table 3.8-4.** Forest Service Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Animals, continued** | | | | |
| Western red bat (*Lasiurus blossevillii*) | Forest Service S | Possible | Possible | Possible |
| Spotted bat (*Euderma maculatum*) | BLM S<br>Forest Service S<br>NPS SC (see species account in Section 3.8.2) | Yes | Yes | Yes |
| Allen's lappet-browed bat (*Idionycteris phyllotis*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Yes | Yes |
| Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Yes | Yes |
| Desert bighorn sheep (*Ovis canadensis nelsoni*) | Forest Service S | Yes | Yes | No |
| Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*) | BLM S<br>Forest Service S<br>(see species account in Section 3.8.2) | No | Yes | No |
| Merriam's shrew (*Sorex merriami*) | Forest Service S | No | Possible | Yes |
| Mogollon vole (*Microtus mogollonensis*) | Forest Service S | No | No | Yes |
| Northern goshawk (*Accipiter gentilis*) | BLM S<br>Forest Service S<br>Forest Service MIS<br>(see species account in Section 3.8.2) | Possible | Possible | Yes |
| Western burrowing owl (*Athene cunicularia hypugea*) | BLM S<br>Forest Service S<br>(see species account in Section 3.8.2) | Yes | Yes | No |
| Lowland leopard frog *(Lithobates* [*Rana*] *yavapaiensis* | Forest Service S | Possible | No | No |
| Northern Leopard Frog (*Lithobates* [*Rana*] *pipiens*) | BLM S<br>Forest Service S<br>(see species account in Section 3.8.2) | Possible | No | No |
| Grand Canyon rattlesnake (*Crotalus oreganus abyssus*) | Forest Service S | Possible | No | No |

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service

MIS = Management Indicator Species: Species managed by the Forest Service because they 1) are thought to be the easiest species for determining population trends; 2) best lend themselves to interpretations of population change relative to habitat condition; and 3) best lend themselves to interpretations of species mix relative to habitat conditions.

S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)

SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

## *Plants*

### TUSAYAN FLAMEFLOWER (*PHEMERANTHUS VALIDULUM*)

The species is found within the proposed withdrawal area (see Figure 3.8-1). It has been reported on the TenX and Kotzin inholdings (Forest Service 1999). The overall range includes several discrete locales: Pine Flats and vicinity, Tusayan, Coconino Plateau, Kaibab Plateau, southeast of Williams, the southern boundary of Grand Canyon National Park, near Grand Canyon Caverns, Rattlesnake Tanks near the San Francisco Mountains in Coconino County, Juniper Mountains, Big Black Mesa, and Black Hills, Yavapai County (AGFD 2002i). Habitat consists of shallow pockets of sandy soil on exposed bedrock ledges and terraces in Madrean pine-oak forest openings at 5,000 to 7,000 feet amsl (Arizona Rare Plant Committee 2001). There is no information on population trends (AGFD 2002i). Surveys conducted in the 1990s resulted in the discovery of 130 populations totaling more than 15,000 plants (Forest Service 1999).

### ARIZONA LEATHERFLOWER (*CLEMATIS HIRSUTISSIMA* VAR. *HIRSUTISSIMA*)

Arizona leatherflower is found within the proposed withdrawal area (see Figure 3.8-1). In Arizona, it is known from the Flagstaff area along Rio de Flag and lower Lake Mary, Volunteer Canyon in the Tusayan, and the Chuska Mountains (Arizona Rare Plant Committee 2001). It occurs in moist mountain meadows, prairies, and open woods and thickets, usually in limestone soils of ponderosa pine and mixed-conifer forests at elevations ranging from 6,800 to 9,000 feet amsl (Arizona Rare Plant Committee 2001).

### TUSAYAN RABBITBRUSH (*CHRYSOTHAMNUS MOLESTUS*)

Tusayan rabbitbrush occurs within the proposed withdrawal area (see Figure 3.8-1). In Arizona, it is generally found in the southern part of the South Parcel (Forest Service 1999). The overall range of the species includes Coconino County from the South Rim of Grand Canyon National Park to the Flagstaff area (AGFD 2005j). Two disjunct populations are present on the Navajo Nation (Hopi Buttes and west of Gray Mountain) (AGFD 2005j). It is typically found in open pinyon-juniper grasslands on slopes and flats (where periodic fires naturally occur at an interval of every 15–30 years) from 5,710 to 6,880 feet amsl (AGFD 2005j). Population trends are unknown (AGFD 2005j). It apparently is extant at 21 locations in Coconino County, Arizona; few to none of these locations are protected (see AGFD 2005j).

### MORTON WILD BUCKWHEAT (*ERIOGONUM MORTONIANUM*)

The species is not known to occur within the proposed withdrawal area. It is found about 4 to 6 miles southwest of Fredonia along SR 389in, Mohave County (AGFD 2001q). It is also found approximately 9 miles east-northeast of Pipe Springs in Utah. Habitat is usually along small drainages in red clay hills of very shallow gypsiferous soils on sandstone and shale uplands (AGFD 2001q). Only one population, with approximately 750 plants, is known in Arizona (AGFD 2001q). The population appears to be stable, with several size and age classes represented. A positive 90-day finding was published in the *Federal Register* (74[240]:66866) for the Morton wild buckwheat, and a 12-month status review to determine whether or not to federally list the species will be published in the future.

## *Animals*

### WESTERN RED BAT (*LASIURUS BLOSSEVILLII*)

The insectivorous bat species is considered likely to occur within the proposed withdrawal area. It resides in Arizona from April through September, primarily in riparian and other woodland habitats where roosting sites are located in the foliage of trees and shrubs (AGFD 2003m). The species has been documented in Grand Canyon National Park, where it is found throughout the river corridor and has been observed and collected at various locations from Bright Angel Creek to Diamond Creek (Payne et al. 2010). Population trends are unknown in Arizona (AGFD 2003m).

### DESERT BIGHORN SHEEP (*OVIS CANADENSIS NELSONI*)

Desert bighorn sheep occur within the proposed withdrawal area (Figure 3.8-8). There are two major habitat areas in the vicinity of the proposed withdrawal area: Kanab Creek and the Paria Canyon–Vermilion Cliffs Wilderness (BLM 2007). Desert bighorn sheep occur along the entire drainage of the Colorado River within Grand Canyon. This species preferred habitat is rough, rocky, sparsely vegetated land, characterized by steep slopes, canyons, and washes (Payne et al. 2010).

With the exception of occasional sightings, bighorn sheep were believed to have been eliminated from the above-listed major habitat areas around the turn of the century. In a cooperative effort between the BLM and AGFD beginning in 1979, it was successfully reintroduced, and populations in these areas now appear stable (BLM 2007). For example, bighorn sheep transplanted to the Paria Canyon–Vermilion Cliffs area (immediately north of House Rock Valley) beginning in 1984 have exhibited one of the best reproductive success rates of any bighorn transplant in Arizona, primarily because of desirable habitat conditions (BLM 2007).

### MERRIAM'S SHREW (*SOREX MERRIAMI*)

Merriam's shrew is likely to occur within the proposed withdrawal area (Hoffmeister 1986). The distribution range in Arizona includes the Coconino Plateau, the Mogollon Plateau in the vicinity of Williams and Flagstaff, and Rose Peak in the White Mountains (Hoffmeister 1986). In Arizona, it inhabits cool, grassy locations near coniferous forests (Hoffmeister 1986). Merriam's shrew is widespread, although uncommon, and the population does not appear to be in decline (International Union for Conservation of Nature 2010). Merriam's shrews are insectivores, eating insects, insect larvae (such as caterpillars), worms, and other small invertebrates (Utah Division of Wildlife Resources 2010a).

### MOGOLLON VOLE (*MICROTUS MOGOLLONENSIS*)

The species occurs within the proposed withdrawal area (Frey and LaRue 1993). The distribution range is primarily Arizona and New Mexico, with peripheral populations in Utah, Colorado, and Texas. It is confined mainly to montane areas, where it prefers grassy habitats in ponderosa pine and mixed-conifer forests (Frey and LaRue 1993). Mogollon voles are herbivores that eat mainly green vegetation (Utah Division of Wildlife Resources 2010b).

Population trends are unknown (AGFD 2003a), primarily as a result of taxonomic confusion. Recent genetic studies place *M. mexicanus hualpaiensis*, which was listed by the USFWS as endangered in 1987, in *M. mogollonensis*. *M. mogollonensis* is now believed to consist of three subspecies: *hualpaiensis*, *mogollonensis*, and *navaho* (AGFD 2003a).

### GRAND CANYON RATTLESNAKE (*CROTALUS OREGANUS ABYSSUS*)

The Grand Canyon rattlesnake possibly occurs within the proposed withdrawal area (Stebbins 1985). This snake is a subspecies of the western rattlesnake and is found in extreme northwestern Arizona. It occurs in a variety of biotic communities, inhabits steep, rocky canyons, rolling hills, high plains, and plateaus of the upper Grand, Marble, Glen, and associated side canyons, as well as on the Arizona Strip, and eats small mammals.

## 3.8.4 National Park Service Species of Concern

The NPS Species of Concern listed in Table 3.8-5 and addressed below are those species that occur in close proximity to the proposed withdrawal area or that may be affected by one of the alternatives. This list is based on correspondence with Grand Canyon National Park biologists and uses the species given in Payne et al. (2010). Information on species trends is included when available. NPS Species of Concern are former USFWS Category 1, 2, and 3 species (USFWS no longer maintains a list of these species). Species included on both BLM and NPS sensitive species lists include Grand Canyon rose, flannelmouth sucker, desert sucker and Mexican long-tongued bat. As noted in Table 3.8-5, several of these species are also listed as sensitive by the BLM and/or the Forest Service and as such are discussed in either Section 3.8.2 or 3.8.3.

**Table 3.8-5.** NPS Sensitive Species and Their Potential for Occurrence on the Proposed Withdrawal Area

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| **Plants** | | | | |
| Grand Canyon rose (*Rosa stellata* ssp. *abyssa*) | BLM S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | No | Possible* |
| Grand Canyon beavertail cactus (*Opuntia basilaris* var. *longiareolata*) | NPS SC | No | No | No |
| Kaibab agave (*Agave utahensis* ssp. *kaibabensis*) | NPS SC | No | No | No |
| McDougall's yellowtops (*Flaveria mcdougallii*) | NPS SC | No | No | No |
| Grand Canyon cave-dwelling primrose (*Primula specuicola*) | NPS SC | No | No | No |
| Kaibab suncup (Grand Canyon Evening-primrose) (*Camissonia specuicola* ssp. *hesperia*) | NPS SC | No | No | No |
| **Animals** | | | | |
| Grand Canyon cave pseudoscorpion (*Archeolarca cavicola*) | NPS SC | No | No | No |
| Mexican long-tongued bat (*Choeronycteris mexicana*) | BLM S<br>NPS SC | Possible | Possible | Possible |
| Southwestern myotis (*Myotis auriculus*) | NPS SC | No | No | No |
| Southwestern river otter (*Lontra canadensis sonora*) | NPS SC | No | No | No |
| Allen's lappet-browed bat (*Idionycteris phyllotis*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Possible | Yes |
| Long-legged myotis (*Myotis volans*) | NPS SC<br>(see species account in Section 3.8.4) | Yes | Possible | Yes |
| Pocketed free-tailed bat (*Nyctinomops femorosaccus*) | NPS SC<br>(see species account in Section 3.8.4) | Possible | Possible | Possible |
| Greater western mastiff bat (*Eumops perotis californicus*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Possible | Possible |

**Table 3.8-5.** NPS Sensitive Species and Their Potential for Occurrence on the Proposed Withdrawal Area (Continued)

| Species | Status | North Parcel | East Parcel | South Parcel |
|---|---|---|---|---|
| Spotted bat (*Euderma maculatum*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Yes | Yes |
| Big free-tailed bat (*Nyctinomops ferorosaccus*) | NPS SC<br>(see species account in Section 3.8.4) | Yes | Yes | Possible |
| Allen's lappet-browed bat (*Idionycteris phyllotis*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Yes | Yes |
| Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*) | BLM S<br>Forest Service S<br>NPS SC<br>(see species account in Section 3.8.2) | Yes | Yes | Yes |
| Flannelmouth sucker (*Catostomus latipinnis*) | BLM S<br>NPS SC<br>(see species account in Section 3.8.2) | No | No | No |
| Desert sucker (*Catostomus* [Pantosteus] *clarki*) | BLM S<br>NPS SC<br>(see species account in Section 3.8.2) | No | No | No |

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service

S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)

SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

* Based on Forest Service (2009a).

## *Plants*

### GRAND CANYON BEAVERTAIL CACTUS (*OPUNTIA BASILARIS* VAR. *LONGIAREOLATA*)

This cactus variety is not known to occur within the proposed withdrawal area. The range in Arizona is apparently confined to Granite Rapids, Grand Canyon National Park, where it is found on rocky soils at the bases of talus slopes at about 2,000 feet amsl (Benson 1982; Brian 2000). According to Benson (1982), the validity of this variety is dubious. The elongate areoles that the specific epithet implies are not at all characteristic for *Opuntia basilaris* var. *longiareolata* and are sometimes found on plants of other varieties (eFloras 2010).

### KAIBAB AGAVE (*AGAVE UTAHENSIS* SSP. *KAIBABENSIS*)

Kaibab agave is not known to occur within the proposed withdrawal area. It is endemic to Coconino and Mohave counties, Arizona, including the Kaibab Plateau south to the South Rim and along the cliffs above the Little Colorado River (AGFD 2005k). In Grand Canyon National Park, it is known from eastern Grand Canyon to the Kanab Plateau. Small populations occur in Virgin Canyon above the Virgin Gorge and in Lime Kiln Canyon, Mohave County (AGFD 2005k). Habitat is open ledges, rims, and level to moderately sloping ledges of limestone and sandstone-derived soils (Brian 2000) in the Mohave and Great Basin Desertscrub and Great Basin Conifer Woodland. It has been collected on the Esplanade

Formation and on Coconino Sandstone just above the Supai Formation (AGFD 2005k). Population trends are unknown (AGFD 2005k).

### MCDOUGALL'S YELLOWTOPS (*FLAVERIA MCDOUGALLII*)

The species is not known to occur within the proposed withdrawal area. It is known from a limited number of populations along the tributaries and main Colorado River corridor of western Grand Canyon National Park, from Matkatimiba Canyon to Lava Falls Rapid, in Coconino and Mohave counties (AGFD 2005k; Arizona Rare Plant Committee 2001). It grows in hanging gardens or terrace ledges in perennial alkaline or saline seeps, in Muav Limestone and at the Muav Limestone Bright Angel Shale interface from 1,700 to 2,000 feet amsl (AGFD 2005k). The species is considered locally abundant within its limited habitat (NatureServe 2005).

### GRAND CANYON CAVE-DWELLING PRIMROSE (*PRIMULA SPECUICOLA*)

The species is not known to occur within the proposed withdrawal area. In Arizona, it is endemic to the canyons of the Colorado River in Coconino and Mohave counties, including Grand Canyon National Park (AGFD 2004d). It grows in moist sites from hanging gardens or alcoves in canyons with limestone cliffs from 3,500 to 5,200 feet amsl in Utah and from 1,250 to 7,600 feet amsl in Arizona (AGFD 2004d). Populations appear to be stable (AGFD 2004d). In 1979, there were 10 estimated populations, with few to several hundred individuals per population (see AGFD 2004d).

### KAIBAB SUNCUP (GRAND CANYON EVENING-PRIMROSE) (*CAMISSONIA SPECUICOLA* SSP. *HESPERIA*)

The species is not known to occur within the proposed withdrawal area. There are two disjunct populations along the Colorado River in Arizona, in Havasu and Hualapai canyons, Coconino County, and from Separation Canyon to Spencer Canyon, Mohave County (AGFD 2004e; Brian 2000). It is found scattered on open slopes and in rock crevices, washes, and dry streambeds, often on limestone at 1,240 to 4,500 feet amsl (AGFD 2004e). Population trends are unknown (AGFD 2004e).

## *Animals*

### GRAND CANYON CAVE PSEUDOSCORPION (*ARCHEOLARCA CAVICOLA*)

The species is not known to occur within the proposed withdrawal area. The only known location is along the Colorado River at Cave of the Domes, Grand Canyon National Park, Arizona (AGFD 2003n), about 5 miles north of the Kaibab National Forest. However, Payne et al. (2010) reference several specimens confirmed in two caves in the Lower Gorge. It is found in subterranean cave habitat with bats and/or rodents (AGFD 2003n). Population trends are unknown (AGFD 2003n).

### SOUTHWESTERN MYOTIS (*MYOTIS AURICULUS*)

The insectivorous bat species is not known to occur within the proposed withdrawal area. According to Payne et al. (2010), this species has been captured once along the Colorado River in Grand Canyon National Park. It is found primarily in Gila, Maricopa, and Cochise counties (AGFD 2003o). Although typically found in ponderosa pine habitat and other semi-arid woodland habitats, it is also sometimes captured in desert grasslands (AGFD 2003o). Populations appear to be stable, although few data exist throughout the species' range (AGFD 2003o). It may be expanding its range northward in the United States.

### SOUTHWESTERN RIVER OTTER (*LONTRA CANADENSIS SONORA*)

The native subspecies of river otter is not known to occur within the proposed withdrawal area. It is probably extirpated from its former range along the Colorado River (Payne et al. 2010). Although there are occasional unconfirmed sightings of otters along the Colorado River below Lake Mead, it is likely that these are a nonnative subspecies introduced into the river drainage by AGFD between 1978 and 1991 (Payne et al. 2010). A river otter subspecies from Louisiana, *L. c. lataxina*, was successfully introduced into the Verde River drainage in central Arizona during 1981–1983 and may eventually cause genetic swamping of any native individuals, if any still exist (AGFD 2002j).

Although apparently never abundant, the southwestern river otter population has declined and is now considered very rare by AGFD (AGFD 2002j). Evidence cited above also suggests the possibility of inbreeding between native, if any still exist, and introduced otters.

### LONG-LEGGED MYOTIS (*MYOTIS VOLANS*)

This species is included on both the BLM and NPS species lists. According to the distribution map at AGFD (2003f) and information from Forest Service (2008a, 2009c), this insectivorous bat species has been recorded within the North and South parcels. The Kaibab National Forest records are from the PIPO Snag Roost, Camp 36 Tank, and Mile and a Half Tank (Forest Service 2008a, 2009c). It is considered likely to occur on East Parcel. Long-legged myotis is found in forested mountains in Apache, Cochise, Coconino, Gila, Mohave, and Yavapai counties (AGFD 2003f) and has been collected along the Colorado River corridor in Grand Canyon National Park (Payne et al. 2010). Although primarily a coniferous forest bat, it may also be found in riparian and desert habitats (AGFD 2003f). Populations are considered stable in Arizona (AGFD 2003f).

### BIG FREE-TAILED BAT (*NYCTINOMOPS MACROTIS*)

This insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a). It is considered likely to occur within the South Parcel. It is widely spread throughout the state but is probably absent from coniferous Mogollon Plateau (AGFD 2003g). It is primarily an inhabitant of rugged, rocky country and riparian areas (AGFD 2003g). Populations appear to be stable, although not common, except sometimes locally (AGFD 2003g).

### POCKETED FREE-TAILED BAT (*NYCTINOMOPS FEMOROSACCUS*)

This insectivorous bat species is considered possible within the proposed withdrawal area. It was collected in Grand Canyon National Park for the first time in 2002 near RM 209 (Payne et al. 2010). The range is otherwise limited primarily to the south half of Arizona in Pima, Gila, Mohave, Maricopa, La Paz, Pinal, Graham, Cochise, and Yuma counties (AGFD 2003j).

## 3.8.5 Arizona Game and Fish Department Species of Greatest Conservation Need

The AGFD has statutory authority and obligation under the ARS for fish and wildlife management in the state, including the proposed withdrawal area, except within Grand Canyon National Park. This statutory obligation includes management of both game and non-game wildlife. In cooperation with the AGFD, BLM and Forest Service develop management plans for wildlife species and habitats (BLM 2007). Many of the management directions for wildlife included in these habitat management plans are based on statewide goals of the AGFD in managing particular species. The BLM and Forest Service management plans include construction and maintenance of habitat improvement projects, primarily water developments for big- and small-game species, but many non-game species benefit from these projects as well. Other habitat enhancement projects implemented include prescribed burns, seeding, and chemical or mechanical treatments of poor-quality habitat areas. Wildlife habitat monitoring studies are being conducted to assess the results of management toward meeting wildlife objectives. In cooperation with the USFWS and AGFD, several species have been reintroduced to former ranges, and existing populations have been augmented. These include pronghorn, desert bighorn sheep, mule deer, and Merriam's turkey, as well as northern leopard frog and Apache trout.

The AGFD Wildlife Action Plan provides a strategic framework and information resource designed to help conserve terrestrial and aquatic wildlife and their habitats in Arizona (AGFD 2010b). The action plan focuses on habitat types, provides recommended conservation actions for each habitat type on a regional basis, and develops conservation priorities for the 183 SGCN in Arizona. Included among these SGCN are 28 crustaceans and mollusks, 33 fish, 12 amphibians, 26 reptiles, 49 birds, and 35 mammals. Special attention is given to federally listed species, federal candidate species, species currently petitioned for listing, recently delisted species, and species for which conservation agreements already exist.

Several species listed as SGCN occur in the proposed withdrawal area, and most of these are addressed in Section 3.8 as special status species. Among the SGCN addressed in Section 3.8 include Niobrara ambersnail, Kanab ambersnail, northern leopard frog, relict leopard frog, Sonoran desert tortoise, flannelmouth sucker, humpback chub, razorback sucker, speckled dace, bluehead sucker, olive-sided flycatcher (*Contopus borealis*), sage thrasher, western yellow-billed cuckoo, northern goshawk, American peregrine falcon, western burrowing owl, Mexican spotted owl, southwestern willow flycatcher, condor, bald eagle, Yuma clapper rail, desert bighorn sheep, pronghorn, southwestern river otter, Mogollon vole, Merriam's shrew, Houserock Valley chisel-toothed kangaroo rat, black-footed ferret, greater western mastiff bat, western red bat, western yellow bat (*Lasiurus xanthinus*), and big free-tailed bat (AGFD 2010b).

Several additional SGCN may occur on or are known to occur in the vicinity of the proposed withdrawal area. These include a variety of avian species found at higher elevations in habitats (i.e., mixed conifer, spruce-fir, aspen) on the Kaibab Plateau but not on the parcels themselves. Based on breeding distribution maps in Corman and Wise-Gervais (2005), these bird species include American three-toed woodpecker (*Picoides tridactylus*), western purple martin (*Progne subis*), red-naped sapsucker (*Sphyrapicus nuchalis*), Lewis's woodpecker (*Melanerpes lewis*), Lincoln's sparrow (*Melospiza lincolnii*), MacGillivray's warbler (*Oporornis tolmiei*), downy woodpecker (*Picoides pubescens*), green-tailed towhee (*Pipilo chlorurus*), ruby-crowned kinglet (*Regulus satrapa*), and golden-crowned kinglet (*R. calendula*).

## American three-toed woodpecker (*Picoides tridactylus*)

It is unknown whether the American three-toed woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. American three-toed woodpeckers are generally associated with spruce forests, although their occurrence in other types of coniferous forest varies geographically (Short 1974). American three-toed woodpeckers occur as far north as Alaska and extend through the boreal forests of Canada south into the lower 48 states. American three-toed woodpeckers flake off bark to forage on bark beetles (Scolytidae) and are typically found in old growth forests and/or disturbed areas that have high densities of bark beetle larvae (Short 1974). While any disturbance that produces a large number of dead/decaying trees may be important for this species (i.e., insect outbreaks, flooding, disease), multiple studies have noted the importance of burns for American three-toed woodpeckers (Short 1974).

## Western purple martin (*Progne subis*)

It is unknown whether the western purple martin is located within the proposed withdrawal area, but it is a species that is possible in the region. The purple martin can be found throughout North America in summer and winters in South America (Animal Diversity Web 2010). The original habitat of this species was probably forest edge and riparian habitats, but many populations now inhabit cities and towns. The habitat of this species is coniferous forests near water sources. The diet of this species is flying insects (Animal Diversity Web 2010).

## Red-naped sapsucker (*Sphyrapicus nuchalis*)

It is unknown whether the red-naped sapsucker is located within the proposed withdrawal area, but it is a species that is possible in the region. The red-naped sapsucker is a woodpecker of lower elevations in the Rocky Mountains (NatureServe 2005). It prefers to make sap wells in willow trees but will use a variety of tree species. Their habitat includes mixed forests in the Rocky Mountains and Great Basin areas of North America. They nest in cavities of dead trees.

## Lewis's woodpecker (*Melanerpes lewis*)

It is unknown whether the Lewis's woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. This species is associated with mature montane and riparian forests from interior southern Canada to Arizona and New Mexico and from coastal California east to Colorado (Cornell Laboratory Ornithology 2010a).

Three principal habitats are open ponderosa pine forest, open riparian woodland dominated by cottonwood, and logged or burned pine forest; however, breeding birds are also found in oak woodland, nut and fruit orchards, pinyon pine-juniper woodland, a variety of pine and fir forests, and agricultural areas, including farm and ranchland. Important aspects of breeding habitat include an open canopy, a brushy understory offering ground cover and abundant insects, dead or downed woody material, available perches, and abundant insects (Cornell Laboratory of Ornithology 2010a).

## Lincoln's sparrow (*Melospiza lincolnii*)

It is unknown whether the Lincoln's sparrow is located within the proposed withdrawal area, but it is a species that is possible in the region. Lincoln's sparrow occurs from northern Canada south through the Rocky Mountains and the Pacific coastal ranges to southern California, Arizona, and New Mexico (Utah Division of Wildlife Resources 2010c). During winter, it is found in the south-central and southwestern United States, south to Honduras. Habitats used by Lincoln's sparrow during the breeding season include wet meadows, bogs, and riparian thickets, especially where these habitats include willows and where shrub cover is dense; during migration and in winter, this species uses a much broader array of habitats, ranging from weedy pastures to tropical forests. This species feeds mainly on terrestrial invertebrates (arthropods) and small seeds.

## MacGillivray's warbler (*Oporornis tolmiei*)

It is unknown if the MacGillivray's warbler is located within the proposed withdrawal area, but it is a species that is possible in the region. MacGillivray's warblers are migratory birds that spend their summers in temperate forests located in the western United States and in boreal forests of west Canada (Cornell Laboratory of Ornithology 2010b). In autumn, these birds will migrate back to Central America, where they will stay in temperate shrublands for the winter. This species primarily feeds on insects but will also take spiders and occasionally worms. They also are known to feed at sapsucker drill wells.

### Downy woodpecker (*Picoides pubescens*)

It is unknown whether the downy woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. The downy woodpecker is a common year-round resident in forests, riparian woodlands, parks, and suburbs throughout Canada and most of the United States (Utah Division of Wildlife Resources 2010d). The diet of the downy woodpecker consists primarily of insects, but fruits, seeds, and sap are also consumed. Individuals either glean food items directly off of a tree, or drill into tree bark.

### Green-tailed towhee (*Pipilo chlorurus*)

It is unknown whether the green-tailed towhee is located within the proposed withdrawal area, but it is a species that is possible in the region. The green-tailed towhee is a large secretive sparrow that uses different habitats throughout its range (Utah Division of Wildlife Resources 2010e). At low elevations, it is found in diverse shrub communities or in pinyon-juniper forests. At higher elevations, it is frequently found in disturbed forests and along forest edges. Green-tailed towhees forage for food under dense cover either on the ground or in low vegetation. They scratch the ground to expose small seeds and insects, which they then pluck off the ground. Less often, they will take insects or fruits directly off vegetation.

### Ruby-crowned kinglet (*Regulus satrapa*)

It is unknown whether the ruby-crowned kinglet is located within the proposed withdrawal area, but it is a species that is possible in the region. The ruby-crowned kinglet is a small songbird that breeds in boreal, subalpine, and mixed coniferous forests in Canada and in both the northeastern and western United States (Utah Division of Wildlife Resources 2010f). This bird winters in coniferous and deciduous forests across the United States and into northeastern Mexico. The diet of the ruby-crowned kinglet consists primarily of insects that are either gleaned from leaves and limbs, or chased down and captured.

### Golden-crowned kinglet (*R. calendula*)

It is unknown whether the golden-crowned kinglet is located within the proposed withdrawal area, but it is a species that is possible in the region. The golden-crowned kinglet is a small songbird that breeds in boreal, subalpine, and mixed coniferous forests in Canada and in both the northeastern and western United States (Utah Division of Wildlife Resources 2010g). This bird winters in coniferous and deciduous forests across the United States and into northeastern Mexico. The diet of the ruby-crowned kinglet consists primarily of insects that are either gleaned from leaves and limbs or chased down and captured.

## 3.8.6 Resource Condition Indicators

Table 3.8-6 gives the resource condition indicators for special status species.

**Table 3.8-6.** Special Status Species Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Special status species habitat | Issues associated with special status species habitat include fragmentation of habitat by roads, noise from exploration or development activities that disrupts species, species disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species. | *Indicator*: Acres and type of habitat lost and duration of loss.<br>*Indicator*: Changes in migratory or foraging behavior.<br>*Indicator*: Avoidance or adaptation of species to noise source/visual intrusion.<br>*Indicator*: Acres of habitat loss as a result of establishment of invasive species caused by mineral exploration or development activities. |

**Table 3.8-6.** Special Status Species Condition Indicators (Continued)

| | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Special status species populations | Potential loss of critical special status species winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc. | *Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time. |
| Special status species mortality | The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality. In addition to wildlife vehicle accidents, injury to individual plants from crushing or removal and loss or modification of habitat through actions such as clearing and road construction has potential to impacts special status species. | *Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity. |

# 3.9 VISUAL RESOURCES

## 3.9.1 Introduction

Visual resources are the visible physical features on a landscape and may include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. This character is formed by the variety and intensity of the landscape features and the four basic elements of form, line, color, and texture. These factors give an area a unique quality that distinguishes it from its immediate surroundings. Usually, the more variety of these elements a landscape has, the more interesting or scenic the landscape becomes if the elements coexist harmoniously. Scenic quality is the relative value of a landscape from a visual perception point of view.

The region where the proposed withdrawal area is located in Coconino and Mohave counties, Arizona (see Figure 1.1-1), is internationally recognized for its diverse landscapes and scenic qualities and offers many developed and dispersed backcountry recreation opportunities for sightseeing, wildlife viewing, and on-road touring. It attracts large numbers of tourists, varying from local residents to visitors from around the world, who come to the area to enjoy the area's dramatic scenic qualities. Distinct and notable scenic features in the region include the Grand Canyon, Vermilion Cliffs, Kaibab Plateau, Coconino Plateau, Mount (Mt.) Trumbull, and others. The analysis area for visual resources includes lands where potential changes to the landscape may be discerned.

## 3.9.2 Landscape Character

The proposed withdrawal area is in the southwestern portion of the Colorado Plateau. Scenery throughout the proposed withdrawal area is made up of a diverse variety of physical elements. The landscape is generally characterized by colorful sedimentary rock formations, steep-walled canyons, wooded plateaus, broad plains, dark gray cinder cones, fields of rugged volcanic rock, and major fault scarps. Because of the remote and undeveloped nature of much of the proposed withdrawal area, visitors to the area are rewarded with unrestricted views of forested ridges, steep, colorful canyons, and vast, open plains.

Human modifications occur throughout the proposed withdrawal area and contribute to the overall landscape character. These modifications consist primarily of roads and ranching developments and include some transmission lines, mining development, and trails.

## 3.9.3 Federal Visual Resource Management Systems

The BLM, Forest Service, and NPS all use a visual resource inventory and contrast analysis process to analyze impacts to visual resources. However, each agency applies its own system to establish Visual Resource Management (VRM) objectives or scenic integrity levels. Typically, a visual resource inventory process involves rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or Key Observation Points. This information is used to assign a visual quality rating and management objectives to a tract of land that are subsequently used to manage and analyze activities and uses of that land.

Visual analysis involves determining whether the potential visual impacts from proposed activities or developments would meet the management objectives established for the area. A visual contrast rating process is used for this analysis, which involves comparing the proposed withdrawal features with the major features in the existing landscape using the basic design elements of form, line, color, and texture.

The following sections detail the BLM, Forest Service, and NPS VRM systems.

### *Bureau of Land Management*

The BLM (South and East parcels) uses the VRM system to manage visual resources on public lands (BLM 1986a, 1986b). Most of these two parcels are managed under the direction contained within the Arizona Strip Field Office RMP (BLM 2008b). The primary objective of VRM for the North and East parcels is to maintain the existing visual quality of BLM-administered lands and to protect unique and fragile visual resources. The VRM system uses four classes to describe the different degrees of modification allowed to the basic elements of the landscape (i.e., line, form, color, and texture). The VRM classes and their objectives are described in Table 3.9-1.

**Table 3.9-1.** Visual Resource Management Class Descriptions

| VRM Class | Description |
|---|---|
| I | The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention. |
| II | The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape. |
| III | The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape. |
| IV | The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape. |

### *Forest Service*

On most National Forest System lands, the Forest Service uses a Scenery Management System (SMS), which replaces the Forest Service's former Visual Management System (Forest Service 1974) for management of visual resources. *Landscape Aesthetics: A Handbook for Scenery Management*, Agricultural Handbook 701 (Forest Service 1995), defines a system for inventory and analysis of the aesthetic values of National Forest System lands. Both the Forest Service and BLM systems rely on visual inventory and scenic quality classes to manage visual resources.

The Kaibab National Forest currently uses both the SMS and the Visual Management System. The South Parcel is managed under the newer SMS, and the small areas of the Kaibab National Forest within the North and East parcels are managed under the older Visual Management System. The *Environmental Assessment for Amendment of the Kaibab National Forest Management Plan—Recreation and Scenery Management* (Kaibab EA) (Forest Service 2004) determined that the Kaibab National Forest's Visual Management System inventory and mapping was inadequate. This was the result of insufficient visual quality mapping for the Kaibab LRMP/ROD (Forest Service 1988) in which forest managers assigned Visual Quality Objectives (VQOs) to areas of known visual concern (major travel ways, high-use Forest Roads, scenic areas, and recreation sites) but did not map the remaining areas. The Kaibab EA was used to inventory and update VRM on the Kaibab National Forest to the SMS system, but this was only completed for the Tusayan Ranger District (the South Parcel of the proposed withdrawal area). The Kaibab LRMP/ROD was amended to adopt more comprehensive mapping, standards, and the Recreation Opportunity Spectrum (ROS)-SMS Guidebook, but only for the South Parcel. Both Forest Service VRM systems are described below.

### VISUAL MANAGEMENT SYSTEM

VQOs are used for VRM of some Forest Service landscapes, depending on the status of the applicable Forest Plan. VQOs establish the acceptable degree of alteration of the characteristic landscape (Table 3.9-2). Each VQO describes a different degree of acceptable alteration of the natural landscape. The degree of alteration is measured in terms of visual contrast with the surrounding landscape generated by introduced changes in form, line, color, or texture. The Kaibab National Forest uses the Visual Management System on their lands within the North and East parcels.

**Table 3.9-2.** Forest Service Visual Quality Objective Descriptions

| VQO Category | Definition |
|---|---|
| Preservation | Allows ecological change only and management activities that are not noticeable to observers. |
| Retention | Allows management activities that are not evident to the casual forest visitor. |
| Partial Retention | Allows management activities that may be evident to the observer but must remain subordinate to the characteristic landscape. |
| Modification | Allows management activities that may dominate the characteristic landscape but that must, at the same time, use naturally established form, line, color, and texture. |

### SCENERY MANAGEMENT SYSTEM

The new system used by the Forest Service, the SMS, includes a scenery inventory system similar to the BLM system that assigns Scenic Integrity Objectives (SIOs) to landscapes. The SIO determines the degree of acceptable change or alteration to the visual landscape. The Kaibab National Forest uses the SMS on the Tusayan Ranger District (South Parcel) to guide management activities in terms of visual resources. Table 3.9-3 describes the SIOs.

## *National Park Service*

The proposed withdrawal area does not include lands within Grand Canyon National Park. However, because of the Park's central location and geographic proximity to the three proposed withdrawal parcels the NPS mandate to conserve visual resources is part of the analysis.

**Table 3.9-3.** Forest Service Scenery Management System Scenic Integrity Objectives

| SIO | Landscape Theme |
|---|---|
| Very High | The landscape is intact, with only minute, if any, deviations. The existing character and sense of place should be expressed at the highest level. Human influence from historic use or management should appear completely natural to the majority of viewers. |
| High | The landscape appears unaltered and intact. Deviations may be present but should repeat the line, form, color, and textures of the existing landscape character so completely, and at such a scale, that they are not evident. |
| Moderate | The landscape appears slightly altered. Noticeable changes should remain visually subordinate to the landscape character being viewed. |
| Low | The landscape appears moderately altered. Deviations and changes to the landscape may begin to dominate the landscape character. These changes should borrow valued landscape attributes such as size, shape, edge effects, patterns of natural openings, vegetative type changes, or architectural styles that are outside the altered landscape. |

Source: Forest Service (1995).

NPS does not apply a classification system to managing scenic quality within national parks. As mandated under the Organic Act [16 USC 1], all visual resources and scenic quality within national parks are to be conserved and managed in an unimpaired condition for the enjoyment of future generations. Potential impairment of the resource is determined using context, intensity, duration, and timing to gauge the level of impacts of proposed projects within the National Park System. Through the NEPA process, threshold values have been developed to assist the evaluator in determining whether a project's activities would constitute an impairment of visual resources. Grand Canyon National Park is managed under a General Management Plan (NPS 1995).

The Organic Act [16 USC 1] also addresses that potential impairment of park resources may result from sources or activities outside the park. The NPS will conduct cooperative conservation to work with others to anticipate, avoid, and resolve potential conflicts and protect park resources.

## 3.9.4 Visual Resource Descriptions

The following sections describe the existing landscape of each parcel. This is done in terms of the basic elements of the characteristic landforms, vegetation, and human modifications found throughout each parcel. Observation points that are representative of the characteristic landscape within each parcel are identified, and the geographic context of those points is described. Because visual details are diminished the farther the observer is removed, landscapes are subdivided into three distance zones based on relative visibility from travel routes or observation points. The three zones are foreground–middle ground, background, and seldom seen. The foreground–middle ground zone includes views that are less than 3 to 5 miles away. Views beyond the foreground–middle ground zone but less than 15 miles away are usually called background zone. Views not seen as foreground–middle ground or background (i.e., hidden from view) are in the seldom-seen zone. VRM objectives have been assigned by BLM and Forest Service to all lands within the three parcels, and a detailed breakdown of those objectives is provided.

These elements—characteristic landscape, geographic context, and agency VRM objectives—will be the basis for assessing visual impacts through contrast analysis and distance zones in Chapter 4.

### *North Parcel*

The North Parcel is located north of the Grand Canyon and includes portions of the Kanab and the Uinkaret plateaus (Figure 3.9-1). Elevations of the North Parcel vary between 4,000 feet amsl along Kanab Creek to approximately 6,500 feet amsl at Hancock Knoll. As documented in the Arizona Strip ROD/RMP (BLM 2008b), the BLM designated the Kanab Creek, Moonshine Ridge, and Johnson Spring ACECs, the plateau between Nates and Robinson canyons (south of Hack Canyon), and the Old Spanish

National Historic Trail as VRM Class II; an east-west utility corridor as VRM Class IV; and the remainder of the parcel as VRM Class III. Modifications to the characteristic landscape of the North Parcel consist of exploration and development, the utility corridor, and a network of dirt roads to provide access for recreation opportunities, mining operations, livestock grazing, fire suppression, and other land management activities. Table 3.9-4 describes the acres per visual resource classification within the North Parcel, and Figure 3.9-1 depicts the visual resource designations. This parcel also includes a small section of Forest Service land on the east side, along Kanab Creek. This contains the VQO designation of modification on the upper segment of Kanab Creek.

**Table 3.9-4.** North Parcel Visual Resource Class Acreage for BLM and Forest Service Land

| | Acres |
|---|---|
| **BLM VRM Class** | |
| Class I | 0 |
| Class II | 63,208 |
| Class III | 509,935 |
| Class IV | 23,422 |
| **Forest Service VQO** | |
| Preservation | 0 |
| Retention | 0 |
| Partial Retention | 0 |
| Modification | 3,590 |

For the purposes of this analysis, several observation areas were established within the North Parcel. These observation areas include views along major travel corridors (U.S. 89A, SR 389), Toroweap Road (dirt road), and Big Springs Road (dirt road), as well as several trailheads within and adjacent to the North Parcel (see Figure 3.9-1).

## U.S. 89A CORRIDOR

U.S. 89A traverses the eastern portion of the North Parcel from east to west (see Figure 3.9-1). The dominant landscape view is of the vast, open, and undeveloped plains of the gently rolling Kanab Plateau. Views south of U.S. 89A include foreground–middle ground views of Kanab Plateau and possible glimpses of Kanab Creek Canyon, parts of which are within the Kanab Creek Wilderness. Foreground and middle ground views west of U.S. 89A include views of Yellowstone Mesa, while views north of U.S. 89A include views of the Shinarump Cliffs. A primary feature is the vertical rise of the Kaibab Plateau to the west.

## SWAPP TRAILHEAD

Swapp Trailhead is located east of Kanab Creek and north of Snake Gulch, with access along BLM Road 22 from U.S. 89A (see Figure 3.9-1). Foreground and middle ground views to the east and south from Swapp Trailhead include the rising Kaibab Plateau and Kaibab National Forest and views across Snake Gulch into the Kanab Plateau to the east. Background views to the west look across Kanab Creek toward Yellowstone Mesa and Antelope Valley.

### HACK CANYON TRAILHEAD

Hack Canyon Trailhead is located within the North Parcel, just west of the Kanab Creek Wilderness boundary in Hack Canyon (see Figure 3.9-1). Hack Canyon Trailhead is accessed from SR 389 and Toroweap Road. Foreground and middle ground views to the east of this trailhead include views into Kanab Creek Wilderness and the Kaibab Plateau.

### TOROWEAP ROAD CORRIDOR WITHIN ANTELOPE VALLEY

Toroweap Road is one of two major roads within the North Parcel and is accessed from SR 389 west of Fredonia, Arizona (see Figure 3.9-1). In general, Toroweap Road cuts across the North Parcel in a southwesterly direction through the Kanab Plateau and Antelope Valley. Views from Toroweap Road, while within Antelope Valley, include foreground and middle ground views of rolling plains; background views of Findlay Knolls, Heaton Knolls, and Hancock Knoll. Middle ground views west from Toroweap Road include views of Antelope Valley. Middle ground views north from Toroweap Road include views of Yellowstone Mesa and more background views of the Vermilion Cliffs.

### CLAYHOLE ROAD CORRIDOR

Clayhole Road/BLM Road 5 is located along the western boundary of the North Parcel, and like Toroweap Road, it provides access for several recreation sites within Grand Canyon National Park (see Figure 3.9-1). Typical views near the road include a flat landscape with distant view of mesas and the Canaan and Cottonwood mountains to the north. The southern portion of the road has distant views of a few small cinder cones. Views east of Clayhole Road include foreground and middle ground views of Yellowstone Mesa and Antelope Valley. Foreground and middle ground views south include Toroweap Valley and background views of distant plains.

### SR 389 CORRIDOR

SR 389 is located outside the North Parcel and offers casual travelers background views of various locations within the North Parcel (see Figure 3.9-1). Views are dominated by vast, open, undeveloped plains of the Kanab Plateau, which contain sagebrush and grass vegetation. The dominant visual elements include views south of the Uinkaret Plateau, Yellowstone Mesa, Antelope Valley, and Kanab Plateau. Located approximately 3 miles south of SR 389 is an east-west utility corridor within the North Parcel, which is visible in the foreground and middle ground views from SR 389.

## *East Parcel*

The East Parcel is located south of the Paria Plateau and Vermilion Cliffs National Monument and west of the Colorado River (Figure 3.9-2). The East Parcel varies between 4,400 and 5,600 feet amsl, and vegetation is dominated by grassland species, and sparse juniper trees and shrubs. U.S. 89A is generally the northern boundary of the East Parcel. BLM Road 8910 (Buffalo Ranch Road) and a network of dirt roads provide access to the Rider Canyon and North Canyon trailheads, livestock grazing facilities, and other land management activities. The casual observer has view of the East Parcel from along U.S. 89A. This paved road follows near the base of the Vermilion Cliffs.

Table 3.9-5 lists the number of acres per visual resource classification within the East Parcel. Figure 3.9-2 depicts the visual resource classifications within the East Parcel. The north half of House Rock Valley is designated Class II because of broad vistas from U.S. 89A and the Vermilion Cliffs area. The Marble Canyon ACEC is also designated Class II. The southern portion of the East Parcel is designated VRM Class III. The Paria Canyon–Vermilion Cliffs Wilderness, adjacent to this parcel, is designated Class I. A segment of Forest Service land is included within the western edge of the parcel. This is designated a VQO modification, except for a small partial retention corridor along U.S. 89A.

**Table 3.9-5.** East Parcel Visual Resource Class Acreage for BLM and Forest Service Land

| | Acres |
|---|---|
| **BLM VRM Class** | |
| Class I | 0 |
| Class II | 63,296 |
| Class III | 50,316 |
| Class IV | 86 |
| **Forest Service VQO** | |
| Preservation | 0 |
| Retention | 0 |
| Partial Retention | 818 |
| Modification | 30,494 |

## U.S. 89 CORRIDOR

U.S. 89 is located on the Navajo Nation and east of the East Parcel (see Figure 3.9-2). U.S. 89 provides casual observers foreground and background views of the East Parcel and varies in distance from just a few miles away to more than 20 miles away. Background views include the canyon walls of the Colorado River and views of House Rock Valley.

## U.S. 89A–SOAP CREEK TRAILHEAD

Two observation points along U.S. 89A were established within the East Parcel and include House Rock Valley Overlook and Soap Creek Trailhead (see Figure 3.9-2). Soap Creek Trailhead is located east of U.S. 89A, a few miles southwest the Marble Canyon Bridge crossing over the Colorado River. Foreground and background views east include views of Echo Ridge and Marble Canyon. Background views west from this observation point include views of House Rock Valley and U.S. 89A. Foreground views of Vermilion Cliffs are possible north of this observation point.

## U.S. 89A–HOUSE ROCK VALLEY OVERLOOK

House Rock Valley Overlook is located along of U.S. 89A on the Kaibab National Forest (see Figure 3.9-2). This is a popular overlook that experiences high visitation from regional travelers. It provides unbroken views of the House Rock Valley area, which is surrounded by the Vermilion Cliffs to the north and Marble Canyon to the east. More distant views include the Kaibab Plateau and Kaibab National Forest.

## RIDER CANYON TRAILHEAD

Rider Canyon Trailhead is located within the East Parcel and is accessed by BLM Road 8910 south of SR 389 (see Figure 3.9-2). Views east of this observation point include foreground views of Rider Canyon. Background views toward Echo Cliffs on the Navajo Nation are also possible. Middle ground views south of this observation point include House Rock Valley. West of this observation point are background views of House Rock Valley, Kaibab Plateau, and Kaibab National Forest. North of this observation point are middle ground views of the Vermilion Cliffs.

## South Parcel

The South Parcel is located south of the Grand Canyon and is managed by the Forest Service. The South Parcel slopes from northeast to southwest, and elevations vary from approximately 5,800 to 7,000 feet amsl. Vegetation within the eastern portion of the South Parcel is dominated by grasslands interspersed with scattered juniper and shrubs, while vegetation in the western and northern portions of the parcel is predominantly tall ponderosa pine forests. Red Butte is one of the few features of vertical relief on the South Parcel; it rises in the southern portion of the parcel. The Coconino Rim, in the northeastern portion of the parcel, rises up from the Colorado River and also presents a distinct view. Dramatic views of the Grand Canyon occur at various points in the parcel.

The South Parcel is intersected by several paved routes and Forest Service roads. U.S. 180/SR 64 is a north-south transportation corridor in the western portion of the South Parcel. Forest Service Road 302 runs predominantly from east to west in the middle of the South Parcel, and SR 64 is located in the northeastern portion of the South Parcel.

Table 3.9-6 presents acres of SIOs for the South Parcel, as illustrated in Figure 3.9-3. Areas classified as "high" include Red Butte and the Coconino Rim area. Most of the parcel is designated "moderate," with a few isolated pockets of "low."

**Table 3.9-6.** South Parcel Visual Resource Class Acreage

| SIO | Acres |
|---|---|
| Very High | 0 |
| High | 25,519 |
| Moderate | 283,291 |
| Low | 15,621 |

### RED BUTTE–SR 64 OBSERVATION POINT

The Forest Service has established one official visual quality observation point within the South Parcel. Red Butte SIO-2 encompasses a 3,545-acre area and is located east of SR 64 in the southwestern portion of the South Parcel (see Figure 3.9-3). Red Butte is accessed by Forest Service Road 305. The casual traveler within the South Parcel would have viewing opportunities along SR 64 and from several existing Forest Service dirt roads. Views of the casual observer traveling along SR 64 in the southwestern portion of the South Parcel would include foreground and middle ground views of rolling terrain with grassland and junipers, with the highest feature (Red Butte) visible. The top of Red Butte is accessible by a hiking trail and provides hikers with broad regional views that include the San Francisco Peaks and north to the Grand Canyon and Mt. Trumbull.

### TUSAYAN–STATE ROUTE 64 CORRIDOR

Views along SR 64 in the northwestern portion of the South Parcel would be mostly limited to the foreground views and existing right-of-way because of the abundance of ponderosa pine trees. SR 64 and the Grand Canyon Railroad are major transportation features in the western portion of the South Parcel (see Figure 3.9-3). The Grand Canyon Airport, an established Forest Service campground (Ten-X), and the town of Tusayan are also located in the northwestern portion of the South Parcel.

### EASTERN STATE ROUTE 64 CORRIDOR

The casual observer traveling along SR 64 in the eastern portion of the South Parcel would have foreground views of rolling terrain with sparse vegetation (see Figure 3.9-3). The casual observer would also have background views west of the northeastern slopes of the Coconino Rim and background views east toward the Little Colorado River. The casual observer travelling within Grand Canyon National Park has some views into the South Parcel from the SR 64 corridor. These include background views of Red Butte and minimal foreground views.

### FOREST SERVICE ROAD 302 CORRIDOR

The South Parcel also contains a network of dirt roads that serve recreation, grazing, and fire maintenance activities. Forest Service Road 302 is an east-west road that is approximately in the middle of the South Parcel and has a network of dirt roads branching from it (see Figure 3.9-3). Views from select locations along these dirt roads would vary but in general are limited to foreground views because of the natural topography of rolling hills, ridges, and drainages. One east-west utility line (power) easement is located in the southern portion of the South Parcel.

## *Grand Canyon National Park*

There are several viewpoints and visual corridors within Grand Canyon National Park that are in the vicinity of the proposed withdrawal area or provide potential views into the withdrawal area. These areas are described below and illustrated in Figure 3.9-3.

### KANAB POINT

Kanab Point is part of Grand Canyon National Park and is accessed through the North Parcel from SR 389 and Toroweap Road (see Figure 3.9-1). Foreground and middle ground views to the east and south of this point include views of the Colorado River Canyon and Kanab Creek Wilderness. Foreground and middle ground views to the north include the Kanab Creek Wilderness.

### TUCKUP CANYON TRAILHEAD

Tuckup Canyon Trailhead is located within Grand Canyon National Park and accessed from SR 389 via Toroweap Road (see Figure 3.9-1). Foreground and middle ground views to the east and south of this trailhead include views of the canyons of the Colorado River and tributaries. West of Tuckup Canyon Trailhead are background views of Mount Logan and Mount Trumbull. North of the Tuckup Canyon Trailhead are foreground and middle ground views toward Hancock Knoll.

### BRIGHT ANGEL POINT

Bright Angel Point is a paved pedestrian overlook on the North Rim near the North Rim Lodge and is accessed via SR 67. Bright Angel Point overlooks the Grand Canyon with a vista that extends from the southeast to the southwest. Foreground views extend from Angel’s Gate and Coronado Butte to the southeast and continue west to the area of Osa Butte and Powell Memorial. The point overlooks the Bright Angel Fault, and Grand Canyon Village is visible across the canyon. Because of the higher elevation of the North Rim relative to the South Rim, background views extend far to the include the San Francisco Peaks, Red Butte, SR 64 to Grand Canyon Village and Bill Williams Mountain.

## POINT IMPERIAL

Point Imperial, located on the North Rim in Grand Canyon National Park, is accessed by the Point Imperial Road. It is the highest point on the North Rim, at 8,803 amsl. It overlooks the Painted Desert and the east end of Grand Canyon.

## CAPE ROYAL

Cape Royal is a panoramic viewpoint located within Grand Canyon National Park on the North Rim. Cape Royal is accessed via SR 67 and the Cape Royal Road. Cape Royal's high vantage point provides extensive foreground views of the Grand Canyon region extending from the northeast to the northwest. Foreground views include Wotan's Throne and the Palisades of the Desert, Vishnu Temple, Coronado Butte, and Bright Angel Canyon in Grand Canyon. Background views include the Little Colorado River Valley, Desert View, the San Francisco Peaks, Red Butte and Point Sublime. To the North is the Walhalla Plateau in Grand Canyon National Park.

## CAPE FINAL

Cape Final is accessed via a short trail hike from Cape Royal Road. Cape Final offers foreground views to the north into Marble Canyon in Grand Canyon and the Marble Platform. Background views include the Vermilion Cliffs, Echo Cliffs, and Navajo Mountain. It provides views to the east of Cape Solitude and the Little Colorado River valley. Views to the south include foreground views of Grand Canyon, middle ground views of Desert View, and background views of Mount Humphreys. Cape Royal and the Walhalla Plateau in Grand Canyon are visible west of Cape Final.

## SOWATS POINT

Sowats Point is located on Forest Service land overlooking Jumpup and Kanab canyons. Middle ground views to the west include the Kanab Plateau and Jumpup Point. Background views to the west include Mt. Trumbull and Mt. Logan. Views to the south include Fishtail Mesa in Grand Canyon National Park. Views to the north extend into upper Jumpup Canyon.

## HOPI POINT

Hopi Point is located in the south rim area of Grand Canyon National Park west of Grand Canyon Village along the Hermits Rest Road. It provides views of the Grand Canyon and the North Rim, along with some views of the Colorado River to the west.

## TRAILVIEW OVERLOOK

Trailview Overlook is accessed by Hermit Road This viewpoint provides views of the Bright Angel Trail, Bright Angel Creek, and Plateau Point. Background views to the south include the Kaibab Plateau, Red Butte, the San Francisco Peaks, and Bill Williams Mountain.

## GRANDVIEW POINT

Grandview Point is located in the South Rim area of Grand Canyon National Park along Desert View Drive. This popular viewpoint offers panoramic views of Grand Canyon from east to west, including several bends of the Colorado River to the east.

### DESERT VIEW WATCHTOWER

Desert View Watchtower is located at the east end South Rim area of Grand Canyon National Park along Desert View Drive. The viewing tower, at 70 feet high, is the highest point on the South Rim. The tower provides panoramic views of the region, including the Grand Canyon, the Painted Desert to the east, and the San Francisco Peaks to the south. Foreground views of Grand Canyon extend from north to west. To the east, foreground views include Cedar Mesa and the Navajo Reservation. Background views to the north and east extend to the Marble Platform, Navajo Mountain, Echo Cliffs, and Little Colorado River Canyon.

### HERMIT ROAD CORRIDOR

Hermit Road is a scenic route along the west end of Grand Canyon Village on the South Rim that follows the rim for 7 miles out to Hermits Rest. This road is accessed by park shuttle bus, foot, and bicycle most of the year, with private vehicles allowed only during winter months. The road provides access to several viewpoints and offers views of the Grand Canyon to the north and the Kaibab Plateau to the south.

### HAVASUPAI POINT

Havasupai Point is located on the South Rim of Grand Canyon National Park approximately 30 miles from Grand Canyon Village and is primarily accessed by Forest Road 328 and Havasupai Point Road in Grand Canyon National Park. Havasupai Point offers views of Grand Canyon from east to west. Point Sublime and Powell Plateau on the North Rim are both visible from Havasupai Point.

## 3.9.5 Night Sky

The nighttime visual resources (e.g., “dark night skies”) of northern Arizona and southern Utah are nationally significant and represent one of the best opportunities for the American public to experience such a sight (BLM 2008b). These dark night skies are an important characteristic of the remote setting and contribute to the nighttime visual landscape of the area. All parcels in the proposed withdrawal area provide outstanding opportunities for visitors to experience significant views of stars and other objects in the night sky.

Light pollution is caused by outdoor lights that are upwards or sideways. Any light that escapes upward, unless blocked by an object, will scatter throughout the atmosphere and brighten the night sky. Air pollution particles also increase the scattering of light at night, just as they impact visibility during the daytime.

The NPS has developed a system for measuring sky brightness to quantify the source and severity of light pollution and is monitoring parks in the region of the proposed withdrawal area. The nearest monitoring site is in Grand Canyon–Parashant National Monument, which is directly east of the North Parcel. The most recent data were collected at McDonald Flat on February 24, 2006, as detailed in the night sky quality monitoring report (NPS 2006a). The report states

> Seeing good, transparency very good, daytime visibility about 80 miles. Very dark at zenith, very little airglow tonight. Detail in Milky Way extensive, galactic light extends east to Beehive cluster in Cancer and nearly to Polaris in Ursa Minor. Gegenschein easy, zodiacal band visible from Saturn through gegenschein east into the airglow. Light dome of Las Vegas casts a shadow, irritates night vision, definitely brightest thing in the sky. Noticeable decrease in size and brightness as night progresses. Other light domes minimal intrusion on an otherwise pristine sky. (NPS 2006a)

The report also discusses zenith limiting magnitude, which refers to the faintest stars that can be observed with the naked eye. There are 14,000 stars visible at magnitude 7.0 conditions, 5,000 stars visible at magnitude 6.0 conditions, and only a few dozen stars visible at magnitude 1.0. The best night skies range from magnitude 6.6 to 7.5. The Grand Canyon–Parashant National Monument had a zenith limiting magnitude value of 7.1, which is at the high end of the scale and provides views of approximately 14,000 stars.

### 3.9.6 Grand Canyon National Park Class I Airshed

Grand Canyon National Park is classified under the CAA as a Class I area. This requires the PSD of air quality and allows only very small increments of new pollution above already existing air pollution levels. An important visual resource component of air quality in Grand Canyon National Park is "visibility." Scenic vistas can be diminished by haze that reduces contrast, color, and visibility of landscape features. A change in contrast of not more than 5% at sensitive view areas is considered acceptable.

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas and publishes IMPROVE data. The purpose of this monitoring is to identify and evaluate patterns and trends in regional visibility. Data from three IMPROVE monitors within Grand Canyon National Park show that fine ($PM_{2.5}$) and coarse ($PM_{10}$) particulates were the largest contributors to the impairment of visibility. These particulates impact the standard visual range for each monitor location. The standard visual range is the distance that can be seen in a given day. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park (GRCA1, GRCA2, and INGA1) range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days (IMPROVE 2010).

For a more detailed discussion on Air Quality, see Section 3.2.

### 3.9.7 Visual Quality Indicators

The specific indicators for visual resource conditions are as follows:

- Consistency with and conformity to designated BLM VRM class objectives;
- Consistency with and conformity to Forest Service scenic quality management or integrity objectives;
- Consistency with and conformance to Park visual objectives from key viewpoints within the Park; and
- Qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal parcels and Grand Canyon National Park.

## 3.10 SOUNDSCAPES

The Grand Canyon National Park Enlargement Act of 1975 [PL 93-620] established that natural quiet should be protected as a resource and a value to the Park. Natural quiet is defined as the level of all natural sounds in an area, excluding all mechanical, electrical, and other human-caused sounds. Natural quiet is the baseline sound level used for this study.

The information presented in this section was derived from the following reports: *Mining Adjacent to Grand Canyon National Park: Potential Impacts to the Natural Soundscape of the Park*, dated January 28, 2010 (Ambrose 2010a), *Sound Levels of Equipment and Operations at the Arizona 1 Uranium Mine in Northern Arizona*, dated June 21, 2010 (Ambrose 2010b), and *Sound Levels and Audibility of Common Sounds in Frontcountry and Transitional Areas in Grand Canyon National Park, 2007–2008* (Ambrose 2008).

## 3.10.1 Noise Fundamentals

Airborne sound is the rapid fluctuation of air pressure caused by mechanical vibrations. Noise is defined as unwanted sound that interferes with normal activities or in some way reduces the quality of the environment. Response to noise varies according to its type, perceived importance, appropriateness in the setting, time of day, and the sensitivity of the individual receptor.

### Definitions of Acoustical Terms

The following section describes the acoustical terms used throughout this analysis.

- *Ambient noise level* is defined as the composite of noise from all sources near and far, the normal or existing level of environmental noise at a given location.
- *Decibel* (dB) is the physical unit commonly used to describe sound levels. Technically, a dB is a unit of measure that describes the amplitude of sound equal to 20 times the base 10 logarithm of the ratio of the reference pressure to the sound of pressure, which is 20 micropascals (µPa).

Sound measurement is further refined by using a *decibel "A-weighted" sound level* (dBA) scale that more closely describes how a person perceives sound. The dBA scale is logarithmic; therefore, individual dBA values for different sources cannot simply be added together to calculate the sound level for the two sources. For example, two 50-dBA sources, added logarithmically, produce a collective noise level of 53 dBA.

- *Equivalent noise level* ($L_{eq}$) is the energy average A-weighted noise level during the measurement period.
- *Intruding noise* is the noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends on its amplitude, duration, frequency, time of occurrence, and tonal informational content, as well as the prevailing ambient noise level.
- *Percentile noise level* ($L_n$) is the A-weighted noise level exceeded during n% of the measurement period. For example, $L_{10}$ is a relatively loud noise exceeded only 10% of the time, while $L_{90}$ is a relatively quiet sound exceeded 90% of the time. People tend to exhibit differing sensitivity to noise depending on the time of day, with noise generated at night being more annoying than that generated during the day.

### Sound Levels of Representative Sounds and Noises

A *day-night average noise level* ($L_{dn}$) is used to determine whether noise would be perceived adversely. The EPA developed an index (threshold) to assess noise impacts from a variety of sources using residential receptors. If $L_{dn}$ values exceed 65 dBA, residential development is not recommended (EPA 1974). Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful; levels higher than 80 dBA over continuous periods can result in hearing loss. Constant noises tend to be less noticeable than irregular or periodic noises. Table 3.10-1 presents sound levels for some common noise sources and the human response to those decibel levels.

**Table 3.10-1.** Sound Levels of Representative Sounds and Noises

| Source | Sound Level (dBA) | Human Response |
|---|---|---|
| Jet Takeoff (Nearby) | 150 | |
| Jet Takeoff (50 feet) | 140 | |
| 50-HP Siren (100 feet) | 130 | |
| Loud Rock Concert (Near Stage) | 120 | Pain threshold |
| Construction Noise (10 feet) | 110 | Intolerable |
| Jet Takeoff (2,000 feet) | 100 | |
| Heavy Truck (25 feet) | 90 | |
| Garbage Disposal (2 feet) | 80 | Constant exposure endangers hearing |
| Busy Traffic | 70 | |
| Normal Conversation | 60 | |
| Light Traffic (100 feet) | 50 | Quiet |
| Library | 40 | |
| Soft Whisper (15 feet) | 30 | Very quiet |
| Rustling Leaves | 20 | |
| Normal Breathing | 10 | Barely audible |
| Threshold of Hearing | 0 | |

Source: Beranek (1988).

## 3.10.2 Noise Assessment Components

Soundscapes are affected by the following factors:

- Proximity to noise sensitive areas (NSAs): NSAs are defined as the occupants of a location where a state of quietness is a basis for use or where excessive noise interferes with the normal use of the location. Typical NSAs include parks and wilderness areas. Natural soundscapes are an accumulation of all natural sounds that occur in the unpopulated parks and wilderness areas. The NSAs of concern in or near the proposed withdrawal area include the following: Kaibab National Forest, the Vermilion Cliffs National Monument, the North Rim of the Park, Bright Angel Point, the east entrance to the Park (Desert View), the South Rim of the Park, and Yavapai Point Museum. The critical question is whether the NSAs will be adversely affected by proposed withdrawal noise.
- “Transmission path” or medium: The “transmission path” or medium for sound or noise is most often the atmosphere (i.e., air), while for vibration, the medium is the earth or a human-made structure. In order for the noise/vibration to be transmitted, the transmission path must support the free propagation of the small vibratory motions that make up the sound and vibration energy. Atmospheric conditions (e.g., wind speed and direction, temperature, humidity, precipitation) influence the attenuation of sound. Barriers and/or discontinuities that attenuate the flow of sound or vibration energy may compromise the path.
- Source: The sources of sound and vibration are any generators of small back-and-forth motions (i.e., motions that transfer their motional energy to the transmission path where it is propagated). The acoustic characteristics of the sources are very important. Sources must generate sound or vibration of sufficient strength, approximate pitch, and duration so that the sound or vibration

may be perceived and is capable of causing adverse effects, compared with the natural ambient sounds. The new sources of proposed withdrawal noise/vibration are discussed further in Chapter 4.

## 3.10.3 Regulatory Setting

The following subsections identify federal, state, and local laws and regulations that are pertinent to the evaluation of the proposed withdrawal area and analysis of soundscape impacts.

Federal laws and regulations: There are numerous laws and guidelines at the federal level that are relevant to the assessment of air and ground transportation noise and vibration impacts. These include the following:

- Federal Highway Administration Procedures for Abatement of Highway Traffic Noise and Construction Noise [23 CFR 772]
- National Environmental Policy Act of 1969 [PL 91-190, 42 USC 4321, *et seq.*, 40 CFR 1506.5]
- Noise Control Act of 1972, as amended [PL 92-574, 42 USC 4901 *et seq*.]
- Occupational Safety and Health Administration (OSHA) Occupational Noise Exposure; Hearing Conservation Amendment (*Federal Register* 48[46]:9738–9785)
- Mine Safety and Health Administration (MSHA) Occupational Noise Exposure [30 CFR 62]
- U.S. Surface Transportation Board Environmental Rules [49 CFR 1105.7(6)]
- Special Flight Rules in the Vicinity of Grand Canyon National Park [14 CFR Part 91 et al.]
- National Park Service Director's Order 47: Soundscape Preservation and Noise Management, December 1, 2004.
- The Coconino County Comprehensive Plan, September 23, 2003.

In addition to the aforementioned regulations, NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

There are no BLM, Forest Service, or state noise regulations or standards applicable to exploration or development activity or to the proposed withdrawal area.

## 3.10.4 Existing Conditions

All three of the proposed withdrawal parcels border Grand Canyon National Park. The area is naturally quiet and generally not subject to modern sources of unnatural sound intrusion or noise. Natural ambient sound levels in non-tourist areas of the Park are generally low level, ranging from 18.3 to 22.8 dBA, with a log mean natural ambient sound level of 20.8 dBA. The existing ambient (L50) sound levels in tourist areas vary, depending on the amount of visitation, but are consistently higher than the L50 levels in the same acoustic zones of non-tourist areas. The L50 of the busiest, most visited front country areas are 20 to 30 dBA higher than the L50 in non-tourist areas of the same acoustic zone. At tourist areas with fewer visitors or with restrictions on vehicle access, the differences are much smaller (Ambrose 2010a).

The existing ambient L50 levels in tourist areas of the Park during the daytime, in the summer, range from 23.7 dBA (measured 3.7 miles below the Grand Canyon rim along Bright Angel Trail) to 56.6 dBA at the west end of Village Loop Road (Ambrose 2008). Current potential sound sources include highway traffic, tour and commercial airplane over flights, vehicles, and Park visitors (Ambrose 2010b).

The current soundscapes of the Kaibab National Forest consist of both natural sounds and a variety of human-generated sounds. The major noise producers include highway traffic, military overflights, and general aviation flights (BLM 2007).

The current soundscape of the Havasupai, Hopi, Hualapai, Kaibab-Paiute, and Navajo reservations consists of both natural ambient sounds and a variety of human-generated sounds. Noise sources include some residential noise, air tour flights, commercial flight patterns, highway traffic, and visitors to the monuments and reservations.

In August 2009, Denison received authorization from the ADEQ to operate its Arizona 1 Mine, located approximately 35 miles south of Fredonia, Arizona. This mine is in the North Parcel of the proposed withdrawal area. The mine started operations in December 2009. Denison Mines provided a list of equipment to be used at the Arizona 1 Mine site that could be considered typical of equipment that would likely be used at other mines in the areas, operating under similar mining conditions (personal communication, Lorraine Christian, BLM 2010). The equipment in use at the Arizona 1 Mine includes the following:

- 40-ton haul trucks (loaded with 25 tons of ore)
- Two front-end loaders with 2.5- to 3.5-yard buckets
- One water truck
- One forklift
- One vent fan
- One sorting screen
- One emergency generator
- Electric transformer

The above equipment list was included for illustration purposes only. Any proposed future mine site locations would be expected to use differing numbers and varieties of mining equipment, and any attempt to extrapolate sound levels from data relating to this existing mining operation is impractical and therefore unwarranted.

## *General Description of Resource*

Noise related to uranium mining activities results from initial heavy-duty construction equipment operations (e.g., trucks, backhoes, excavators, etc.) and long-term from production operations (e.g., haul trucks, mine shaft vent fans, sorting screen operations, etc.). The region of influence attributed to any noise source is based on the location of noise-sensitive receptors relative to the activity. To properly evaluate any potential effects that could be caused by noise, each individual sound-producing activity would need to be evaluated/modeled using the specific mine site location, number and types of equipment, operation schedules, site-specific topography, and climatic conditions relative to the projected location of receptors of concern.

## *Resource Condition Indicators*

The soundscape condition indicators to be evaluated in Chapter 4 of this assessment are as follows:

- Discussion of the possible changes in ambient noise levels in the immediate vicinity of any proposed uranium mine sites. The nature of noise modeling requires specific details regarding the locations and distances between all sources and receivers of interest.

- Discussion of the potential increases in ambient noise levels in the immediate vicinity of any proposed uranium mine site operational activities, compared with the existing baseline noise levels at the nearest NSA.
- Discussion of the potential increases in ambient noise levels associated with mine exploration and development activity to determine compliance with applicable federal regulations and federal land manager rules, policies, and orders.

To assess the current value of the resource condition indicators, measurement of existing background noise levels in the specific area of any potential mine sites would be required. Once the background values have been accurately established, screening level noise models could be run. Either measured or manufacturer noise data from proposed mining equipment would be used for modeling. The results of the model would allow for a mathematically sound estimate of possible noise effects of proposed mining operations at virtually any remote receiver of interest as agreed to by the concerned parties. Without specific knowledge of the location of potential mine sites, no realistic conclusions can be drawn with regard to the possible noise effects of their operation on the Park or any other nearby receiver of concern.

Federal law establishes special rules for the air space in and around Grand Canyon National Park. As a minimum condition, any potential helicopter prospecting operations would need to be conducted within those established guidelines. Cursory noise estimates of these operations cannot be reliably completed without knowing specific noise characteristics of the helicopter to be used and detailed flight paths for the prospecting operations.

As a first level evaluation, the noise level values produced by the noise model could be compared directly to related noise standards. The EPA has determined that an $L_{dn}$ of 55 dBA protects the public from indoor and outdoor activity noise interference. NPS, under 36 CFR 2.12, Audio Disturbances, prohibits operation of motorized equipment or machinery that exceeds a noise level of 60 dBA at 50 feet, or, if below that level, nevertheless makes noise that is unreasonable.

## *Current Value Resource Condition Indicators*

The current value or condition of the soundscape within the proposed withdrawal parcels with respect to each of the resource condition indicators is presented in Table 3.10-2.

**Table 3.10-2.** Soundscape Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Noise disruption from exploration or development activity | The areas subject to noise effects and the intensity of sound from these activities need to be evaluated for each proposed site and all associated operations. Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park. | *Indicator*: The decibel level due to exploration and mining equipment.<br>*Indicator*: The distance and direction between the source and receiver and for the evaluation of noise attenuation to baseline sound levels.<br>*Indicator*: Comparison measured or modeled values with applicable rules, policies, or orders established by the federal land managers.<br>*Indicator*: Comparison of specified values to regulations established by the EPA and the U.S. Department of Transportation. |

# 3.11 CULTURAL RESOURCES

Cultural resources are physical phenomena associated with past or present cultures and include archaeological sites and historic buildings and structures, as well as places of traditional religious and cultural importance. Cultural resources also include TCPs, which is a formal designation for properties vital to a community's practices and beliefs. These properties are tied to a community's cultural identity. Traditional cultural and sacred places, ethnographic landscapes, and TCPs are addressed in Section 3.12.

Cultural resources refer to both human-made and natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. The proposed withdrawal area is composed of three parcels, each of which contains unique and distinctive resources that represent several themes that are important to history and prehistory.

Management of resources on all three proposed withdrawal parcels is primarily guided by the NHPA requirements described in Chapter 1. In addition, the BLM and Forest Service have their own supplemental directives and management plans.

## 3.11.1 Cultural Setting

Archaeologists generally divide the cultural history of the American Southwest into five major periods, whose time spans vary by geographic region. In the Grand Canyon region, these periods include the Paleoindian (9500–6500 B.C.), Archaic (6500 B.C.–A.D. 500), Formative (A.D. 500–1300), Protohistoric (A.D. 1300–1540), and Historic (A.D. 1540–present) (Willey and Phillips 1958). Each of these periods does not represent a single cultural tradition; rather, it signifies the occurrence of several cultures with similar traits that existed at roughly the same time. Even the most "homogeneous" of cultural periods, the mobile hunter-gatherer Paleoindians, can be divided into different traditions based on what type of projectile point was used. The hunter-gatherers of the Archaic produced even more types of projectile points and the first grinding stones for plant processing. The greatest diversity of the prehistoric age can be seen during the Formative, when people practiced agriculture, lived in a variety of structure types, and made and traded many different types of ceramics and other goods. Throughout prehistory, all groups took advantage of the varied resources available in different altitudes and geographic zones. For example, during the Formative and Protohistoric, many people farmed in canyons where the creeks and rivers ran and then would hunt wild game and gather wild plants on the plateaus. With the arrival of the Europeans, the region saw even more varied uses like cattle grazing, mining, timbering, homesteading, railroads, and eventually tourism. Many of these uses by several groups, including American Indians, continue today. See Appendix I for a detailed culture history of the area.

## 3.11.2 Identification of Prehistoric and Historic Cultural Resources

A Class I inventory of all known cultural resources within the three proposed withdrawal parcels was conducted to quantify site type and distribution (Seymour et al. 2010). The Class I inventory consists of a comprehensive review of files from the BLM, the Kaibab National Forest, and AZSITE (a statewide archaeology database), as well as a review of available literature and maps of the proposed withdrawal area. Sensitivity maps were derived from this information and from analysis of previously published ethnographic information.

Under the NHPA, significant cultural resources are those eligible for the NRHP. To be NRHP eligible, a property must be at least 50 years old (with rare exceptions) and possess integrity of location, design, setting, materials, workmanship, feeling, and association. A site, building, structure, or district may be determined eligible if it meets at least one of four criteria [36 CFR 60.4]:

> Criterion A: Associated with events that have made a significant contribution to the broad patterns of our history;
>
> Criterion B: Associated with the lives of persons significant in our past;
>
> Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> Criterion D: Have yielded, or may be likely to yield, information important in prehistory or history.

Table 3.11-1 provides information on the number of sites and their NRHP eligibility status. Table 3.11-2 enumerates the listed NRHP properties and the criteria under which they were determined eligible.

Within the three parcels, 447 sites have been evaluated and recommended or determined NRHP eligible (see Table 3.11-1). Twelve sites have already been listed in the NRHP (see Table 3.11-2). To date, 196 sites have been recommended or determined ineligible for the NRHP; 1,880 sites have not yet been evaluated with respect to NRHP eligibility status.

**Table 3.11-1.** National Register of Historic Places Status of Archaeological Sites and Historic-Age Properties by Parcel

| | North | East | South | Total |
|---|---|---|---|---|
| Listed | 0 | 1 | 11 | **12** |
| Eligible | 119 | 60 | 268 | **447** |
| Ineligible | 97 | 7 | 92 | **196** |
| Unevaluated | 407 | 103 | 1,370 | **1,880** |
| **Total** | **623** | **171** | **1741** | **2,535** |

**Table 3.11-2.** National Register of Historic Places Listed Properties

| Name of Property | Site Number | NRHP Criterion/Criteria |
|---|---|---|
| Kane Ranch Headquarters | | A |
| Tusayan Saginaw and Manistee Railroad | | A and D |
| Grand Canyon Railway | | A and C |
| Hull Cabin Historic District | | A, B, and C |
| Grand Canyon Airport Historic District | | A and C |
| Cabin 1 | 03070400159 | A and C |
| Cabin 6 | 03070400807 | A and C |
| Tusayan/Moqui Ranger Station | 03070400813 | A and C |
| Grand View Lookout Tower and Cabin | 03070400621 | A and C |
| Grandview Lookout Tree | 03070400860 | A |
| Hull Tank Lookout Tree | 03070400868 | A |
| Tusayan Lookout Tree | 03070400869 | A |

Note: With the exception of Kane Ranch Headquarters, which is in the East Parcel, all are located in the South Parcel.

Site density per surveyed acre varies by parcel: the North Parcel has a site density of 13.7 sites per surveyed square mile; the East Parcel has a site density of 32.3 sites per surveyed square mile; and the South Parcel has a site density of 14.8 sites per surveyed square mile. Only 2.5% of the East Parcel has been systematically surveyed; 5.3% of the North Parcel has been systematically surveyed. The South Parcel has the highest number of known sites with the highest percentage of inventoried land. A little more than 23% (23.5%) of the parcel has been subject to systematic inventory. Assuming that the inventory locations were random, at least with respect to the presence or absence of cultural resources, it would be relatively safe to predict a doubling of archaeological sites in the South Parcel. Perhaps as few as 10% of the expected sites have been identified in the North and East parcels. It is likely that the numbers are even higher, since portions of the North Parcel have considerably more available water than the South Parcel. In addition, many sites in the North Parcel were recorded during unsystematic survey. Figures 3.11-1 through 3.11-3 show the concentration of known sites in each parcel by Section. Site concentrations are shown rather than sites per surveyed acre to include those sites recorded during unsystematic surveys.

## *Site Affiliations and Descriptions*

The three parcels contain archaeological sites resulting from thousands of years of human occupation. Table 3.11-3 summarizes the major time periods and cultural affiliations assigned to documented sites. As Paleoindian sites are notably rare, the pre-Formative category combines sites of the Paleoindian and Archaic periods. The Formative category is broadened to include sites of the Protohistoric period, which can be difficult to identify on the basis of site data.

**Table 3.11-3.** Cultural Affiliation Totals for Each Parcel

| | | North Parcel | East Parcel | South Parcel | Total |
|---|---|---|---|---|---|
| **Unknown** | Unknown American Indian* | 262 | 34 | 562 | **858** |
| **Pre-Formative** | Archaic | 45 | 4 | 68 | **117** |
| | Paleoindian | 1 | 1 | 0 | **2** |
| | Paleoindian/Archaic | 2 | 0 | 0 | **2** |
| *Pre-Formative Subtotal* | | *48* | *5* | *68* | ***121*** |
| **Formative** | Ancestral Puebloan | 161 | 96 | 305 | **562** |
| | Ancestral Puebloan/Virgin | 53 | 1 | 0 | **54** |
| | Archaic/Ancestral Puebloan | 7 | 1 | 0 | **8** |
| | Cerbat and Cerbat/Pai | 0 | 0 | 32 | **32** |
| | Cohonina | 0 | 0 | 491 | **491** |
| | Paiute | 5 | 0 | 0 | **5** |
| *Formative Subtotal* | | *226* | *98* | *828* | ***1,152*** |
| **Historic** | Euro-American | 39 | 9 | 98 | **146** |
| | Government | 1 | 0 | 0 | **1** |
| | Havasupai | 0 | 0 | 1 | **1** |
| | Navajo | 0 | 0 | 97 | **97** |
| *Historic Subtotal* | | *40* | *9* | *196* | ***245*** |
| **Unspecified or Limited Information** | | 47 | 25 | 87 | **159** |
| **Total** | | **623** | **171** | **1,741** | **2,535** |

* The Unknown American Indian category consists of flaked stone artifact scatters with no temporally or culturally diagnostic projectile points or other flaked tools.

The pre-Formative category consists of the following Cultural Affiliation subcategories: Archaic, Paleoindian, and a combination of the two. Unknown American Indian sites are sites that lack distinctive artifacts to support assignment to a specific time period or cultural affiliation. Some of these sites may represent hunting or resource collection sites for later Formative peoples, but they lack ceramics and only contain stone artifacts that cannot be attributed to a certain culture or period. If a site was recorded as having multiple occupational periods or was associated with multiple cultural identities, it was labeled as such. This process of combining multiple information sets applies to all subcategories.

The Formative category consists of numerous cultural identities within the subcategory of Cultural Affiliation: Ancestral Puebloan, Cohonina, etc. The Cultural Affiliation subcategory of the Historic period category consists of various cultural identities, including historic Navajo, Euro-American, and American Indian sites of unknown tribal affiliation. Other categories under Cultural Affiliation for the category of the Historic period are sites that had limited information or sites that could not be determined to be historic or prehistoric in origin; these sites were classified as Indeterminate.

## *Types of Prehistoric and Historic Sites*

The Class I inventory indicates a strong potential for significant prehistoric and historic cultural resources within the three proposed withdrawal parcels in areas that have yet to be inventoried. Because Class III (on-the-ground, intensive) surveys are required prior to authorizing specific surface-disturbing activity, the number of known significant sites is likely to increase over time.

All three parcels contain a diverse range of site types, representing activities and land uses that took place over thousands of years. Approximately one-third of the sites cannot be reliably assigned to a specific cultural tradition or time period. They consist largely of prehistoric or American Indian artifact scatters that lack pottery or other datable items. These sites resulted from temporary use of dispersed locations for traveling, short-term shelter, and collecting natural resources for food, medicine, and production of tools and other items. Although many of these sites may be pre-Formative, others may date to the Formative or later periods, as known Paleoindian and Archaic period sites account for less than 10% of the sites in each parcel.

### NORTH PARCEL

As shown in Table 3.11-3, 35% of the known archaeological sites are Ancestral Puebloan sites of the Formative period. Those clearly associated with the Virgin and Virgin/Moapa traditions, centered to the west of the North Parcel, account for 23% of the Formative sites and are rarely found in the East and South parcels. Site types include settlements or habitations, temporary camps, granaries and caches used for food storage, and rock art.

Fewer than 10% of the recorded sites date to the Historic period and reflect the legacy of ranching, homesteading, and mining activities. These sites include cabins, corrals, roads, trails, mines, cairns, and artifact scatters.

### EAST PARCEL

As shown in Table 3.11-3, 57% of the known archaeological sites are Ancestral Puebloan sites of the Formative period. The range of site types is similar to that of the North Parcel, except for a cluster of water-control features related to farming activities at the base of the Kaibab Plateau.

About 5% of the sites date to the Historic period and are related primarily to ranching and transportation. Inscriptions are located along the routes of the historic Dominguez-Escalante and Mormon Honeymoon trails, which traversed the northern margin of the parcel below the Vermilion Cliffs.

### SOUTH PARCEL

As shown in Table 3.11-3, 46% of the known archaeological sites are Ancestral Puebloan sites, primarily associated with the Cohonina tradition of the Formative period. The Cerbat tradition accounts for 4% of the Formative sites. Site types include settlements or habitations, temporary residences, artifact scatters, and resource procurement and processing locations.

Six percent of the sites are from the Historic period and are associated with ranching, mining, logging, and forest management activities. They include cabins, corrals, mines, roads, five lookout towers, and four railroad tracks/beds. The Civilian Conservation Corps constructed many of the roads, towers, and other facilities in the 1930s. There are also 97 recorded sites attributed to use by the Navajo and one site attributed to the Havasupai, including the remains of temporary shelters, hogans, and sweat lodges.

## 3.11.3 Resource Condition Indicators

Appropriate resource condition indicators for cultural resources are as follows:

- The number of known prehistoric and historic sites to be affected and number of acres to be disturbed by mining exploration and development.
- Changes in settings or visual qualities that contribute to the integrity of cultural resource sites (evaluated qualitatively) and the degree to which reclamation practices can be used to restore the settings of sites.

### *Current Value Resource Condition Indicators*

Although it is difficult to know the current condition of all of the cultural resources in the three proposed withdrawal parcels, sites adjacent to existing access roads have likely been subject to the greatest levels of direct damage and are likely more vulnerable to theft and vandalism. Erosion of archaeological sites caused by newly graded roads and increased vehicular activity may also result in the loss of integrity.

Archaeological site vandalism is a serious problem throughout the western United States. The Kaibab National Forest and the BLM have recorded incidents of site vandalism, particularly at highly visible sites such as pueblos, historic buildings, and other structures. Unfortunately, since many sites have yet to be fully recorded or re-inspected, the total amount of vandalism may not be ascertainable. That said, because of the remote nature of many of the sites, it is likely that many sites have not been vandalized.

# 3.12 AMERICAN INDIAN RESOURCES

The term American Indian resources refers to places, which may include archaeological sites, that are regarded as important to Indian cultures and traditions. These places may be individual landforms or larger geographic features, they may be places associated with sacred beings or ancestors, or they may be places where people came and still come to hunt game or to gather plant resources. Several laws and policies protect American Indian resources:

- The National Historic Preservation Act [16 USC 470] created the NRHP and the Section 106 process, which requires federal agencies to consider the effects of their actions on historic properties, including places of traditional religious and cultural importance to Indian tribes.
- The American Indian Religious Freedom Act [PL 95-341; 42 USC 1996] establishes a national policy to protect the right of American Indians and other indigenous groups to exercise their traditional religions.

- EO 13007, Indian Sacred Sites, was designed to accommodate access to American Indian sacred sites on federal land and to avoid harm to these sites "to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions."
- NEPA requires assessing potential impacts of a federal undertaking to the human environment, including places of cultural importance, consistent with the stated policy to preserve important cultural aspects of our national heritage.

## 3.12.1 Traditional Cultural Values and Practices

American Indians in the Southwest have an intimate relationship with their traditional territories, especially that of the Grand Canyon area (Fairley 2004; Hirst 2006; Stoffle et al. 2005). For the purposes of this analysis, the term Grand Canyon area encompasses the Grand Canyon, the proposed withdrawal area, and the lands immediately adjacent to both; however, precise boundaries cannot be established at this time because what is considered the "Grand Canyon area" will vary across tribes. Many groups see their history and culture as being bound and expressed in the landscape. Often, certain places were shaped by the actions of ancestors or spirit beings, or these beings and their actions are embodied in natural features and landmarks. All of these beliefs mean that for American Indians their traditional territories contain places that are of "traditional religious or cultural importance" [NHPA (16 USC 470)]. Some of these places are considered by tribes to be TCPs which a federal agency may determine as eligible for the NRHP. TCPs are places that are connected to "those beliefs, customs, and practices of a living community of people" (Parker and King 1998). TCPs generally embody values, beliefs, or practices that are widely shared within the group and have been passed down through generations. To be determined eligible for the NRHP, a property must meet one or more of the legal eligibility criteria. Few properties have received formal evaluations. This EIS addresses potential impacts to places that tribes define as traditionally important regardless of their NRHP eligibility status.

One NRHP-eligible TCP, Red Butte, is located within the South Parcel. However, many places within the proposed withdrawal area may have qualities that would render them eligible for the NRHP as TCPs.

Data on places important to some tribes within the withdrawal parcels are presently available for the following American Indian groups: Southern Paiute (Las Vegas Paiute Tribe, Kaibab Band of Paiute Indians, Moapa Band of Paiute Indians, Pahrump Paiute Indian Tribe, Paiute Tribe of Utah, which includes the Shivwits Band of Paiute, and San Juan Southern Paiute Tribe), Havasupai Indian Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Pueblo of Zuni.

### *Southern Paiute*

The Southern Paiute today consist of the Kaibab Band of Paiute Indians, San Juan Southern Paiute, Paiute Indian Tribe of Utah, which includes the Shivwits Band of the Paiute, Moapa Band of Paiute Indians, and Las Vegas Tribe of Paiute Indians. Before the arrival of European-Americans, the Southern Paiute were primarily hunter-gatherers who practiced a limited amount of cultivation. Their traditional territory extended from the Grand Canyon north into Utah and Nevada.

For the Southern Paiute and other Numic language speakers everything in the world has *puhu* (power) (Stoffle et al. 2005). Puhu permeates everything and "is why everything is alive, has a will, and is capable of action" (Stoffle et al. 2005:19). Puhu connects all things and can move throughout the world. The Southern Paiute consider all of their traditional territory sacred because it is connected to stories of mythic beings (Franklin and Bunte 1994). For example, the San Juan Paiute believe that people came about when Coyote opened a quiver that was given to him by Ocean Grandmother. All the different peoples emerged out of the quiver, with the Paiute being last. Coyote opened the quiver southeast of the

Colorado River, which is considered the San Juan Paiute's homeland and the center of the world (Franklin and Bunte 1994).

The reservation of the Kaibab Band of Paiute Indians borders the northern border of the North Parcel, and they are the most intimately connected of the Southern Paiute bands to the proposed withdrawal area. Both the North and East parcels are part of their traditional homeland and have been used by them for as long as they can remember. Several important traditional sacred and cultural places for the Kaibab Band of Paiute Indians are located within the boundaries of the proposed withdrawal area.

### *Havasupai Tribe*

The Havasupai Tribe today occupy a 185,000-acre reservation located within Havasu Canyon and up onto the Coconino Plateau; however, their traditional territory stretched from the Colorado River to Bill Williams Mountain and from the Aubrey Cliffs to the Little Colorado River and included the entire South Parcel (Schwartz 1983). Traditionally, Havasupai lived within the Havasu Canyon, which is within the Grand Canyon, in the summer and on the plateau in the winter. Havasupai farmed the canyon bottom in the summer and relied on hunted and gathered resources from the plateau in the winter.

According to their beliefs, the Havasupai peoples emerged from the earth in the Grand Canyon in search of light (Tilousi 1993). Havasupai origin tales tell of a time when the people lived beneath the earth and had no light to hunt by (Smithson and Euler 1994:36; Tilousi 1993). Two brothers traveled through a hole in the earth and acquired the sun and the moon for the people. The Havasupai believe that the Canyon, the surrounding plateau, and all the plants and animals were given to them to care for. They believe themselves to be a part of the Grand Canyon and that they cannot be separated from it (Hirst 2006:207). The Havasupai have tales about many of the landforms in and around the Grand Canyon, including landforms within the proposed withdrawal area. It is important to the Havasupai that they are asked "about the sacredness of the area, about places where the bone of our ancestors are buried" (Tilousi 1993).

### *Hualapai Tribe*

Before the arrival of European-Americans, the Hualapai Tribe's traditional territory stretched from the Colorado River south to the Bill Williams River and from the Black Mountains east to Havasu Canyon (McGuire 1983). According to their stories, the Hualapai, along with the Havasupai and Yavapai, were created in the west at Wikame or "Spirit Mountain" by two brother deities (Fairley 2004). All the Pai peoples then journeyed to the Grand Canyon, led by the older of the two brothers, who taught them all they needed to survive in the area (Kroeber 1935:15–26; Hualapai Tribe 1993; Stevens and Mercer 1998 cited in Fairley 2004:66). They all lived together until a children's fight led to the three tribes' splitting up; the Hualapai and Yavapai parted ways, and the Havasupai moved into the Grand Canyon.

The Grand Canyon and the surrounding areas are regarded as sacred to the Hualapai. Many of the landforms are connected to stories about the ancestors, with the river and the Grand Canyon serving as the "backbone" or Ha' Yi-Data (Hualapai Tribe 1993; Stevens and Mercer 1998, cited in Fairley 2004:66; Whatoname 2009).

### *Navajo Nation*

The Navajo traditional territory extends from just west of the Rio Grande in New Mexico to the Colorado River in Arizona and from north of the San Juan River to just south of the Little Colorado River (Brugge 1983). The Navajo consider the Colorado River itself as sacred and a source of power; it also represents the westernmost boundary of Navajoland (Roberts et al. 1995, cited in Fairley 2004:69–70). According to Navajo stories, the Navajo emerged from earth after they had traveled through several underground worlds (Gill 1982, 1983; Klah 1942; Stephen 1930). Violence and conflicts that sometimes led to destruction caused them to seek a new world each time. Once they had emerged onto the current world's surface, they were in Dinetah, or their traditional homeland, which is bordered by four sacred mountains. These mountains are associated with the cardinal directions and are located at each of the four corners of the world (Gill 1982). Many of the mountains and other landforms seen today were created by the actions of sacred beings after the Navajo emerged from the worlds below. The Navajo have a story about how each place came to be; the association of traditional territory with the sacred beings and their actions makes the entire area sacred to the Navajo. These places include archaeological sites throughout their traditional territory, as these were the homes of their ancestors. Navajo ceremonies, songs, prayers, and sandpaintings all reference these ancestral places.

### *Hopi Tribe*

The Hopi traditional territory extends over the entire state of Arizona. The Hopi, along with all other people, emerged into the current world, the Fourth World, from the Third World at a place called Sipapuni located in the Grand Canyon (Fairley 2004; Nuvamsa 2008). Upon emerging into the Fourth World, the Hopi were met by Maasaw, the Earth Guardian, who charged the Hopi with the care of the earth. The different peoples left the Sipapuni and journeyed toward the east (Vecsey 1983). Some stopped and settled for a while before moving east again; these are the builders of the ruins seen throughout the land (Stephen 1929; Vecsey 1983). The Hopi finally settled on Black Mesa; each of the clans arrived separately. Although the Hopi currently do not live near the Grand Canyon, it is the origin place of their people, and they see themselves as stewards of the earth, including the Grand Canyon and the proposed withdrawal area (Ferguson 1997; Nuvamsa 2008).

### *Pueblo of Zuni*

The traditional territory of the Pueblo of Zuni extends into both Arizona and New Mexico. Like the Hopi, the Zuni emerged into the Fourth World in the Grand Canyon. Once they emerged, they were told to seek the "middle place;" once they arrived there, they could settle and build their town (Ferguson and Hart 1985:21–23; Gill 1982). The Zuni traveled for several years and tried to settle in a few places. Each time, their village was destroyed or they decided to move because the location was deemed not to be the middle place (Gill 1982; Parsons 1923). The Zuni eventually asked a series of animals to help them locate the middle place; finally, a water strider found the place and told the Zuni to settle beneath his heart (Parsons 1923). Like the Hopi, the Zuni are intimately connected to Grand Canyon, and, like the Hopi, the ruins found in the area are the towns of their ancestors (Ferguson and Hart 1985:21–23).

## 3.12.2 American Indian Use Areas

The following discussion is based on research of sources available to the public, as well as a report on important ethnographic resources within the proposed withdrawal area commissioned by the NPS (Hedquist and Ferguson 2010). The following information is entirely from published sources unless otherwise noted. Because of the sensitive nature of some information provided by tribes not found in published literature, some areas may not be discussed in detail.

In addition to the places described below, because of association with their ancestors, American Indians often consider prehistoric and historic sites as significant. Most American Indians prefer that archaeological sites not be disturbed and that access to them be limited in order to prevent vandalism.

## *Colorado Plateau*

The Colorado Plateau, both north and south of the Grand Canyon, is regarded by many tribes as a traditional cultural landscape extending back thousands of years. The concept of 'cultural landscape' or 'ethnographic landscape' is taken from scholarly literature and is used in the EIS exclusively in this sense. These terms are not intended to imply any kind of landscape level protection. Within the Colorado Plateau, there are several smaller areas, as well as specific places that are of concern to one or more tribes for traditional, cultural, or sacred reasons. Several studies have detailed the traditional ethnographic landscapes of the Southern Paiute on the Arizona Strip, although the area has also been used by other groups (Austin et al. 2005; Stoffle et al. 1997; Stoffle et al. 2005). These studies have identified several sensitive areas in both the North and East parcels, as well as areas immediately adjacent to the proposed withdrawal area. The places important to the Southern Paiute vary in size and shape and are not necessarily mutually exclusive. In addition, the Havasupai have expressed cultural concerns about the Kanab Plateau during consultation.

The lands that form the South Parcel represent traditional use areas for several tribes: Southern Paiute, Hualapai, Havasupai, Hopi, Navajo, Yavapai, and Pueblo of Zuni. These tribes share concern for the entire area, as well as specific locations within the parcel, which reflect long-term use and overlapping territories.

Many of the important landscapes and places are connected with water. For example, the Southern Paiute consider the Colorado River the "blood vein of the earth" (Stoffle et al. 2005). Other creeks and rivers are smaller veins that are "water connection places," which link all parts of the land to one another (Stoffle et al. 2005). Springs, as water sources, also are special places. According to Kelly (1964:11–13), springs could be "owned" by Paiute family groups, who would camp there over the course of their seasonal cycle.

Trails served as important communication and trade routes for many different peoples throughout the proposed withdrawal parcels. Many trails followed important water sources or served as pilgrimage routes. Other important areas include places used for traditional hunting and gathering. Kelley (1964) identified several areas within all three proposed withdrawal parcels that were used for various subsistence activities by the Southern Paiute. She identified economic clusters/seasonal cycles and areas used for specific resource procurement activities. Kelly defined these economic clusters/seasonal cycles based on spring location and how groups traveled from spring to spring in order to collect seasonal resources (Kelley 1964:11, 22–23). The lands in the North and East parcels were used primarily by the Southern Paiute; the lands of the South Parcel were used by the Hopi, Havasupai, and Navajo for subsistence (Hedquist and Ferguson 2010). These areas are not defined as economic clusters/seasonal cycle areas but are considered traditional use areas.

In addition, there are specific religiously and culturally significant places throughout the three proposed withdrawal parcels. These places may be considered sacred to one or more tribes and used for ceremonial, as well as other, purposes.

### GRAND CANYON REGION LANDSCAPE

The Grand Canyon region landscape stretches from Navajo Mountain and the Kaibab Plateau in the east to the Beaver Dam Mountains to the west and from the Paunsaugunt and Markagunt plateaus in the north and the Colorado River in the south, and it is the largest of the Paiute traditional landscapes. The boundaries encompass "the watersheds that drain into the Colorado River" (Stoffle et al. 1997). The Grand Canyon, known as Piapaxa 'uipi or "Big River Canyon," is the "central focus of . . . [the] landscape" (Stoffle et al. 1997); however, the Grand Canyon regional landscape consists of myriad connected places throughout the entire area (Stoffle et al. 1997). Importantly, the region represents the extent of the traditional Paiute seasonal movement prior to the arrival of Europeans.

## *North Parcel*

### KANAB CREEK ECOSCAPE

The Kanab Creek ecoscape stretches from Bulrush and Hack Canyon washes in the east to Snake Gulch to the west and from the confluence of Kanab Creek with the Colorado River in the south to the Pink Cliffs in the north. Like the Grand Canyon region landscape, the Kanab Creek ecoscape is defined by watersheds (Stoffle et al. 2000). The Kanab Creek watershed falls within the traditional territory of the Kaibab Band of the Paiute, who farmed along the creek and exploited the various plant and animal resources available throughout the area (Stoffle et al. 1997; Stoffle et al. 2000). The Kanab Creek ecoscape was also an important north-south trade route and served as a refuge for Paiutes during European-American encroachment (Stoffle et al. 1997; Stoffle et al. 2000).

### KANAB CREEK AND THE COLORADO RIVER

Although they are included in the above landscapes, the Kanab Creek and Colorado River are themselves considered significant places to the Paiute, especially to the Kaibab Band of the Paiute. The Southern Paiute Consortium considers these and "the whole region in and around Grand Canyon as an indivisible Traditional Cultural Property" (Southern Paiute Consortium 2010). For the Navajo, the Colorado River is thought of as a TCP since it plays a role in their creation stories (Molenaar 2005:17). The Zuni and the Hopi emerged in the Grand Canyon from the previous worlds. Although the Zuni consider the confluence of the Little Colorado and Colorado rivers a TCP, the entire Grand Canyon and river habitat are "integrally connected to Zuni religious beliefs, ceremonies, and prayers" (Dongoske 2009:2).

### KANAB CREEK GHOST DANCE SITE

A rock art site associated with the Ghost Dance is located within the Kanab Creek Canyon at an unpublished location (Stoffle et al. 2000). The site consists of pictographs painted on and petroglyphs pecked into a sandstone outcrop. It has likely been used for more than 2,000 years. The Kaibab Paiute have identified one panel of white figures as being associated with the Ghost Dance ceremony, which was performed in the late nineteenth century (Stoffle et al. 2000). The Ghost Dance was a revitalization movement that began among the Paiute in Nevada but quickly spread throughout tribes in Northern Arizona and Utah and into the Great Plains (Kehoe 1989).

### SPRINGS

Three springs located within the North Parcel are important to the Southern Paiute. Moonshine Spring is located just west of Bulrush Wash, Wa'akarerempa or Yellowstone Spring is located on Yellowstone Mesa, and Tinkanivac or Antelope Spring is located in Antelope Valley (Austin et al. 2005:79; Hedquist and Ferguson 2010:9; Kelley 1964:8). Moonshine and Yellowstone springs also have several archaeological sites associated with them. The Moonshine Ridge ACEC encompasses Moonshine Spring and its associated archaeological sites.

### TRAILS

Several trails cross the North Parcel. Along Kanab Creek, a trail stretches from the northern edge of the parcel to the Grand Canyon. The Kanab Creek trail was the Paiute's "entrance" into the canyon (Stoffle et al. 2005:182). Another trail ran from the spring Tinkanivac to the Colorado River (Kelley 1964:88; Stoffle et al. 1994:76).

Although not specifically mentioned in the literature, access routes to culturally significant places south of the parcel must also be considered. Mt. Trumbull, Toroweap, Vulcan’s Anvil, and several springs, which are all part of Paiute traditional territory, are located just outside the southwest corner of the parcel. Access to these areas is primarily through the North Parcel. Modern access is via roads; however, the existence of trails to this area has been documented in the ethnographic literature. Many modern roads and trails follow ancient American Indian trails through the North Parcel. During consultation, the Hopi Tribe indicated that several places north of the Grand Canyon, including Mt. Trumbull, have traditional cultural importance. The Hopi travel through the North and East parcels to reach places of ritual importance north of the Grand Canyon.

#### ECONOMIC/SUBSISTENCE AREAS AND TRADITIONAL TERRITORIES

Both the traditional territories Kaibab and Uinkaret bands of the Southern Paiute occur within portions of the North Parcel (Kelley 1934:548, 551). Kelley (1964) identified the Economic Cluster/Seasonal Cycle I as extending from Moonshine Spring north into the current Kaibab Paiute Reservation (Kelley 1964:11). Other important resource procurement areas include an antelope hunting range in Antelope Valley (Austin et al. 2005:3, 80; Kelley 1934:554; Kelley and Fowler 1986:369) and a mescal gathering location along Kanab Creek (Austin et al. 2005:3; Kelley 1934:554; Kelley and Fowler 1986:369).

### *East Parcel*

#### HOUSE ROCK VALLEY (AESAK LAND)

The Paiute called House Rock Valley Aesak or “basket-like” (Austin et al. 2005:57). The entire valley was used by the Paiute to gather plant resources and to hunt animals. Although House Rock Valley was traditionally the territory of the Kaibab Paiute, the San Juan Paiute were allowed to collect seeds in the fall. In return, the Kaibab Paiute could collect seeds in the summer from the territory of the San Juan Paiute. As part of this agreement, the host group would hold a round dance for the visitors; the dance allowed continued interaction between the groups and often led to intergroup marriages (Bunte and Franklin 1987:19).

#### KANE RANCH (OARINKANIVAC AND PAGAMPIAGANTI)

Two springs important to the Paiute sit on the Kane Ranch property: Oarinkanivac and Pagampiaganti. Families would camp at these springs seasonally when foraging for resources (Kelly 1964:10–12).

#### HOUSE ROCK VALLEY TRAILS

Trails are also an important component for the Paiute of the House Rock Valley (Stoffle et al. 2005). For example, what is now known as the Mormon Honeymoon Trail was once an American Indian trail along the Vermilion Cliffs. This trail accessed several important spring sites along the cliffs, including Deer and House Rock springs. This trail and the sites along it should be considered a connected resource.

Another trail running from Kane Ranch to the Colorado River connects the springs to the Grand Canyon near the location of the Hopi Salt Mine (Kelley 1964:89; Stoffle et al. 1994:76).

### ECONOMIC/SUBSISTENCE RESOURCE AREAS

The Paiute Economic Cluster/Seasonal Cycle VIII and Economic Cluster/Seasonal Cycle IX extend into the East Parcel in the north (Hedquist and Ferguson 2010:12, 65–66; Kelley 1964:11–22). Both of these are associated with springs along the Vermilion Cliffs; the Economic Cluster/Seasonal Cycle IX is also associated with Kane Ranch and the two springs located there. Also, areas for hunting deer and antelope are located in the valley (Austin et al. 2005:3; Ferguson and Hedquist 2009:8; Kelley 1934:554; Kelley and Fowler 1986:369).

In addition to the places and landscapes discussed above, several important places are directly adjacent to the proposed withdrawal area and should be considered. These include several sites along the Vermilion Cliffs (including the California condor release site, West Bench Pueblo, Signature Rock, and Jacob's Pool), as well as Vasey's Paradise (personal communication, J. Balsom, Grand Canyon National Park 2010).

## *South Parcel*

### RED BUTTE

Red Butte is located in the southern portion of the South Parcel and is a known sacred site for the Havasupai, Hualapai, Navajo, Hopi, and Zuni. The Forest Service has determined that Red Butte is eligible for listing in the NRHP as a TCP for its association and importance to American Indian beliefs and ceremonialism. The Forest Service has worked with the above named tribes to document Red Butte's importance as a gathering place for trade and ceremonialism for the tribes. In addition, the tribes have expressed concern in the past for the travel corridor from Red Butte north to the Grand Canyon (personal communication, J. Balsom, Grand Canyon National Park 2010).

### NAVAJO CULTURAL LANDSCAPE

The South Parcel is within the Navajo Nation's traditional claim area (Hedquist and Ferguson 2010:249). Within that claim area lies the Coconino Plateau cultural landscape known as Dzil Libáí or Grey Mountain (Linford 2000:69). The area was used mainly in the nineteenth century and served as a battlefield for conflicts between the Navajo and Mexicans (Linford 2000:69). In the South Parcel, the number of archaeological sites of the Historic period attributed to the Navajo (99) indicates that they were regularly using the area. Most of these sites, scattered throughout the parcel, are the remains of sweat lodges and other shelters. These may have been temporary camps associated with hunting, other activities, or periodic travel to the Grand Canyon from the homeland. In addition, a Navajo ceremonial site is located on the Coconino Plateau, but its exact location is unknown (Hedquist and Ferguson 2010:14; Roberts et al. 1995:91).

### HOPI TRADITIONAL USE AREA

The Hopi traditional use area or claim area covers the entire state of Arizona, which includes the South Parcel (Hedquist and Ferguson 2010:251; Kuwanwisiwma and Ferguson 2010).

### HUALAPAI TRADTIONAL TERRITORY

The Hualapai have long used and continue to use the South Parcel for settlement, hunting and gathering, gardening, trade, and travel. In oral histories, Hualapai elders describe birth places as well as gatherings near Red Butte with the Hopi, Havasupai, and other tribes. Trails were important in maintaining social, kinship, and trade relations with other tribes. Items traded by the Hualapai to other groups included tanned deer hides and red paint (hematite). Hualapai place names east of the South Parcel reflect the close relationships between the Hualapai and the western area of Hopi settlements around present-day Moenkopi.

### TRAILS

A network of trails crosses the South Parcel, connecting the Hopi and Zuni with the Havasupai and Hualapai. These trails generally run east-west and extend well beyond the boundaries of the parcel. Some trails run all the way from the Rio Grande Pueblos to the Pacific Ocean. Many of these trails can be seen on early General Land Office maps from the turn of the century. The best known trails are those that run from Hopi Mesa to the Grand Canyon and the territory of the Havasupai. At least one trail leads past Red Butte on its way to the Grand Canyon (Colton 1964). Two Navajo trails used to access the canyon and Havasupai territory are found in the northern portion of the South Parcel (Roberts et al. 1995:73–74). These trails not only represent long-distance trade, but also long-standing and important social and kinship relations between the Hualapai, Hopi, and other tribes.

### HAVASUPAI SEASONAL CAMPS

The Havasupai traditional use area encompasses the South Parcel (Hedquist and Ferguson 2010:252). Two Havasupai seasonal camps are located in the northern portion of the South Parcel: one is located near Hull Tank; the other is at Rain Tank. The area around Hull Tank is used for pinyon collection while the camp at Rain Tank was primarily associated with trade with the Hopi and Navajo (Manners 1974:106; Wray 1990:19, 46).

### SPRINGS

The Hualapai and Havasupai consider all springs in the South Parcel and surrounding areas to be sacred, and the health and vitality of these springs is vital to the well-being of the people and all living beings.

## *Natural Resources*

Many plant and animal species found the proposed withdrawal area are important to the cultural and religious practices of American Indian tribes. For example, the bald eagle figures prominently in many American Indian cultures. Several plant species are gathered within the proposed withdrawal area. The Hualapai harvest Kaibab agave (*Agave utahensis* var. *kaibabensis*) from areas near and within the proposed withdrawal area. Other plant species important to the Hualapai found in the proposed withdrawal area are listed in Table 3.12-1.

**Table 3.12-1.** Plants Important to the Hualapai in the Proposed Withdrawal Area

| Plant | Scientific Name | Plant | Scientific Name |
|---|---|---|---|
| Algerita | *Berberis fermontii* | Big Sagebrush | *Artemisia* sp. |
| Apache Plum | *Fallugia paradoxa* | Black Walnut | *Juglans maior* |
| Arizona Ash | *Flaxinus velutina* | Black Willow | *Salix* spp. |
| Arizona Manzanita | *Arctostaphylos* sp. | Burrobrush | *Hymenoclea* sp. |
| Arrow weed | *Pluchea sericea* | Catsclaw | *Acacia* sp. |
| Banana Yucca | *Yucca baccata* | Cattail | *Typha* sp. |
| Barrel Cactus | *Ferocactus* sp. | Cholla | *Opuntia* sp. |
| Beargrass | *Nolina* sp. | Cliffrose | *Cowinia mexicana* |

**Table 3.12-1.** Plants Important to the Hualapai in the Proposed Withdrawal Area (Continued)

| Plant | Scientific Name | Plant | Scientific Name |
|---|---|---|---|
| Cottonwood Tree | *Populus* sp. | Ponderosa Pine | *Pinus ponderosa* |
| Creosotebush | *Larrea tridentata* | Prickly Pear | *Opuntia* spp. |
| Desert Willow | *Chilopsis lineris* | Reed | *Phragmites comminus trin.* |
| Devil's Claw | *Proboscidea parviflora* | Seep Willow | *Baccharis spp.* |
| Dock, Wild Rhubarb | *Rumex hymenosepalus Ton.* | Shrub Live Oak | *Quercus turbinella* |
| Filaree | *Erodicum* sp. | Snakeweed | *Gutierrezia* spp. |
| Four Winged Salt Bush | *Atiplex* spp. | Soapweed | *Nolina parryi* |
| Gambel Oak | *Quercus gambelii* | Squawberry | *Rhus trilobata* |
| Globemallow | *Sphaeralcea* sp. | Stick Leaf | *Mentzelia* spp. |
| Indian Tea, Mormon Tea | *Ephedra* spp. | Sunflower | *Helianthus* spp. |
| Juniper | *Juniperus* sp. | Wild Mulberry | *Morus* sp. |
| Mescal agave | *Agave* sp. | Wild Onion | *Allium* spp. |
| Mesquite | *Prosopis* sp. | Wild Onion/Turnip | *Cymoqterus* spp. |
| Milkweed | *Asclepias* spp. | Wild Tabacco | *Nicotiana trigonophylla* |
| Mohave Yucca | *Yucca mohavensis sarg.* | Wild Tomato | *Physalis* spp. |
| Netleaf Mexican Locust | *Robina neomexicana* | Wildgrape | *Vitis* sp. |
| Ocotillo | *Fouquieria* spp. | Yerba Santa | *Eriodictyon angustifolium* |
| Piñon Pine | *Pinus edulis* | | |

Source: Adapted from Watahomigie et al. (1982).

### *Trust Resources and Assets*

BLM Manual Handbook H-8120-1, *Guidelines for Conducting Tribal Consultation* (BLM 2004), defines Indian trust assets as "lands, natural resources, money, or other assets held by the Federal Government in trust or restricted against alienation for Indian tribes and individual Indians (Secretarial Order No. 3215, April 28, 2000). Trust is a formal, legally defined, property-based relationship that depends on the existence of three elements: (1) a trust asset (lands, resources, money, etc.); (2) a beneficial owner (the Indian tribe or individual Indian allottee); and (3) a trustee (the Secretary of the Interior)."
There are no Trust Resources or Assets located within the proposed withdrawal parcels.

## 3.12.3 Resource Condition Indicators

Resource condition indicators for traditionally important places are not easily definable or quantifiable. The importance of landscapes and places can be understood through a group or individual's "sense of place." Sense of place refers to how people experience and understand a location; the experience and understanding are a product of one's cultural history and values, such that different groups can experience the same place in different ways (Allen et al. 2009; Farnum et al. 2005). Sense of place is tied to group and individual emotions and backgrounds, making it difficult to define and even harder to quantify.

When dealing with places of traditional heritage, the analysis of possible impacts is dependent on the emotional and intellectual response of the concerned groups and individuals. It is, in essence, their reaction and opinions alone that determine whether there is an impact and the relative significance of that impact. Indicators include the following:

- The proximity and size of possible surface, visual, or auditory disturbance to, or within, identified TCPs.
- Number of acres of total possible disturbance by mineral exploration and development.
- Proximity of traditional use areas to anticipated mineral exploration and development.
- Likelihood of concurrent or overlapping timing of traditional activity with mineral exploration and development.
- Manner and degree of auditory or visual disruptions in the traditional use area.
- Number and types of traditional cultural use areas, sacred sites, and trails that could be disturbed by mineral exploration and development.

# 3.13 WILDERNESS RESOURCES

## 3.13.1 Wilderness

Permanent wilderness protection for federal lands comes only through Congressional action that creates “statutory” or “designated” wilderness areas. Such lands are managed under the mandates of the Wilderness Act of 1964 [16 USC 1131–1136] and any special management instructions that Congress may include in the specific legislation that “designates” specific wilderness areas. The Wilderness Act dictates that wilderness areas are managed to protect and preserve their “wilderness character.”

Congressional intent for the meaning of wilderness character is expressed in the Definition of Wilderness, Section 2(c) of the 1964 Wilderness Act. The BLM, Forest Service, NPS and other agencies apply the legal definition to identify four tangible qualities of wilderness that make up the description of wilderness character relevant and practical to wilderness stewardship:

- **Untrammeled:** The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man” and “generally appears to have been affected primarily by the forces of nature.”
- **Natural:** The Wilderness Act states that wilderness is “protected and managed so as to preserve its natural conditions.” Wilderness ecological systems are substantially free from the effects of modern civilization.
- **Undeveloped:** The Wilderness Act states that wilderness is an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, “where man himself is a visitor who does not remain” and “with the imprint of man’s work substantially unnoticeable.”
- **Solitude or a primitive and unconfined type of recreation:** The Wilderness Act states that wilderness has “outstanding opportunities for solitude or a primitive and unconfined type of recreation.”

There are three wilderness areas immediately adjacent to the proposed withdrawal area: Kanab Creek (which is jointly managed by the BLM and Forest Service and is adjacent to the North Parcel); Paria Canyon–Vermilion Cliffs (jointly managed by the Arizona Strip Field Office and Utah BLM, and adjacent to the East Parcel); and Saddle Mountain (managed by the Forest Service and adjacent to the East Parcel).

The Arizona Wilderness Act of 1984 designated these three areas. The Arizona Wilderness Act released certain BLM lands in the Arizona Strip and KNF lands from further wilderness review. The Act specifies that areas not designated wilderness shall be managed for multiple uses; that the creation of protective perimeters or buffers for uses up to the boundary of the wilderness area is not the intention of the Act; and that the wilderness designations would be subject to valid existing rights. Importantly, the Act did not preclude future reviews for wilderness or other conservation uses by the Secretary.

The three wilderness areas within or immediately adjacent to the proposed withdrawal area currently provide a standard of solitude and naturalness that ranges from good to outstanding. They contain little to no evidence of surface disturbance, other than former vehicle ways and scattered prospects. Federal lands within wilderness areas are closed to mineral entry, subject to valid existing rights. No valid mineral discoveries have been documented in any of these wilderness areas.

Lands that have the tangible qualities of a wilderness but that have not been designated a wilderness by an act of Congress are sometimes managed to maintain wilderness characteristics. Wilderness characteristics are discussed and analyzed in Sections 3.14 and 4.14 of this FEIS.

### *Kanab Creek Wilderness*

The Kanab Creek Wilderness is managed jointly by the BLM and Forest Service in accordance with the *Kanab Creek Wilderness Implementation Schedule* (BLM and Forest Service 1988) and covers 70,460 acres. The Kanab Creek Wilderness straddles the Mohave–Coconino county line and is contiguous along about 14 miles of its boundary with NPS lands in Grand Canyon National Park. The Kanab Creek Wilderness is located on the eastern border of the North Parcel and is part of the largest canyon system on the north side of the Grand Canyon. It includes impressive rock formations, colorations, and features carved by wind and water. Numerous springs provide an interesting contrast with the generally arid terrain. The cliffs are home to bands of desert bighorn sheep as well as peregrine falcons.

### *Paria Canyon–Vermilion Cliffs Wilderness*

The Paria Canyon–Vermilion Cliffs Wilderness is managed by the BLM in accordance with the *Paria Canyon–Vermilion Cliffs Wilderness: Wilderness Management Plan* (BLM 1986c) and covers 112,500 acres. The wilderness is located approximately 10 miles west of Page, Arizona, in Coconino County, Arizona, and Kane County, Utah. The wilderness is located along the northern border of the East Parcel. Nationally known for its beauty, Paria Canyon has towering walls streaked with desert varnish, huge red rock amphitheaters, sandstone arches, wooded terraces, and hanging gardens. The 3,000-foot escarpment known as the Vermilion Cliffs dominates the remainder of the wilderness with its thick Navajo sandstone face, steep, boulder-strewn slopes, rugged arroyos, and stark overall appearance. Desert bighorn sheep and peregrine falcon inhabit the area.

### *Saddle Mountain Wilderness*

The Saddle Mountain Wilderness contains a total of 40,539 acres and is managed by the Forest Service. The wilderness straddles the eastern edge of the Kaibab Plateau and is located southwest of the East Parcel. Three permanent springs in North Canyon and one in South Canyon provide water and a gathering place for the local inhabitants, including pronghorn antelope, blue grouse (*Dendragapus obscures*), small mammals, and a buffalo herd. Trailheads that access the wilderness originate at the top of the Kaibab Plateau and at its base in House Rock Valley. The Saddle Mountain Trail parallels the main ridge for approximately 4 miles and rewards hikers with views of the Marble Canyon Gorge, Cocks Comb, House Rock Valley, and the Vermilion Cliffs. It also provides access into Grand Canyon National Park. The North and South canyon trails, 7 and 4 miles long, respectively, follow canyon bottoms.

### *Proposed Wilderness*

A wilderness proposal was prepared for Grand Canyon National Park in 1980; it was updated in 1993 and awaits further action. It proposed a wilderness designation for 1,109,257 acres, with an additional 29,820 acres of potential wilderness within Grand Canyon National Park, pending the resolution of Park boundary and motorized riverboat issues. These areas offer visitors opportunities for solitude and primitive recreation. The management of these areas should preserve the wilderness values and character (NPS 1995).

The 2006 *NPS Management Polices* and Director's Order 41 require that proposed wilderness areas be managed the same as designated wilderness and that no actions be taken that would diminish wilderness suitability until the legislative process for wilderness designation has been completed. Therefore, NPS manages all proposed wilderness areas as wilderness and anticipates the final resolution of wilderness issues and the preparation of a wilderness management plan as future actions. NPS policies address wilderness management as well as management of threats to park resources (NPS 2006b). The NPS-proposed wilderness is managed under the wilderness character attributes described in Section 3.13.1.

Nonwilderness undeveloped areas continue to serve primarily as primitive thresholds to wilderness. Areas currently excluded from proposed wilderness inside the Grand Canyon National Park include 1) several dirt roads throughout the Park; 2) the area on the South Rim from Hermits Rest to Desert View; 3) Bright Angel Point on the North Rim (300 feet on either side of paved roads and 150 feet on either side of unpaved roads); 4) the Tuweep developed area; and 5) the corridor trails.

## 3.13.2 Resource Indicators

The wilderness resource condition indicators used to characterize wilderness are those indicators that reflect the wilderness characteristics that supported the wilderness designation, as described in Section 3.13.1: land that is untrammeled, natural, undeveloped, and offers solitude or a primitive and unconfined type of recreation (Table 3.13-1).

**Table 3.13-1.** Wilderness Resource Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator |
|---|---|---|
| Wilderness areas | Designated wilderness is already withdrawn from location and entry under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to designated wilderness areas, which may affect wilderness resources. | *Indicator*: Changes in the land's tangible wilderness qualities: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation. |

# 3.14 WILDERNESS CHARACTERISTICS

Federal lands that possess the tangible qualities of a wilderness but that have not been designated a wilderness by an act of Congress are sometimes managed to maintain certain wilderness characteristics. Certain areas of adjacent federal lands, including Grand Canyon National Park, Grand Canyon–Parashant National Monument, and Vermilion Cliffs National Monument, are managed to maintain wilderness characteristics (Figure 3.14-1). The BLM Arizona Strip Field Office, Kaibab Tusayan Ranger District, and NPS all provide management direction in their respective land management plans for wilderness characteristics; this direction is discussed in detail below.

BLM maintains wilderness resource inventories on a regular and continuing basis for public lands under its jurisdiction. BLM Instructional Memo (IM) 2003-275 directs the BLM to protect wilderness characteristics through land use planning and project-level decisions unless the BLM determines, in accordance with IM 2003-275, that impairment of wilderness characteristics is appropriate and consistent with other applicable requirements of law and other resource management considerations.

As discussed below, the proposed withdrawal includes both lands possessing wilderness characteristics as well as lands managed to maintain wilderness characteristics; primarily within or adjacent to the North and East parcels. The analysis area for wilderness characteristics includes the proposed withdrawal areas, and extends to adjacent public lands that possess wilderness characteristics: lands within the Arizona Strip Field Office, Grand Canyon–Parashant National Monument, Vermilion Cliffs National Monument, and Grand Canyon National Park.

## 3.14.1 Resource Indicators

The wilderness characteristics resources condition indicators used to characterize the potential impacts to wilderness characteristics are the qualities for which the wilderness is designated: land that has a high degree of naturalness, an outstanding opportunity for solitude, and an outstanding opportunity for primitive and unconfined recreation (Table 3.14-1). BLM, KNF, and NPS all have guidelines and/or policies in place to manage for wilderness characteristics.

**Table 3.14-1.** Wilderness Characteristics Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator |
|---|---|---|
| Wilderness characteristics | Lands possessing or managed to maintain wilderness characteristics may not already be withdrawn from location and entry under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to lands possessing or managed to maintain wilderness characteristics, which may result in changes to the land's wilderness characteristics. | *Indicator*: Changes in the land's wilderness characteristics: high degree of naturalness, outstanding opportunities for solitude, or outstanding opportunities for primitive and unconfined recreation. |

## 3.14.2 Bureau of Land Management

BLM IM 2003-275 presents the guidelines for managing wilderness characteristics. BLM IM 2003-275 states, "The BLM may consider information on wilderness characteristics, along with information on other uses and values, when preparing land use plans." Table 3.14-2 provides an overview of wilderness characteristics for BLM lands in the Affected Environment, including Vermilion Cliffs National Monument and Grand Canyon–Parashant National Monument (BLM 2008b).

**Table 3.14-2.** Overview of BLM Wilderness Characteristics

| Lands Possessing Wilderness Characteristics | Acreage | Lands Managed to Maintain Wilderness Characteristics | Acreage | Lands Managed to Maintain Wilderness Characteristics within the Proposed Withdrawal Area | Acreage |
|---|---|---|---|---|---|
| Arizona Strip Field Office | 158,033 | Arizona Strip Field Office | 34,764 | Arizona Strip Field Office | 12,846 |
| Grand Canyon Parashant National Monument* | 440,899 | Grand Canyon Parashant National Monument* | 215,345 | Grand Canyon–Parashant National Monument* | 0 |
| Vermilion Cliffs National Monument | 97,380 | Vermilion Cliffs National Monument | 34,566 | Vermilion Cliffs National Monument | 0 |
| **Totals** | **696,312** | | **284,675** | | **12,846** |

Sources: BLM (2008b, 2008e, 2008f); NPS (2008).

* Grand Canyon–Parashant National Monument Includes NPS acreages.

The Arizona Strip Field Office (BLM 2008b) identified approximately 34,764 acres of land adjacent to Kanab Creek Wilderness that possess naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation—characteristics of land described in BLM IM 2003-275 as land containing wilderness characteristics. BLM and NPS lands that possess the above values may be managed to maintain or enhance some or all of those characteristics (BLM 2007).

As described in Table 3.14-2 and illustrated in Figure 3.14-1, there are approximately 12,846 acres of BLM lands managed to maintain wilderness characteristics within the proposed withdrawal area. This acreage includes the Grama and Hack Canyon areas, which are adjacent to Kanab Creek Wilderness. Grama Canyon's lands that are managed to maintain wilderness characteristics total approximately 7,109 acres; Hack Canyon's lands that are managed to maintain wilderness characteristics total approximately 5,737 acres. These areas are managed to maintain the following wilderness characteristics:

- High Degree of Naturalness: Lands and resources affected primarily by the forces of nature and where the imprint of human activity is substantially unnoticeable.
- Outstanding Opportunities for Solitude: When the sights, sounds and evidence of other people are rare or infrequent and where visitors can be isolated, alone or secluded from others.
- Outstanding Opportunities for Primitive and Unconfined Recreation: Where the use of the area will be through non-motorized, non-mechanical means, and where no or minimal developed recreation facilities are encountered.

There are no lands managed to maintain wilderness characteristics within the East Parcel. BLM lands that are managed to maintain wilderness characteristics outside the withdrawal area include 215,345 acres within Grand Canyon–Parashant National Monument (Grand Canyon–Parashant National Monument is jointly managed by BLM and NPS; therefore, this acreage includes NPS lands); 37,566 acres within Vermilion Cliffs National Monument; and 21,916 acres of Arizona Strip Field Office land. In addition, other regional BLM field offices in Washington and Kane counties, Utah, may manage lands to maintain wilderness characteristics.

## 3.14.3 Forest Service

The KNF is currently undergoing a Forest Plan Revision. Through the Forest Plan Revision, Forest Service Manual and Handbook directives provide guidance about wilderness evaluation and management for the Forest Plan revision.

The KNF Forest Plan revision has not designated any lands to be managed to maintain wilderness characteristics (personal communication, Liz Schuppert, Forest Service 2011) within the Tusayan Ranger District, which includes the South Parcel.

## 3.14.4 National Park Service

According the 1995 Grand Canyon National Park General Management Plan, more than 1 million acres in the Park meet the criteria for wilderness designation as part of the national wilderness preservation system (see Figure 3.14-1). These areas proposed for wilderness, although not designated wilderness, are managed as wilderness by the Park. In addition, the Colorado River corridor and adjacent lands are managed as proposed potential wilderness, totaling approximately 12,900 acres (personal communication, Linda Jalbert, NPS 2011).

Additional NPS lands managed to maintain wilderness characteristics outside the withdrawal area include 215,345 acres within Grand Canyon–Parashant National Monument (Grand Canyon–Parashant National

Monument is jointly managed by BLM and NPS; therefore, this acreage includes BLM lands) (NPS 2008).

# 3.15 RECREATION RESOURCES

Recreation activities occurring throughout northern Arizona, including in the proposed withdrawal area and the adjacent Grand Canyon, involve a broad spectrum of pursuits, ranging from dispersed and casual recreation to organized, BLM- and Forest Service–permitted group uses. Typical recreation in the region includes OHV driving, scenic driving, hunting, hiking, wildlife viewing, horseback riding, camping, backpacking, mountain biking, geocaching, picnicking, night-sky viewing, and photography. The region is known for its large-scale undeveloped areas and remoteness, which provide a wide variety of recreational opportunities for users who wish to experience primitive and undeveloped recreation, as well as those seeking more organized or packaged recreation experiences. Figure 3.15-1 provides an overview of recreation in and surrounding the proposed withdrawal area.

The affected environment is based on defining the existing conditions of recreation resources using the management guidelines from the Arizona Strip ROD/RMP (BLM 2008b) and Kaibab LMP/ROD (Forest Service 1988).

## 3.15.1 Recreation Resource Attractions

A vast network of improved and primitive roads, although remote and often requiring high-clearance vehicles, offers a variety of opportunities for driving for pleasure or vehicle exploring. Some of these roads were constructed for mining purposes, and, in some cases, are still used for mining, in addition to public recreation. Figure 3.15-1 illustrates the recreation attraction, including GMUs, campgrounds, overlooks, interpretive sites, and trailheads. Figure 3.15-2 illustrates the existing transportation and access network in the proposed withdrawal area. Remnants of historic trails, such as the Honeymoon Trail, Dominguez-Escalante Route, and the recently designated Old Spanish National Historic Trail, lie within the Arizona Strip. Both the Arizona Strip Field Office and Tusayan Ranger District of the Kaibab National Forest are currently working on revising route designations through separate NEPA processes. The resultant route designations will likely differ from the existing network described in Table 3.15-1 and illustrated in Figure 3.15-2.

The vast majority of BLM lands and the proposed withdrawal area are without formally constructed trails for foot, horse, bike, or motorcycle. Therefore, exploration of its roadless areas via off-route foot or horse travel requires exceptional navigation and outdoor skills. Table 3.15-1 describes the uses of existing routes within the proposed withdrawal area. The Tusayan Ranger District of the Kaibab National Forest has several constructed trails, including the Arizona Trail, a recently designated National Scenic Trail. Table 3.15-1 describes existing routes within the proposed withdrawal area.

**Table 3.15-1.** Existing Routes within the Proposed Withdrawal Area: Mileage Summary by Use and Maintenance Level

| Use Designation | Example of Recreation Use | Miles |
|---|---|---|
| Paved roads | Scenic driving, heritage touring | 70.64 |
| Unpaved roads | Scenic driving, recreational vehicle use, heritage touring, horseback riding, mountain biking, hiking | 2,497.57 |
| Closed roads | Horseback riding, hiking | 0.62 |
| Reclaimed roads | Hiking | 23.94 |
| **Total** | | **2,592.77** |

Sources: BLM (2010f); Forest Service (2010b).

The proposed withdrawal area includes various lands managed to maintain the wilderness characteristics of naturalness, solitude, and opportunities for primitive recreation. These characteristics are defined as follows.

**Naturalness:** Lands and resources exhibit a high degree of naturalness, are affected primarily by the forces of nature, and are areas in which the imprint of human activity is substantially unnoticeable. The BLM has authority to inventory, assess, and/or monitor the attributes of the lands and resources on public lands, which, taken together, are an indication of an area's naturalness. These attributes may include the presence or absence of roads and trails, fences and other improvements, the nature and extent of landscape modifications, the presence of native vegetation communities, and the connectivity of habitats.

**Outstanding Opportunities for Solitude:** Visitors may have outstanding opportunities for solitude when the sights, sounds, and evidence of other people are rare or infrequent and where visitors can be isolated, alone, or secluded from others.

**Outstanding Opportunities for a Primitive and Unconfined Type of Recreation:** Visitors may have outstanding opportunities for primitive and unconfined types of recreation where the use of the area is through non-motorized, non-mechanical means and where no or minimal developed recreation facilities are encountered.

The fact that many of these areas typically include unique scenic beauty and diverse landscape settings increases their recreational quality (BLM 2008b). Recreation sites illustrated in Figure 3.15-1 include trailheads, overlooks and vistas, wildlife viewing areas, camp and picnic grounds, and interpretive sites. These recreation sites are detailed in Table 3.15-2.

**Table 3.15-2.** Inventory of Recreation Sites and Visitor Data within the Proposed Withdrawal Area

| Proposed Withdrawal Area | Land Manager | Recreation Site | Site Type | Visitor Counts (2009)* |
|---|---|---|---|---|
| East Parcel | Forest Service | House Rock Valley Overlook Interpretive Site | Interpretive site | 5,371 |
| East Parcel | Forest Service | Navajo Trail | Trailhead | N/A |
| East Parcel | BLM | Soap Creek | Trailhead | 328 |
| East Parcel | BLM | Rider Canyon | Trailhead | 36 |
| East Parcel | BLM | North Canyon Creek | Trailhead | 36 |
| East Parcel | BLM | Badger Creek | Trailhead | 120 |
| East Parcel | BLM | Dominquez-Escalante Interpretive Site | Historic Site | 10,635 |
| East Parcel | BLM | Condor Interpretive Site | Wildlife/Overlook | 4,200 |
| North Parcel | BLM | Hack Canyon | Trailhead | 402 |
| North Parcel | BLM | Swapp Trail | Trailhead | N/A |
| North Parcel | Forest Service | Gunsight Point | Overlook | N/A |
| North Parcel | Forest Service | Hatch Cabin | Cabin | N/A |
| North Parcel | BLM | Rock Canyon | Trailhead | N/A |
| South Parcel | Forest Service | Ten-X Family Campground | Family Campground | N/A |
| South Parcel | Forest Service | Charlie Tank Group Camp Ground | Group campground | N/A |
| South Parcel | Forest Service | Tusayan Bike Trails | Trailheads | N/A |
| South Parcel | Forest Service | Arizona Trail | Trailhead | N/A |
| South Parcel | Forest Service | Red Butte | Trailhead | N/A |
| South Parcel | Forest Service | Russell Tank Fishing Parking Area | Fishing site | N/A |

**Table 3.15-2.** Inventory of Recreation Sites and Visitor Data within the Proposed Withdrawal Area (Continued)

| Proposed Withdrawal Area | Land Manager | Recreation Site | Site Type | Visitor Counts (2009)* |
|---|---|---|---|---|
| *Outside Withdrawal Area* | NPS | Bass Trail | Trailhead | N/A |
| *Outside Withdrawal Area* | NPS | Kanab Point | Overlook | N/A |
| *Outside Withdrawal Area* | NPS | 150 Mile Canyon | Trailhead | N/A |
| *Outside Withdrawal Area* | Forest Service/NPS | South Canyon | Trailhead | 54 |
| *Outside Withdrawal Area* | NPS | SB Point | Overlook | N/A |
| *Outside Withdrawal Area* | NPS | Grand Canyon Gateway | Park entrance | 4,418,773 |
| *Outside Withdrawal Area* | NPS/BLM | Tuckup Point | Overlook | N/A |
| *Outside Withdrawal Area* | NPS | Toroweap | Campground/Overlook | 3,859 |

Sources: BLM (2009b); Forest Service (2009e); NPS (2009b).

Note: Access to some recreation sites on public lands adjacent to the proposed withdrawal and in Grand Canyon National Park requires users to travel on routes that occur within the proposed withdrawal area; these are therefore considered in this analysis.

* Land management agencies do not track public visitation at some recreation sites.

The open landscapes provide long-distance vistas easily viewed from both paved and unpaved routes. The entire segment of U.S. 89A through the Arizona Strip Field Office is designated by the State of Arizona as a state scenic road. The Arizona Department of Transportation (ADOT)is currently analyzing the potential of U.S. 89A for designation as a National Scenic Byway (personal communication, Richard Spotts, BLM 2010). The segment, along with the other paved routes mentioned, is part of the multiple-partner Vermilion Cliffs Highways Project, which is an initiative to provide interpretive signs at approximately 23 sites (BLM 2008b).

Grand Canyon National Park manages adjacent lands on the North Parcel and the Marble Platform in House Rock Valley (areas adjacent to the Park in the East Parcel are known as the Marble Platform) to maintain its current undeveloped character. These areas are zoned by the Park as Primitive (NPS 1988). NPS zoning does not apply to activities on adjacent multiple-use lands.

## 3.15.2 North and East Parcels

### *Existing Recreation Activities*

The plains, plateaus, mountains, cliffs, and sweeping scenery of the Arizona Strip provide a wide range of opportunities for dispersed, moderately regulated recreation. Exploration, driving for pleasure, hiking, backpacking, camping, picnicking, big- and small-game hunting, wildlife observation, and competitive and organized group events are the most common activity types. Motorized or mechanized vehicle use, walking, or horseback riding are typical modes of travel.

Current recreation setting conditions in the proposed withdrawal area range from primitive to rural, with most of the land being semi-primitive motorized and roaded natural. No urban settings are present directly on BLM-administered lands.

### *Recreation Management—Resources, Signage, and Recreation Facilities*

The proposed withdrawal area (North and East parcels) are accessed by a network of unpaved BLM and Forest Service routes. Many are primitive and can be rough much of the year. This system of routes provides a variety of backcountry driving opportunities and access to key destinations and features. Popular routes include the Toroweap Road, Big Springs Road, and BLM Route 8910 (see Figure 3.15-2).

Access to the remote areas within these parcels offers both the hardy, outdoor adventurer and the sightseeing tourist a wide variety of primitive roads that provide outstanding opportunities for 4-wheel-drive (4WD) and all-terrain vehicle (ATV) exploring and driving opportunities to key destinations and features or for just enjoying the variety of recreation activities. Exploration of most of the backcountry areas within the proposed withdrawal area requires excellent navigational, outdoor and, in some places, canyoneering skills (BLM 2008b).

Few formally constructed non-motorized trails are present in the North and East parcels. Other hiking routes in the proposed withdrawal area tend to take advantage of canyon bottoms, such as Soap Creek, Rider and Hack canyons, or old cattle and sheep trails, such as around the Navajo Trail, Arizona Trail, or ridgelines and old roads.

There are no developed camping facilities within the North and East parcels of the proposed withdrawal area. At-large and dispersed camping occurs at many existing primitive or undeveloped sites along existing roads, trails, and spur roads or trails.

Various small interpretive sites, such as the Dominguez-Escalante Site, Condor Release Interpretive Site, and a variety of single interpretive signs are scattered throughout the area, for example at House Rock Valley Overlook and along the historic Honeymoon Trail.

Visitors typically enjoy the area year-round (although access in the winter can be difficult because of mud and/or snow).

The community interface areas see the greatest variety of recreation users and the highest day-use visitation rates (BLM 2008b) in the proposed withdrawal area. Table 3.15-2 shows annual visitation numbers (where available). Because of the remote nature of much of the area and the dispersed nature of most recreation activities in which visitors engage, it is difficult to obtain actual numbers of most visits to the North and East parcels. For example, no reliable visitor data exist for backcountry camping and OHV use, although these activities frequently take place. The estimates for BLM visitor use are based on data collected from various traffic counters, registration sheets, and professional assumptions determined by data collected on field patrol. No social surveys have been conducted for BLM lands within the proposed withdrawal area.

Motorized activities in these areas are popular and increasing, along with the demand for more opportunities. For instance, local community groups envision the potential to establish formal networks of OHV and/or motorcycle routes connecting various communities in the Arizona Strip (BLM 2008b).

The 2009 Recreation Management Information System (RMIS) data show that BLM lands managed by the Arizona Strip Field Office received approximately 182,564 visitors in 2009. The RMIS numbers are generated by strategic traffic counters and visitor sign-in kiosks. The RMIS results for recreation use of the Arizona Strip by recreation activity showed results that were similar to those of the Kaibab’s National Visitor Use Monitoring Program (NVUM) data, discussed in Section 3.15.3. Interpretation, nature study, and education were the most frequent recreation activities, with approximately 50% of the 2009 visitors engaging in some form of this (BLM 2009b). Scenic driving/viewing was the second-most common recreation activity in the Arizona Strip, with approximately 26% of the 2009 visitors engaging in some form of scenic viewing/driving for pleasure. Table 3.15-3 illustrates the recreation activity in 2009 for the Arizona Strip.

**Table 3.15-3.** Arizona Strip Field Office Visitor Use Activity Groupings for 2009

| Visitor Use Activity | No. of Participants | Visitor Days |
|---|---|---|
| Camping and picnicking | 24,778 | 13,937 |
| Driving for pleasure | 48,343 | 24,172 |
| Hunting | 2,421 | 8,062 |
| Interpretation, education, and nature study | 92,439 | 4,900 |
| Non-motorized travel | 7,480 | 3,398 |
| OHV travel | 1,813 | 806 |
| Specialized non-motor sports, events, and activities | 5,288 | 1,271 |
| Winter/non-motorized activities | 2 | 1 |
| **Total** | **182,564** | **56,547** |

Source: BLM (2009c).

## 3.15.3 South Parcel

The recreation study area for Forest Service lands within the proposed withdrawal area includes the South Parcel, which encompasses the Tusayan Ranger District of the Kaibab National Forest. The Kanab Creek Wilderness, located adjacent to the North Parcel, is jointly managed by the BLM and the Forest Service. The East Parcel also includes Kaibab National Forest land along the western boundary of the parcel.

The Tusayan Ranger District is bordered on the east by the Navajo Reservation, where the rugged Coconino Rim drops off toward the Little Colorado River. To the south, Red Butte dominates the landscape. This volcanic hill is a remnant of past volcanic activities and has cultural significance for many American Indian tribes. With its close proximity to several tribes, the Tusayan Ranger District is an important area for forest product gathering as well as for traditional and ceremonial uses.

The Tusayan Ranger District lies to the south of Grand Canyon National Park. Millions of visitors from the United States and abroad pass through the Tusayan Ranger District every year. The Ten-X Campground offers basic amenities and close proximity to the Grand Canyon. Mountain bikers, hikers, and equestrians enjoy the Arizona National Scenic Trail, which crosses the South Parcel from south to north and passes into Grand Canyon National Park (see Figure 3.15-1). There are backcountry camping, scenery, and wildlife viewing opportunities. The Tusayan Ranger District is known for its trophy-sized elk. There are excellent hunting opportunities for deer, elk, and pronghorn antelope (Forest Service 1988). Many people gather fuel wood for both personal and commercial use. Christmas tree cutting is a popular winter activity (Forest Service 2009g).

Visitors have different motivations for the activities in which they want to participate and preferences for the recreation setting in which they like to recreate. For some forest visitors, traveling on a scenic developed or primitive road with friends or family is ideal. For other forest visitors, visiting remote areas where the signs of human development are absent is ideal. With recognition of such differences in user preferences, the primary aim of managing outdoor recreation is to provide an environment in which visitors can enjoy a satisfying experience in a range of settings.

### *Existing Recreation Activities*

Recreation activities within the Tusayan Ranger District (South Parcel) are similar to those within the Arizona Strip. Unique landscapes, climate, vegetation, and wildlife provide a wide array of recreation opportunities. Developed recreation sites are uncommon in the Tusayan Ranger District (Forest Service

2009g). Exploration, driving for pleasure, hiking, backpacking, camping, picnicking, big- and small-game hunting, wildlife observation, and competitive and organized group events are the most common activity types. Motorized or mechanized vehicle use, walking, or horseback riding are typical modes of travel.

Current recreation setting conditions in the Forest Service lands within the proposed withdrawal area range from Primitive to Rural. No urban settings are present; however, the proposed withdrawal area interfaces with the community of Tusayan (see Figures 3.15-1 and 3.15-3, depicting key attraction sites and recreation settings, respectively).

### *Recreation Management—Resources, Signage, and Recreation Facilities*

The South Parcel of the proposed withdrawal area has approximately 1,892 miles of maintained, unpaved Forest Service roads and trails (Forest Service 2010b). Many are primitive and can be rough much of the year. This system of roads and trails provides a variety of backcountry driving opportunities and access to key destinations and features (see Figure 3.15-2).

Access to these remote areas offers both the hardy, outdoor adventurer and the sightseeing tourist a wide variety of primitive roads that provide outstanding opportunities for 4WD and ATV exploring and driving opportunities to key destinations and features or for just enjoying the variety of recreation activities.

Red Butte, the Arizona Trail, and the Tusayan Bike Trails are among the few formally constructed trails for foot, horse, or bike in the Tusayan Ranger District of the proposed withdrawal area.

There are two developed camping facilities within the South Parcel of the proposed withdrawal area. Ten-X Campground, and Charlie Tank Group Campground are all located along the Grand Canyon Gateway corridor along U.S. 180/SR 64 (see Figure 3.15-1). Dispersed camping occurs at many existing primitive or undeveloped sites along existing routes and spur routes.

The 2005 NVUM report (the best available visitation data) estimated that the Kaibab National Forest received up to 225,000 annual visits to recreation facilities in 2005. Among these site visits, most visitations occurred in undeveloped areas; these areas were also the sites for stays of the longest duration, as shown in Table 3.15-4.

**Table 3.15-4.** Duration of Visits to Kaibab National Forest

| Visit Type | Average Duration (hours) | Median Duration (hours) |
|---|---|---|
| Site visit | 19.3 | 3.7 |
| Day use developed | 2.7 | 2.0 |
| Overnight use developed | 26.9 | 18.8 |
| Undeveloped areas | 45.5 | 3.0 |
| Designated Wilderness | 10.5 | 4.3 |
| National Forest visit | 35.7 | 6.0 |

Source: Forest Service (2009e:FY 2005 data).

The most popular recreation activity for the Kaibab National Forest in 2005 was viewing natural features, with 54.7% of all visitors, followed by hiking and walking for pleasure, with 47.2%. Table 3.15-5 details recreation participation by activity in the Kaibab National Forest.

**Table 3.15-5.** Activity Participation on Kaibab National Forest

| Activity | Total Activity Participation (%)*† | Main Activity (%)‡ | No. of Respondents for Whom Main Activity§ | Average Hours Spent Doing Main Activity (Hours) |
|---|---|---|---|---|
| Some other activity | 26.1 | 22.6 | 206 | 4.3 |
| Viewing natural features | 54.7 | 17.2 | 76 | 6.5 |
| Hiking/walking | 47.2 | 12.0 | 97 | 4.4 |
| Driving for pleasure | 44.2 | 11.4 | 42 | 3.1 |
| Viewing wildlife | 44.8 | 5.8 | 18 | 7.1 |
| Developed camping | 13.7 | 5.4 | 65 | 23.7 |
| Other non-motorized | 8.3 | 5.4 | 71 | 8.0 |
| Motorized trail activity | 7.0 | 4.9 | 7 | 1.3 |
| Hunting | 4.9 | 4.6 | 9 | 42.0 |
| Relaxing | 36.7 | 3.7 | 49 | 23.4 |
| Primitive camping | 13.2 | 3.1 | 29 | 21.3 |
| Bicycling | 6.4 | 2.1 | 8 | 7.3 |
| Fishing | 3.6 | 1.6 | 9 | 7.9 |
| Downhill skiing | 1.6 | 1.4 | 43 | 3.2 |
| Resort use | 8.9 | 1.3 | 5 | 21.8 |
| Visiting historic sites | 21.5 | 1.2 | 6 | 3.8 |
| Backpacking | 2.8 | 0.9 | 5 | 10.4 |
| Picnicking | 12.4 | 0.8 | 5 | 8.8 |
| OHV use | 3.4 | 0.8 | 1 | 2.0 |
| No activity reported | 0.5 | 0.7 | 5 | |
| Nature study | 10.9 | 0.5 | 5 | 15.0 |
| Horseback riding | 2.4 | 0.2 | 1 | 5.0 |
| Nature center activities | 18.9 | 0.1 | 2 | 3.2 |
| Non-motorized water | 0.2 | 0.1 | 4 | 3.4 |
| Cross-country skiing | 0.1 | 0.1 | 3 | 4.0 |
| Other motorized activity | 1.7 | 0.0 | 0 | |
| Gathering forest products | 1.7 | 0.0 | 0 | |
| Motorized water activities | 0.3 | 0.0 | 0 | |
| Snowmobiling | 0.0 | 0.0 | 0 | |

Source: Forest Service (2009e:FY 2005 data).

* Survey respondents could select multiple activities, so this column may total more than 100%.

† The number in this column is the number of survey respondents who indicated participation in this activity.

‡ Survey respondents were asked to select just one of their activities as their main reason for the forest visit. Some respondents selected more than one, so this column may total more than 100%.

§ The number in this column is the number of survey respondents who indicated this activity was their main activity.

# 3.15.4 Recreation Opportunity Spectrum

## *Bureau of Land Management Recreation Opportunity Spectrum*

Critical to producing recreation opportunities is the condition of recreation settings on which those opportunities depend. The condition of recreation settings is on a spectrum from Primitive to Urban and can be classified and mapped, based on the variation that exists in the various physical, social, and administrative attributes of any landscape. The physical setting describes variations in components such as remoteness, naturalness, and facilities. The social setting reflects the variations in components such as group size, number and types of contacts, encounters between individuals or groups, and the evidence of use by others. The administrative setting can reflect variations in the kind and extent of components such as visitor services, management controls, user fees, and mechanized use.

## *Forest Service Recreation Opportunity Spectrum*

The Kaibab LRMP/ROD (Forest Service 1988) ROS mapping classified the Tusayan Ranger District in the Roaded Natural and Semi-primitive Motorized ROS classes. In 2003 and 2004, when ROS existing conditions were inventoried and re-mapped as part of the South Zone Recreation Desired Future Condition project, it was documented that some of the Roaded Natural areas have trended toward Roaded Modified and Rural ROS conditions, and some Semi-primitive Motorized and Semi-primitive Non-Motorized areas have changed to Roaded Natural and Roaded Modified ROS classes. The net result of the landscape's becoming more uniform appearing, more roaded, and more managed is a loss of a spectrum of available recreation settings and opportunities across the South Zone, particularly the Semi-primitive Motorized and Semi-primitive Non-motorized ROS settings. Although very limited and becoming even more so, there are still areas that meet Semi-primitive Motorized and Semi-primitive Non-motorized ROS class requirements on the Tusayan Ranger District. The loss of Semi-primitive Motorized and Semi-primitive Non-motorized ROS areas is usually considered irreversible (Forest Service 2004).

Recent survey results indicated recreation users (visitors and local residents) to the Tusayan Ranger District participate in a wide variety of recreation activities in a broad spectrum of recreation settings. Survey results also indicated that users have a preference for pursing recreation experiences and activities in more natural-appearing landscapes, consistent with Primitive, Semi-primitive Non-motorized, Semi-primitive Motorized, and Roaded Natural ROS class settings. The survey results demonstrated a growing gap between recreation visitors' demand for more natural-appearing ROS class settings and the trend toward more managed-appearing ROS class conditions (Forest Service 2004).

Using the ROS as a basis for classifying existing recreation setting character conditions, the proposed withdrawal area contains combinations of five out of the six recreation environments shown in Figure 3.15-3 and described in Table 3.15-6. They range from areas that are primitive, have low use, and involve inconspicuous administration to rural areas near communities with higher use and a highly visible administrative presence. The wide variety of moderately regulated recreation settings in the proposed withdrawal area greatly enhances the quality of recreation experience and benefit outcomes for most visitors.

**Table 3.15-6.** Recreation Opportunity Spectrum within the Proposed Withdrawal Area

| ROS | Total Acreage |
|---|---|
| Primitive | 452 |
| Semi-primitive Non-motorized | 108,715 |
| Semi-primitive Motorized | 594,455 |
| Roaded Natural | 286,145 |
| Roaded Modified | 12,792 |
| Rural | 2,104 |
| Urban | 518 |
| No ROS designation | 1,364 |
| **Total** | **1,006,545** |

Sources: BLM (2009d); Forest Service (2009f).

### *NPS Backcountry Zoning System*

The Grand Canyon National Park backcountry lands, which are outside the proposed withdrawal area, are divided into Use Areas based on established patterns of use and resource management considerations. Use Area boundaries are defined according to identifiable topographic features, such as ridge tops and drainages.

To better guide management actions in the backcountry and to provide an opportunity for a wide variety of backcountry experiences, each Use Area is classified into one of four Management Zones: Corridor, Threshold, Primitive, or Wild (Figure 3.15-4). The zones provide different recreational opportunities and levels of resource protection. Use Areas on or accessed via the Kanab Plateau (North Parcel) and Marble Platform (East Parcel) are primarily zoned as Primitive.

## 3.15.5 Management Units

Management units are Geographic Areas (GAs) with similar resource management goals that are identified to better manage resources. The BLM and Forest Service are required to conduct projects consistent with management prescriptions developed for specific management units. Figure 3.15-5 shows the management units within the proposed withdrawal area.

### *Bureau of Land Management Lands*

The BLM uses four management unit categories (Community, Corridors, Back Roads, and Outback) to guide land use decisions and provide access into specific GAs with similar landscapes, resources, and resource uses (BLM 2008b). These four management unit types range from “close to home” opportunities to “more primitive” and “self-directed” opportunities.

#### COMMUNITY MANAGEMENT UNIT (RURAL TRAVEL MANAGEMENT AREA)

BLM-administered lands within the Community Management Unit provide opportunities for community growth and development. These lands also offer the widest variety of recreation opportunities and provide short-term or day-use recreation activities “close to home.” Lands within the Community Management Unit may also provide resources, such as fuelwood and mineral materials, access to permitted commercial and recreation activities, and scenic backdrops or settings for communities.

Portions of the North and East parcels are within the Community Management Unit (BLM 2008b). These areas are concentrated along the northern border of the Arizona Strip, primarily around the communities of Colorado City, Fredonia, and Marble Canyon.

#### GEOGRAPHIC AREA 9—UPPER BASIN

Lands within GA 9 are situated across the northeastern portion of the South Parcel. The area contains sensitive travel corridors, including SR 64, and scenic features such as the Coconino Rim escarpment. Recreation features include the Arizona National Scenic Trail, Grandview Lookout Tower, cross-country ski trails, and historic sites. The area is managed to maintain Semi-primitive recreation opportunities. Open grasslands are scattered throughout the area and provide important forage areas for livestock and big game. The area has moderate to high potential for uranium and low potential for oil and gas (Forest Service 1988).

### GEOGRAPHIC AREA 10—TUSAYAN FORESTLAND

Lands within GA 10 are located in the central section of the South Parcel. Recreation use within the area is moderate, with several areas of concentrated use. Use consists mostly of dispersed camping, hunting, and sight-seeing. Most of the area is grazed by cattle from late spring until fall. The area has moderate potential for uranium and other minerals (Forest Service 1988).

### CORRIDORS MANAGEMENT UNIT (BACKWAYS TRAVEL MANAGEMENT AREA)

Lands within the Corridors Management Unit occur along major travel routes, providing, among other things, access to the Back Roads and Outback management units. They offer a variety of recreation opportunities. These areas also provide access opportunities for short-term or day-use recreation activities related to vehicle touring. In the North Parcel, BLM Roads 5, 109, 22, and U.S. 89A are located within the Corridors Management Unit. In the East Parcel, BLM Road 8910 and U.S. 89A are located within the Corridors Management Unit.

### BACK ROADS MANAGEMENT UNIT (SPECIALIZED TRAVEL MANAGEMENT AREA)

Lands identified within the Back Roads Management Unit are characterized by predominantly natural or natural-appearing environments of moderate to large size with moderate probabilities of experiencing isolation from the sights and sounds of other people. These natural-appearing landscapes and open spaces contribute to high-quality visitor experiences. While concentrations of users will be low, evidence of other user will be relatively high. These lands may also provide resources such as fuelwood and mineral materials. Portions of the North Parcel and the western and northeastern portions of the East Parcel are within the Back Roads Management Unit (BLM 2008b).

### OUTBACK MANAGEMENT UNIT (PRIMITIVE TRAVEL MANAGEMENT AREA)

Lands within the Outback Management Unit provide opportunities for undeveloped, primitive, and self-directed recreation opportunities. Lands classified as within the Outback Management Unit are characterized by predominantly natural or natural-appearing environments of moderate to large size. The lowest level of landscape modifications is expected, compared with the other management units. Remote settings, natural landscapes, solitude, and opportunities for primitive recreation are minimally impacted by human activity. Portions of the North Parcel and the eastern portion of the East Parcel are within the Outback Management Unit (BLM 2008b).

## *Forest Service Lands*

The Kaibab National Forest is divided into 11 discrete GAs. All the land within a given GA is managed under the same emphasis to ensure consistency, efficiency, and integration of management practices across the GA. In addition to GAs, the forest is also divided into Land Use Zones that contain additional or special direction within one or more GA. All GAs are managed to attain resource management objectives and contribute to bringing desired conditions into being. All desired conditions focus on conservation of the ecosystem and the human environment. The Forest Service lands within the proposed withdrawal area are located within GAs 8–10, 12, and 16 and within Land Use Zones 21 and 22. GA 11, the Kanab Creek Wilderness, is adjacent to the North Parcel and described below for analysis purposes.

### GEOGRAPHIC AREA 8—SOUTHERN TUSAYAN WOODLAND

Lands within GA 8 are situated across the southern portion of the South Parcel. The area contains sensitive travelways such as SR 64 and the Arizona National Scenic Trail, important scenic features such as the Red Butte proposed TCP, and recreation resources. The area is managed to maintain semi-primitive recreation opportunities. A major utility corridor crosses the southern portion of this GA. The area has high potential for uranium and low to moderate potential for oil and gas. Open grasslands are scattered throughout the area and provide important forage areas for livestock (Forest Service 1988).

## GEOGRAPHIC AREA 12—WESTERN NORTH KAIBAB WOODLAND

GA 12 includes portions of the west, north, and east sides of the North Kaibab Ranger District of the Kaibab National Forest. A small strip of this GA is located along Kanab Creek and the eastern border within the eastern edge of the North Parcel. The area consists of moderate-use areas that occur along roads and access points overlooking the Grand Canyon. Several of these roads also lead to trailheads that provide access to Kanab Creek Wilderness and Grand Canyon National Park. The area is managed to maintain non-motorized recreation opportunities. Visually sensitive areas occur along U.S. 89A, Forest Road 422, the rim of the Grand Canyon, and several forest roads leading to points overlooking the Grand Canyon. Management activities in these areas are visually subordinate to the characteristic landscape. The area was removed from livestock grazing through a NEPA decision in 2001; the area has not been grazed by permitted livestock since the mid-1990s. The area has moderate to high potential for uranium; however, most of the area is closed to mineral entry and location, subject to valid existing claims (Forest Service 1988).

## GEOGRAPHIC AREA SPECIAL AREA 11—KANAB CREEK WILDERNESS

Lands within GA 11 include the Kanab Creek Wilderness, located in the western part of the North Kaibab Ranger District of the Kaibab National Forest. The portion of Hack Canyon that is managed by the Forest Service, in the eastern portion of the North Parcel, is located within this GA. Use of this wilderness is low and is concentrated in Kanab Creek and Snake Gulch and along the trail system, which links the area to adjacent lands of Grand Canyon National Park. The area is managed for the VQOs of preservation background. The area has moderate to high potential for uranium and other minerals; however, the Arizona Wilderness Act of 1984 withdrew the area to mineral entry and location, subject to valid existing rights (Forest Service 1988).

## GEOGRAPHIC AREA 16—EASTERN NORTH KAIBAB WOODLAND

Lands within GA 16 include the Buffalo Ranch and the extreme east side of the North Kaibab Ranger District of the Kaibab National Forest. The western portion of the East Parcel is located within this GA. Recreation use within the area is low; however, the Forest Service will provide extensive management of recreation, visual, and heritage resources. The area is grazed by cattle and bison. The area has moderate potential for uranium and other minerals (Forest Service 1988).

## LAND USE ZONE 21—EXISTING DEVELOPED RECREATION SITES

This management area includes 15 major existing public- and private-sector developed recreation sites and other small sites, including trailheads and interpretive sites on the Kaibab National Forest. Two existing developed recreation sites are located in the South Parcel. All existing developed recreation sites are withdrawn to mineral entry under the mining laws. The VQO of partial retention for developed recreation sites allows management activities that remain visually subordinate to the characteristic landscape. Roads accessing developed recreation sites are maintained at Level 4 or higher (Forest Service 1988).

#### LAND USE ZONE 22—PROPOSED DEVELOPED RECREATION SITES

This management area includes areas that have been proposed to be developed into recreation sites. One proposed developed recreation site in the South Parcel is located along SR 64 in the northeastern portion of the parcel. Proposed recreation sites are open to mineral entry; however, it appears that none of the sites involve lands known to contain valuable mineral resources. The ultimate location of a proposed developed recreation site is generally based on a combination of desirable attributes of a given area. These sites are managed for the VQO of partial retention of foreground (Forest Service 1988).

## 3.15.6 Resource Condition Indicators

For recreation resources, condition indicators include visitor use by activity (primitive, dispersed recreation versus developed, motorized-based recreation); acres within the ROS designations; desired recreation experiences; and the miles, acres, or number of recreation sites that are currently designated in the proposed withdrawal area.

# 3.16 SOCIAL CONDITIONS

## 3.16.1 Overview

The study area for this analysis is defined to include the counties containing the proposed withdrawal areas (Coconino County and Mohave County in Arizona). The study area also includes nearby counties in southern Utah that might house substantial portions of the mining workforce that could be affected by the alternatives and/or which are likely to provide most of the economic services related to mining and tourism activity in and near the northern and eastern withdrawal areas (Garfield County, Kane County, Washington County, Utah). San Juan County, Utah was also included because it is the home of the only currently active uranium mill in the region (the White Mesa Mill in Blanding).

Several communities within these counties are more likely to be affected by the proposed alternatives than others. The largest communities in the study area, such as the cities of St. George, Utah and Flagstaff, Arizona have large populations and diversified economies. Any changes that might result from the proposed alternatives would be well within the range of typical annual fluctuations in population, employment, earnings and other social and economic metrics for these two communities—and consequently would not be likely to be noticeable (see Sections 4.16 and 4.17). The smaller communities in closest proximity to the proposed withdrawal areas (or to the mill where uranium would be processed) are the most likely to be noticeably affected by economic and demographic changes that could result from the alternatives, and are therefore the focus of the social and economic analyses, in combination with the county level data. These communities are listed below, and depicted in Figure 3.16-1.

Proximate to the North Parcel:

- Colorado City (Arizona)
- Fredonia (Arizona)
- Kaibab CDP (Arizona)
- Kanab (Utah)

Proximate to the East Parcel:

- Bitter Springs CDP (Arizona)
- Page (Arizona)

Proximate to the South Parcel:

- Tusayan CDP (Arizona)

Proximate to the existing uranium mill:

- Blanding (Utah)

In addition to the counties and communities described above, American Indian tribes who live within and adjacent to the withdrawal areas are also discussed; these include the Navajo Nation, Hopi Tribe, Hualapai Tribe, Havasupai Indian Reservation, and Kaibab Band of Paiutes. The Kaibab CDP is located on Kaibab Band of Paiutes tribal land. Some of the Navajo Nation chapters (chapters are local government subdivisions, or communities) proximate to the proposed withdrawal areas include Cameron, Bodaway, Tuba City, and LeChee. Hopi chapters in proximity to the withdrawal areas Moenkopi and West Dinnebito. Although the Navajo Nation and Hopi Tribe are composed of smaller chapters, the tribal demographic information is discussed for the overall tribe, not for the individual communities and chapters within each tribe.

## *Area Communities*

Local community and residents value access to federal lands and resources for a variety of reasons, "whether for earning a living, traditional and subsistence uses such as personal woodcutting, or for recreating" (BLM 2005b:43). Communities located close to lands such as the Grand Canyon, Kaibab National Forest, and BLM lands (including national monuments) also have economies that are tied to these lands. Residents from elsewhere visit and/or relocate to these areas for what may be perceived to be a better quality of life attributable to the rural nature of communities in the study area, as well as potential recreation opportunities such as OHV use, big-game hunting, hiking/walking/running, backpacking, and viewing opportunities. This, in turn, generates more money, which is directed to local, regional, and state economies. Thus, there are economic benefits from tourist activity, as well as potential economic benefits associated with communities that can provide workers and derive other economic benefits from mineral exploration and development on study area federal lands.

Many area communities that have access to federal lands (such as BLM, Forest Service, and NPS lands) have strong ties to these lands; residents can form a strong sense of identity based on the cultural and geographic nature of the area. Following are social profiles of each county and community studied in this analysis, based on information in their respective community and economic development plans. Population and other demographic data for these communities are presented in the following section on "Demographics."

### COCONINO COUNTY

Coconino County is the largest county in Arizona and second largest in the Nation covering approximately 12 million acres. The southern core of Coconino County holds roughly 75% of the population with 60% of the population living in the Flagstaff Regional Planning Area. In general, development throughout the county is rural and low density with large swaths of undeveloped land separating residences.

With elevations ranging from 1,300 to 12,600 feet amsl, the landscape in Coconino County supports a diversity of climatic conditions, wildlife, vegetation, and topography. Thus, preserving rural character is valued within the County. The current General Plan includes techniques to manage sprawl, preserve open space, and enhance the natural quality of environmentally sensitive lands through integrated conservation design to encourage more efficient land use through shared open space and smaller lot size.

Coconino County contains the Grand Canyon National Park in addition to nine nationally designated protected areas which draw significant recreational and tourist activity annually. A large portion of Coconino County's land area is Native American lands covering about 38% of land area, and is home to the Navajo, Hualapai, Hopi, and Havasupai Nations.

As the geographically largest county in Arizona, Coconino County has a diversity of landscape to support a range of economic development opportunities with the City of Flagstaff remaining the economic "hub" of the County.

The Coconino County General Plan provides a Conservation Framework which emphasizes that land use decisions be compatible with the natural potential of the site and the landscape. The Conservation Framework also outlines five ecological principles and eleven conservation guidelines to ensure that economic development provides diverse employment base and ensures the County's continued economic vitality. In addition, the General Plan addresses the growth element and states that the County has never actively sought new industry, though as new economic development opportunities are explored they should be in keeping with the following goals: consistency with rural character; preservation of the features of the natural environment; providing livable wages; and supporting of niche industries that use local resources responsibly.

Tourism is a major economic contributor as there are several tourist destinations that attract millions of visitors annually to Coconino County. The County General Plan encourages the exploration of expanding the role of tourism by pursuing opportunities in eco-tourism and ethno-tourism and by encouraging tourist-related development projects designed to minimize human impact on the environment, and showcase the County's unique natural features (Coconino County 2003).

### Bitter Springs CDP

Located on U.S. 89 just south of the City of Page, Arizona, Bitter Springs is part of the Navajo Nation and is surrounded by Kaibab National Forest to the west, Vermilion Cliffs Monument and Paria Canyon to the north and the Grand Canyon National Park to the southeast. Bitter Springs is over 8 square miles with a population density of about 66 people/square mile. The population of Bitter Springs is largely Native American (98%) and the job base is predominantly manufacturing (52%) and construction (26%).

### Fredonia

Located in Coconino County, Fredonia, Arizona is considered the northern gateway to the Grand Canyon National Park. At about 4,700 feet above sea level, Fredonia is located on the high desert plateau situated between the North Rim Village of the Grand Canyon and Grand Staircase-Escalante National Monument. Fredonia is characterized as a rural town that supports a diversity of recreational activities because of open landscape and scenic vistas.

As discussed in Section 4.17, since losing the mining and timber related jobs that once supported its economic base, the Town of Fredonia has struggled economically. Though the town is struggling economically, as discussed in Environmental Justice, this community does not meet the criteria for an environmental justice community; that is, the population does not exceed 50% minority, and does not meet the criteria used in this analysis for a low-income population. According to the U.S. Census, 7.6% of Fredonia residents (individuals) and 3.3% of families are living below the poverty level (Table 3.16-4).

### Kaibab CDP

The Kaibab CDP is located on the tribal lands of the Kaibab Band of Paiutes, southwest of Fredonia, Arizona, off SR 389 (see Figure 3.16-1). The Kaibab CDP is located directly north of the North Parcel, near the Arizona-Utah border. The CDP covers approximately 190 square miles, with population density estimated to be 1.5 persons per square mile.

### Page

The City of Page, Arizona was planned and developed for workers building the Glen Canyon Dam in 1957. Page is located at 4,300 feet amsl on Manson Mesa overlooking Wahweap Bay of Lake Powell. Page was incorporated in 1975 and its economy is primarily based on recreation as it is a gateway to Lake Powell, Grand Canyon National Park, as well as National Parks in Utah such as Bryce and Zion National Parks (City of Page, Arizona 2011). Energy generation facilities such as the Navajo Generating Station and Glen Canyon Dam provide additional employment within Page (City of Page, Arizona 2011).

The City of Page is actively seeking economic development opportunities in order to obtain new revenues, improve services, and raise the standard of living for its citizens. The City is currently encouraging economic development growth through the sale of available land with incentives for developers (City of Page, Arizona 2011).

### Tusayan

Located less than 5 miles south of the Grand Canyon National Park and within Kaibab National Forest, Tusayan is the smallest town in Arizona at about 144 acres. Incorporated in 2010, Tusayan is considered a resort town accommodating tourists and recreationists destined for the Grand Canyon. Tourist amenities such as helicopter tours, lodging, and transportation are accessed in Tusayan. The Tusayan General Plan allows for industrial activities including mineral extraction subject to conditional use permitting (Town of Tusayan 2002).

## MOHAVE COUNTY

Mohave County was one of the fastest growing counties in the nation from 1990 to 2000, with population growth occurring at about 65% within the decade. Growth is largely based on “snowbirds” or seasonal housing for the retired population. The median age in Mohave County is 8.7 years older than the Arizona state average. The economy within Mohave County was historically based on ranching, mining, and manufacturing but has now shifted to construction, trade, real estate, finance, service, and gaming.

Mohave County identifies short and long-term economic development goals within the General Plan by directly addressing the County’s reliance on the hotel/casino industry for employment. Within the mid-1980s through the 1990s, Mohave County experienced a rapid growth in employment due of the hotel/casino industry in Laughlin, Nevada. The majority of these jobs are low paying service sector jobs filled by Mohave County residents. However, the County is actively working with the business community to encourage investments and economic growth to support local residents. Mohave County’s General Plan also indicates that progressive economic growth compatible with County goals for environmental protection, planned urban development, and economic diversification are crucial to creating a more stable economic base. Diversification of the economy would mean decreasing local reliance on the hotel/casino industry, while increasing employment in other industries within the County. Mohave County has established goals, policies and implementation measures to support commercial and industrial development to promote a diverse and stable County economy (Mohave County 2010).

In addition, Mohave County is “well positioned” to attract tourist activity to destinations like Lake Havasu State Park, Lake Mead, Historic Route 66, Grand Canyon, the London Bridge, as well as other Native American, cultural, natural and scenic attractions (Mohave County 2010)

### Colorado City

Colorado City is located within Mohave County, and was founded in 1913 by members of the Fundamentalist Church of Jesus Christ of Latter Day Saints. Colorado City encompasses about 10.5 square miles with a population density of about 317 per square mile. The median age of Colorado City is 14 years old. The largest single employer within Colorado City is the school district. Other employers include manufacturing plants and regional construction.

## KANE COUNTY

Kane County, Utah encompasses about 3 million acres of remote and rugged land 90% of which is public land, including several nationally designated scenic places (e.g., Glen Canyon Recreational Area, Grand Staircase–Escalante National Monument, Bryce Canyon National Monument, etc). Kane County is characterized by extremes in elevation, vegetation, precipitation, and scenic vistas.

As discussed in Section 3.17, Kane County, like many rural areas in southern Utah, has experienced economic struggles as natural resource extraction jobs diminished and were replaced by lower-paying hospitality jobs (Kane County 2011). The economy of Kane County has traditionally been based upon the natural resources found in the county, specifically agriculture. Within the last two decades significant decreases is agricultural production has negatively affected the population and economy. Additionally, within the last decade approximately one-third of new construction is seasonal housing adjacent to national parks and other recreational areas.

Major economic development goals outlined in the County's General Plan (Kane County 1998) are summarized as follows: "Kane County will be an active partner with other governments to foster a sustainable, broad-based economy which allows traditional economic uses to remain vibrant, while fostering new economic activities which expand economic opportunity, utilize available natural resources, and protect important scenic and social qualities" (Kane County 1998:11). Economic development issues for "tourist resources" and the "natural resources base" are detailed below.

In terms of the natural resources base, an economic development issue identified in the Kane County General Plan is "the ability to utilize the natural resources of the county in a responsible manner without undue political interference" (Kane County 1998:48). In terms of tourist resources, County economic development issue focus on "Tourism program development to date is unbalanced and needs to be rounded out with a concentrated effort to make Kane County a major destination hub under the banner of 'Utah's Park Central' for all classes of travelers to the area" (Kane County 1998:47).

### Kanab

Kanab, Utah, located within Kane County and serving as the County Seat is unique in that it is surrounded by Grand Canyon National Park, Bryce Canyon National Park, Zion National Park, Lake Powell National Recreation Area, Grand Staircase-Escalante National Monument, Pipe Springs National Monument, Coral Pink Sand Dunes State Park, and Cedar Breaks National Monument.

Though Kanab has a long economic history, the economy is currently based on seasonal residents, tourism and recreation. Due to its scenic views and unique landscape character, hundreds of films have been made within Kanab giving it the moniker "Little Hollywood". Although the city benefits economically from tourism and recreation activity, the national recession has been pronounced in the City of Kanab, where sales-related tax revenues have diminished by approximately 16% since 2008 (see Section 3.17).

Currently, Kanab's General Plan indicates that overarching goals for planning include managing growth and capitalizing on its unique identity and location (Kanab 2007). Located within Kane County, principles outlined in CEBA's Economic Development Plan (CEBA 2009) are also supported by Kanab, with a particular focus on the economic health of the city.

## WASHINGTON COUNTY

Washington County, located in southern Utah, has an elevation that ranges between 2,178 and 10,194 feet above sea level. The BLM is the largest land holder within Washington County, which has multiple highly visited recreational destinations including Zion National Park, Old Spanish Trail or Mountain Meadows, and Dixie National Forest. The County's scenic resources make it attractive to visitors and travelers that travel through the area.

Washington County has experienced significant and rapid growth over the last three decades and has the fifth-highest job growth rate in the U.S. Initially, farming and ranching along with some silver mining were the primary economic drivers of the region. Later, when Zion National Park was established, it marked the beginning of tourism as a significant sector in the local economy (see Section 3.17).

The County's General Plan acknowledges that "The economic and ecological health of the county is very much dependent on the manner in which public lands are managed by the various state and federal agencies having jurisdiction over 84% of lands within the county" (Washington County 2010:11). The County has struggled with regulations enforced by federal land managers such as the BLM and Forest Service and the effect of regulation on ensuring that local governments can provide for the health, safety, and welfare of their communities.

## GARFIELD COUNTY

Garfield County is located in southern Utah and encompasses approximately 5,208 square miles. The County is the most rural county in the state, and describes itself as one of the most economically disadvantaged (Fischer, personal communication, August 31). The landscape within the county includes large swaths of open desert as well as nationally designated scenic places such as Bryce Canyon National Park, Grand Staircase–Escalante National Monument, Capital Reef National Park, and a portion of Canyonlands National Park (Garfield County, Utah 2011). Garfield County is also home to the Shootaring Canyon Mill, and inactive mill located near Ticaboo, Utah. In fact, approximately 95% of the County's 5,000+ acres are managed by the government. Like Washington County, because the vast majority of Garfield County is comprised largely of public lands, public lands policies have a tremendous effect on the County.

Garfield County considers themselves a disadvantaged community, particularly in terms of low-income workers. The County's workforce consists of a major segment of low-income workers, including U.S. Citizen and Immigration Services H-2B non-agricultural temporary workers (foreign nationals) (Fischer, personal communication, 2011). Although the County describes themselves as a low-income community, as discussed in Environmental Justice, Garfield County does not meet the criteria used in this analysis for an environmental justice community; that is, the population does not exceed 50% minority and does not meet the criteria for a low-income population. According to the U.S. Census, 10.8% of County residents (individuals) and 6.7% of families are living below the poverty level (see Table 3.16-4).

Like other counties in Southern Utah in the study area, Garfield County's economy has expanded from an agriculture-based and natural resource extraction focus to one which includes industry, retail and tourism, and other service-oriented businesses (Garfield County 2007). It is important to note that between 2000 and 2008, the largest increase in employment was attributed to the mining industry (Garfield County 2010). In fact, the county boasts a relatively diverse employment base (Garfield County 2010:46).

Economic development goals for Garfield County are focused on maintaining a strong and diverse economic base. Additionally, economic development goals include recognizing the importance of tourism in the regional economy, and encouraging diverse tourism related development (Garfield County 2010).

### SAN JUAN COUNTY

San Juan County is located in southeastern Utah and is approximately 7,933 square miles in area. San Juan County is characterized by a variety of landscape types, with elevations ranging from 3,000 to 13,000 feet above sea level as well as nationally-designated scenic areas such as Cedar Mesa, Comb Wash, Hovenweep National Monument, Canyonlands National Park, and a portion of Glen Canyon National Recreational Area. San Juan County also has several oil and gas producing fields produced from Desert Creek and Ismay formations as well as the only operating uranium processing plant located in Blanding, Utah.

Like Washington County, farming, ranching, and silver mining were the primary economic drivers of the region. Establishment of Zion National Park marked the beginning of tourism as a significant sector in the local economy (see Section 3.17). Like Garfield County, "San Juan County has a somewhat diverse economic base and employment profile" (San Juan County 2008:33).

Private lands in the county only account for 8% of area lands; thus, like Garfield County, public lands policies have a tremendous effect on the county's economy and quality of life (San Juan County 2008). In fact, one of the county's "Desired Conditions" in the Master Plan is: "It is San Juan County's desire that the negative impact of federal agencies decisions on San Juan County communities, economies, and residents are minimized." Planning and implementation should include possible mitigation measures to avoid identified negative impacts" (San Juan County 2008:21).

#### Blanding

Blanding, Utah is the most populated city in San Juan County. Blanding serves as a gateway to several natural and archeological resources including Natural Bridges National Monument, Monument Valley, Four Corners, Glen Canyon National Recreational Area, Cedar Mesa, San Juan River, Goosenecks State Park, and Canyonlands National Park. Additionally, Blanding is located about 1 hour from Moab and Arches National Parks.

The economy of Blanding is based on mineral processing, mining, livestock and agriculture, local commerce, tourism, and transportation. A boom in uranium and oil activity in the 1950s was a source of revenue for the construction of new roads and provided the economic climate necessary for the expansion of service industries and an associated population increase. Since the 1980s, the economy of Blanding has come to rely more on tourism activity, as a gateway community (City of Blanding 2011). However, like Kanab, the fiscal effects of the recession have been quite pronounced in the City of Blanding and the City of Kanab, with a 20% decline in sales-related tax revenue since 2008 (see Section 3.17).

## *Demographics*

Population data were obtained from the Census Bureau, ADOC, and the State of Utah Governor's Office of Planning and Budget. Table 3.16-1 summarizes historical and projected populations within the study area.

**Table 3.16-1.** Historical and Projected Population within the Study Area

| Location | Population 1990* | Population 2000[†] | Population 2008[‡] | Population 2010[xx] | Total Change in Population (%) 1990–2000 | Total Change in Population (%) 2000–2010 | Total Change in Population (%) 1990–2010 | Projected Population 2020[‡] | Projected Population 2030[‡] | Projected Population 2040[‡] |
|---|---|---|---|---|---|---|---|---|---|---|
| **U.S.** | 248,709,873 | 281,421,906 | 304,059,724 | 308,745,538 | 13.2% | 9.7% | 24.1% | 335,805[§] | 363,584[§] | 391,946[§] |
| **Arizona** | 3,665,228 | 5,130,632 | 6,500,180 | 6,392,017 | 40.0% | 24.6% | 74.4% | 8,779,567 | 10,347,543 | 11,693,553 |
| **Coconino County** | 96,591 | 116,320 | 128,558 | 134,421 | 20.4% | 15.6% | 39.2% | 159,345 | 173,829 | 186,871 |
| Bitter Springs CDP** | NR | 547 | 1,059 | 452 | NR | -17.4% | NR | 1,600 | 1,954 | 2,273 |
| Fredonia | 1,207 | 1,036 | 1,145 | 1,314 | -14.2% | 26.8% | 8.9% | 1,260 | 1,335 | 1,403 |
| Havasupai Indian Reservation | NR | 503 | NR | 465 | NR | -7.6% | NR | NP | NP | NP |
| Hopi Reservation | NR | 1,134 | NR | 7,185 | NR | 533.6% | NR | NP | NP | NP |
| Navajo Nation[¶] | NR | 23,216 | NR | 173,667 | NR | 648.0% | NR | NP | NP | NP |
| Page | 6,598 | 6,809 | 7,253 | 7,247 | 3.2% | 6.4% | 9.8% | 7,720 | 8,027 | 8,303 |
| Tusayan CDP** | NP | 562 | 616 | 558 | NR | -0.7% | NR | 673 | 711 | 745 |
| **Mohave County** | 93,497 | 155,032 | 196,281 | 200,186 | 65.8% | 29.1% | 114.1% | 281,668 | 330,581 | 367,952 |
| Kaibab Band of Paiutes | NR | 212 | 218 | 240 | NR | 13.2% | NR | 261 | 276 | 289 |
| Kaibab CDP** | NR | 275 | NR | 124 | NR | -54.9% | NR | NP | NP | NP |
| Hualapai Tribe | 1,532 | 1,353 | 1,836 | 1,335 | -11.7% | -1.3% | -12.9% | 2,503 | 2,948 | 3,289 |
| Colorado City | 2,426 | 3,334 | 4,540 | 4,821 | 37.4% | 44.6% | 98.7% | 6,196 | 7,302 | 8,147 |
| **Utah** | 1,722,850 | 2,233,169 | 2,736,424 | 2,763,885 | 29.6% | 23.8% | 60.4% | 3,652,547 | 4,387,831 | 5,171,391 |
| **Kane County** | 5,169 | 6,046 | 6,577 | 7,125 | 17.0% | 17.8% | 37.8% | 8,746 | 10,394 | 12,034 |
| Kanab | 3,289 | 3,564 | NR | 4,312 | 8.4% | 21.0% | 31.1% | 5,216 | 6,198 | 7,177 |
| **San Juan County** | 12,621 | 14,413 | 15,055 | 14,746 | 14.2% | 2.3% | 16.8% | 15,319 | 16,653 | 18,051 |
| Blanding | 3,162 | 3,162 | NR | 3,375 | 0.0% | 6.7% | 6.7% | 3,314 | 3,604 | 3,908 |
| **Washington County** | 48,560 | 90,354 | 137,589 | 138,115 | 86.1% | 52.9% | 184.4% | 279,864 | 415,510 | 559,670 |
| **Garfield County** | 3,980 | 4,735 | 5,044 | 5,172 | 19.0% | 9.2% | 29.9% | 5,843 | 6,823 | 7,656 |

Notes: NP = no projection available at this geographic level; NR = not reported.

* Source: Census Bureau (1990).

[†] Source: Census Bureau (2000).

[‡] Sources: ADOC (2009e); Governor's Office of Planning and Budget (2010).

[xx] Source: Census Bureau (2010).

[§] U.S. projected population written in thousands.

[¶] Navajo Nation Chapters within the study area were combined for the total Navajo Nation population in Coconino County.

**CDP = Census Designated Place

## ARIZONA

Arizona experienced dramatic population growth between 1990 and 2010, with a 74.4% increase in residents, compared to 24.1% for the nation during the same time period. Future projections suggest that this growth is not over with for the state, with a 61.9% growth predicted between 2010 and 2030 (see Table 3.16-1). Coconino and Mohave counties are no exception; these counties have also experienced substantial growth for the past 20 years. Between 1990 and 2010, population increased 39.2% in Coconino County and 114.10% in Mohave County (see Table 3.16-1). As with the state, further growth is expected; between 2010 and 2030, growth in these counties is projected to increase 29.3% and 65.1%, respectively (see Table 3.16-1). Mohave County has experienced the most significant growth between 1990 and 2010 (114.1%), and is expected to see the most growth over the next 20 years (65.1%) (see Table 3.16-1). Much of the recent growth in Mohave County can be attributed to increased tourism activity (Mohave County 2008).

Within Coconino County, population in the Bitter Springs CDP grew 93.6% between 2000 and 2008, with population expected to continue to grow another 332% between 2010 and 2030. Fredonia has actually experienced negative population growth, with the number of residents decreasing 14.2% from 1,207 in 1990 to 1,036 in 2000. Both Page and the Tusayan CDP have experienced modest growth for the past 20 years, with population increasing 6.50% in Page and 9.60% in the Tusayan CDP between 2000 and 2008 (see Table 3.16-1). Fredonia experienced a decline in population between 1990 and 2000; however, population increased 26.8% between 2000 and 2010. Additionally, population is expected to increase another 1.6% in Fredonia over the next 20 years (see Table 3.16-1).

Within Mohave County, Colorado City experienced increases in total population of 98.7% between 1990 and 2010. Population in the Kaibab CDP dropped from 275 in 2000 to 124 in 2010, a 54.9% decline. However, overall, population forecasts for the County continue to show an upward trend increasing population from 6,916 in 2020 to 8,147 in 2040 (see Table 3.16-1).

## UTAH

From 1990 to 2000, Utah's population increased by 29.6%, with a similar increase of 23.8% between 2000 and 2010; growth is expected to continue through 2030. Predicted population growth for Utah is consistent with Arizona projections, with population expected to increase 58.76% between 2010 and 2030 (see Table 3.16-1).

Population growth between 2000 and 2010 for the four counties in the study area has ranged from 2.31% for San Juan County up to 52.86% for Washington County. Kane and Garfield counties have experienced modest growth for the same time period (17.85% and 9.23%, respectively). Each county is predicted to experience some level of growth over the next 20–30 years, however population in Washington County is expected to continue to increase at a staggering rate of 200.84% between 2010 and 2030 (see Table 3.16-1). This remarkable growth for Washington County is attributed to factors such as a moderate climate, rich natural resources in the region, in-migration, aging Baby Boomers, and access to road and air transportation (Washington County 2009). In Kane County, the population of Kanab increased 8.40% between 1990 and 2000. Like the rest of the study area, population in Kanab is expected to continue to increase, with growth expected to reach 101.37% between 2000 and 2040. Very little demographic data is available for Blanding in San Juan, Utah. The population of Blanding was 3,162 in 1990. Population projections by the Governor's Office of Planning and Budget (2010) indicate that Blanding will see some growth through 2040, but will remain relatively modest with a 17.92% increase between 2020 and 2040 (see Table 3.16-1).

## Stakeholder Values

In general, there are two basic perspectives on mineral exploration and development on the Arizona Strip and the Kaibab National Forest: people who support continued mineral exploration and development, and people who would prefer that mineral exploration and development not continue. Many different stakeholders have expressed an interest in the proposed mineral withdrawal because they support the withdrawal, or do not, or they fall somewhere along a spectrum between the two perspectives. Also, there are varying perspectives within different groups; for instance, some American Indians value the mineral exploration and development for the economic benefits (i.e., employment; see Mineral Activity Support discussion below), while other tribal members are influenced by negative experiences associated with uranium mining in the past (see “Withdrawal Support” discussion below). In summary, there are varying interests between individuals and groups who support mineral exploration and development and those who support withdrawal.

Stakeholders include American Indian tribes, local governments, area communities, mining companies, recreationists, and environmental and preservation groups, to name a few.

In many people’s minds, the proposed withdrawal area cannot be separated from the Grand Canyon itself. In fact, people often have such a strong sense of place attached to the Grand Canyon, even if they have never visited it, that potential changes to land management on the Arizona Strip and Kaibab National Forest could have important impacts to people’s quality of life related to the Grand Canyon. The Grand Canyon, along with the Kaibab National Forest and the BLM lands that form the withdrawal parcels, serve as important places of recreation for a variety of stakeholders. The Grand Canyon is a cultural and natural icon for Americans; however, not everyone goes to the Grand Canyon to “see” the same canyon.

Because the Grand Canyon and the surrounding area represent a unique place in the Southwest landscape, people’s values, beliefs, and attitudes are shaped by each individual’s “sense of place” of the area. A variety of factors will influence how people view the Grand Canyon, resulting in differing perspectives, whether the individual is a local resident, or national or international visitor. For this proposed withdrawal, more than 80,000 scoping comments from nearly every state in the United States and from more than 90 countries were submitted; this high level of national and international interest illustrates the importance of the Grand Canyon to people within Arizona, as well as across the United States and internationally.

Alternatively, many local residents (such as those who live in Kane and Washington counties, Utah) do not necessarily associate the proposed withdrawal parcels with the Grand Canyon. Many families have lived in the area for several generations and have strong connections to the land for earning a living and traditional and subsistence uses. Many residents of the communities surrounding the North Parcel are descendents of the Mormon pioneers who settled the area in the 1860s. These people still have strong connections to the land. Access to public land and resources, whether for earning a living, traditional and subsistence uses such as personal woodcutting, or for recreating, is very important to the local people.

Clearly, many people, especially local residents, may be linked to public lands in multiple and overlapping ways. The nature of people’s linkages strongly influences their values and attitudes toward public lands, and their social and cultural relationships to the land and to other people. These relationships are much more nuanced than any numbers in a social and economic profile can convey. They involve sentiments and emotions, attachments to specific special places, and beliefs and traditions developed through contact with public lands.

The following discussion presents some general ideas on how perspectives are developed and what they are related to, although there are likely to be any number of reasons people support the withdrawal or oppose it, or some variation in between. This discussion is not intended to be exhaustive but rather to present an overview of potential stakeholder values related to the proposed withdrawal.

## MINERAL ACTIVITY SUPPORT

Many people, area communities, and local governments would benefit economically from continued or increased mineral exploration and development within the proposed withdrawal area. Mineral exploration and development can provide jobs, increase labor income, and provide tax revenue to local communities and the state, either directly from mining-related jobs, or indirectly from related businesses, construction purchases, etc.

States such as Arizona and Utah benefit from the proximity of a vast array of federal lands by providing economic benefits ranging from recreation opportunities to mineral exploration and development. State and local governments have long viewed these federal lands as being detrimental to the economic health of their communities because of lost property tax revenues; thus, mineral exploration and development and the benefits of this activity can offset lost property tax revenue.

Mineral development also creates new roads, which many recreationists support as these roads open access to area lands that have been previously inaccessible to vehicles. Recreationists enjoy increased access for sight-seeing, leisurely driving, OHV use, etc.

## WITHDRAWAL SUPPORT

Regardless of current changes in mining technology, many people do not embrace mineral exploration and development because they are concerned that continued or increasing mineral exploration and development could impact their quality of life since they benefit economically, scientifically, spiritually, or emotionally, or otherwise from area lands being preserved.

Many people would like to see the proposed withdrawal lands removed from mineral exploration and development because they prefer the solitude they can experience, to see the area landscape and views preserved, the scientific value of the area to be preserved, etc. Each person with some attachment to the proposed withdrawal area has a different reason for their opinions and feelings regarding area lands and mineral exploration and development on these lands.

Some recreationists enjoy the remote and relatively undeveloped character of the area and seek out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. These types of recreationists, unlike those discussed under Mineral Activity Support above, likely prefer that there is less access to area lands, less transformation of the landscape, etc.

Some stakeholders do not directly recreate or have an attachment to the Grand Canyon or region but are concerned about impacts to water quality if mining continues or increases. Irrespective of potential human health effects, continued or increased mining could affect consumer confidence, or perception, about the safety and reliability of municipal drinking water derived from the Colorado River. For American Indians, in particular, past experiences with health problems from working in mines, radiation contamination from dust and debris, the processing of ore on the reservations, and the spillage of radioactive materials into water systems have all affected how people view uranium mining. For example, the Navajo have been deeply affected by the mining of uranium on Navajo Nation lands and land bordering the Navajo Nation. From the 1940s through the 1970s, several uranium mines were set up on Navajo lands (Brugge and Goble 2002). These mines were welcomed as sources of employment for men in an area with very little employment. However, Navajo and non-Navajo miners worked in unsafe conditions with no protective gear against contamination and were not informed about the danger of radiation. Many Navajo miners later developed lung cancer or other ailments. Although these Navajo miners did not all smoke, they were working in unsafe conditions without adequate inhalation protection and thus were exposed to radon and the associated health risks, more so than they would be under current mining practices. Families of miners were affected through contaminated clothing or water (Johansen 1997). Other incidents also directly affected the Navajo; in 1979, a dam near Church Rock, New Mexico, that contained tailings and radioactive water burst and spilled 1,100 tons of tailings and millions of gallons of radioactive water in the Rio Puerco (Johansen 1997). The spill contaminated the drinking water for Navajos and their livestock, and clean-up efforts and public notification were inadequate. These types of experiences and the long-term environmental and health effects influence how all uranium mining is viewed by American Indians, regardless of the technology used or current best management practices (BMPs) for mining. The Navajo Nation has indicated that they will not approve any uranium mining or processing within its boundaries (Shirley 2008).

American Indian groups, such as the Havasupai, Hualapai, Hopi, Navajo, Zuni, and Southern Paiute, view the Grand Canyon, Arizona Strip, and Kaibab National Forest as integral to their culture. American Indians in the region descend from these six tribes and have long inhabited the region. Many of these groups see the area as part of their homeland. The Grand Canyon itself serves as a focal point for many of these homelands and in some cases as the actual point of origin for a people. American Indians feel a deep connection to their homeland. The land is a physical manifestation of their history and is alive; therefore, most American Indians feel that the Grand Canyon and the surrounding areas are sacred land. A detailed discussion of American Indian perspectives on the Grand Canyon can be found in Section 3.12 of this EIS.

### *Public Health and Safety*

Public health aspects of uranium mining for this EIS are considered in terms of potential effects that would result at mines (from natural uranium ore); potential health effects at the mills or other off-site processing centers (from concentrated [enriched, or yellowcake] or depleted uranium [which is a byproduct of enrichment, not mining]) are not considered here. However, much of the following discussion does include a review of the health impacts of depleted uranium because of the paucity of studies of the effects of natural uranium on humans. This is not to imply that miners would be exposed to depleted uranium, but rather because more is known about the health effects from exposure to depleted uranium, it is used here to fill in the gaps of knowledge related to potential health impacts. In fact, natural uranium is more radioactive and may cause more health effects than depleted uranium.

Uranium is a naturally occurring element that is also radioactive; its toxicity to humans varies according to its chemical form and route of exposure. Generally, exposure to uranium can be harmful in some manner via inhalation, ingestion, or skin exposure. It is important to note that nationwide, people are exposed to an average of about 300 millirems per year (mrem/yr) of natural background radiation (National Council on Radiation Protection and Measurements 1987). Table 3.16-2 presents a summary of natural background radiation doses reported by the U.S. Department of Energy (2007) for the nation and the Blanding area.

**Table 3.16-2.** U.S. and Blanding Area Natural Background Radiation Doses

| Radiation Source | U.S. Average Natural Background Radiation Dose (mrem/yr) | Blanding Area Natural Background Radiation Dose (mrem/yr) |
|---|---|---|
| Cosmic and cosmogenic radioactivity | 28 | 68 |
| Terrestrial radioactivity | 28 | 74 |
| Internal radioactivity | 40 | 40 |
| Inhaled radioactivity | 200 | 260 |
| **Total** | **300** | **440** |

Source: U.S. Department of Energy (2007).

## HEALTH RISKS

All mine operations are required to comply with stringent safety and health standards administered by the MSHA through federal regulations at 30 CFR Parts 1 through 199 and, in particular, Part 57. MSHA regulations include requirements for ground support systems, mine ventilation, electrical systems, combustible fluid storage, underground shops, equipment specifications and maintenance, explosives storage and handling, dust control, monitoring and reporting requirements, alarm systems, worker personal safety equipment, and restrictions for public access. To comply with MSHA standards, all mineral exploration and development would require the necessary MSHA mine permits and an MSHA-approved miner training plan, escape and evacuation plan, and ventilation plan.

Mine employees are typically trained in basic rescue and first aid techniques. Additionally, MSHA [30 CFR Part 49], includes requirements for the availability of on-site rescue teams, or access to off-site rescue teams. Per 30 CFR 49, each mine rescue team is required to be fully qualified, trained, and equipped for providing emergency mine rescue service. Additionally, each mine is required to develop a mine rescue notification plan outlining the procedures to follow in notifying the mine rescue teams when rescue is needed. Mine operators in the area can enter into agreements with air rescue services (typically via helicopter) to augment their emergency response capabilities, or provide response capabilities for accidents that occur on the surface, or during hauling.

The discussion of potential health risks associated with uranium mining that follows is based primarily on a 1999 report on the chemistry and toxicological effects of natural and depleted uranium (Craft et al. 2004), a report from the Agency for Toxic Substances and Disease Registry (1999), and from Technical Fact Sheets on Radionuclides (Argonne National Laboratory 2005; EPA 2000, 2010m).

### Cancer

Radioactive material (thus, uranium) can be a cause of cancer. Scientists have never detected harmful radiation effects from low levels of natural uranium, although some harmful effects may be possible. Exposure to uranium can be harmful and carcinogenic under any one of three conditions: inhalation of, ingestion of, or skin exposure to uranium. Inhalation exposure to uranium can cause potentially harmful health effects from both chemical and radioactive exposure, especially if the exposure is over a long period. Potentially harmful health effects from ingested or skin exposure to natural and depleted uranium appear to be solely chemical in nature, not radiological. Inhalation, ingestion or skin exposure to uranium could result from exposure at the mines on site, as well as exposing miner's families to uranium if material is carried home on worker's skin, hair, or clothing. The practice of not wearing protective clothing or taking unwashed clothing home was more common prior to creation of MSHA in the 1970s. Each mine imposes safety mechanisms designed to reduce on-site and off-site exposure, such as wearing protective clothing and gear, and removing this clothing or gear before leaving the mine site, taking a shower, etc. Additionally, per MSHA [30 CFR 75.1712], operators are required to provide adequate facilities for miners to change from the clothes worn underground, to provide for the storing of such clothes from shift to shift, and to provide sanitary and bathing facilities.

Natural and/or depleted uranium are only weakly radioactive and are not likely to cause cancer from radiation; no human cancer has been documented as a result of exposure to natural or depleted uranium (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010). Depleted uranium is a byproduct of uranium enrichment and processing. A paper by Miller et al. (2002) did demonstrate that depleted uranium at relatively high levels could cause cellular transformation. However, Miller et al. (2002) used a human osteoblast immortalized cell line to study the effects of uranium and found that the cells were transformed and did have DNA damage. However, cellular transformation, while indicative of the ability of a compound to alter cells and damage DNA, is only part of identifying a carcinogen. Further studies need to be conducted in humans to determine to what degree uranium causes increases in osteosarcomas.

However, uranium can decay into other radionuclides, which can cause cancer if the exposure is great enough and for a long enough period. Doctors who studied lung and other cancers in uranium miners did not find a link to uranium radiation's being the cause of these cancers. The miners smoked cigarettes and were exposed to other substances that are known to cause cancer, and the observed lung cancers were attributed to large exposures to radon and its radioactive transformation products (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

### Ionizing Radiation

Ionizing radiation is derived from radioactive materials and is a result of the radioactive decay of uranium. Research conducted through Biological Effects of Ionizing Radiation (BEIR) Series VII (BEIR 2006), indicates that risk of developing cancer is related to the dose of the radiation and that any dose would increase this risk. In other words, the dose does not have to reach a specific level before it can cause increased risk—just increasing exposure increases the risk. Similarly, reports from the World Health Organization (2010) state that lung tissue damage is possible after inhalation of uranium, leading to a risk of lung cancer that increases with increasing radiation dose.

However, it is important to note that while risk increases, because depleted uranium is only weakly radioactive, very large amounts of dust (on the order of grams) would have to be inhaled for the additional risk of lung cancer to be detectable in an exposed group.

BEIR (2006:267) states, "Risk may depend on the type of cancer, the magnitude of the dose, the quality of the radiation, the dose-rate, the age and sex of the person exposed, exposure to other carcinogens such as tobacco, and other characteristics of the exposed individual. Despite the abundance of epidemiologic and experimental data on the health effects of exposure to radiation, data are not adequate to quantify these dependencies precisely." BEIR (2006) developed their risk model based on types and levels of radiation different from that seen with uranium, making it difficult to extrapolate their results to a prediction of radiation effects from uranium.

"Because of the extreme difficulty of assessing dose and effects of internally ingested uranium, it is therefore necessary to use available animal and human data to establish exposure limits. Based on those studies, the evidence suggests that exposure to natural uranium is unlikely to be a significant health risk in the population and may well have no measurable effect" (Lantz 2010:3).

### Kidney Disease

Scientists have seen chemical effects from uranium exposure; in fact, kidney disease is the most prominent adverse health outcome. People have developed signs of kidney disease after intake of large amounts of uranium (for example, Gulf War veterans with embedded uranium shrapnel).

Animals have also developed kidney disease after they have been exposed to large amounts of uranium. The following discussion of kidney damage in animals is included to illustrate potential impacts on humans; the effects discussed below have been observed in animals and can also occur in humans if the uranium dose is high enough. See Sections 3.7 and 3.8 for a full discussion of potential health impacts to fish and wildlife and special status species.

In animals, kidney damage is the principal toxic effect of uranium, especially to its soluble compounds (Craft et al. 2004; Lantz 2010). The kidneys have been identified as the most sensitive target of uranium poisoning, consistent with the metallotoxic action of a heavy metal. The effects of uranium exposure seem to be primarily at the cellular level. The toxic response of the kidney is caused by the accumulation of uranium in cells lining the kidney (renal tubular epithelium), which results in premature cellular death and atrophy in the kidneys' tubular wall. The major functions of the cells lining the kidney include reabsorbing water and small molecules from the filtrate into the blood and secreting wastes from the blood into the urine. If the cells in the lining are prematurely dying or atrophying, the result is decreased reabsorption efficiency; this effect has been found in humans and animals. Heavy metal ions, such as uranyl ions (an oxidized state of uranium), are also effective in delaying or blocking the cell division process, thereby magnifying the effects of cell death. As noted, above, these effects on the kidney have been observed in animals and can also occur in humans if the uranium dose is high enough. However, these effects have only been seen in certain severe poisoning incidents in humans (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

## Lung Toxicity

Human and animal studies have shown that long-term retention in the lungs of large quantities of inhaled insoluble uranium particles (e.g., carnotite dust [4% uranium as uranium dioxide and triuranium octaoxide, 80%–90% quartz, and <10% feldspar]) can lead to serious respiratory effects. However, animals exposed to high doses of purified uranium (as uranyl nitrate hexahydrate, uranium tetrachloride, uranium dioxide, uranium trioxide, uranium tetraoxide, uranium fluoride, or uranium acetate) through the inhalation or oral route failed to develop these respiratory ailments. The lack of significant pulmonary injury in animal studies with insoluble compounds indicates that other factors, such as diverse inorganic particle abrasion or chemical reactions, may contribute to these effects (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Respiratory diseases have been associated with human exposure to the atmosphere in uranium mines. Respiratory diseases in uranium miners (fatal in some cases) have been linked to exposure to silica dust, oxide dusts, diesel fumes, and radon and associated radon decay products (also known as "radon daughters" or "radon progeny"), in conjunction with cigarette smoking. In several of these studies, the investigators concluded that, although uranium mining clearly elevates the risk for respiratory disease, uranium contributes minimally, if at all, to this risk. The mine air also contained radon and its daughters and cigarette smoke, which are proven carcinogens. As in human studies, several animal studies in which uranium-containing dusts, such as carnotite uranium dust, were used reported the occurrence of respiratory diseases (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

## Other Toxicities

It is not known whether exposure to uranium causes reproductive effects in people. Very high doses of uranium have caused reproductive problems (reduced sperm counts) in some experiments with laboratory animals; however, most studies show no effects. Further, it is not known whether exposure to uranium has effects on the development of the human fetus. Very high doses of uranium in drinking water can affect the development of the fetus in laboratory animals. One study reported birth defects, and another reported an increase in fetal deaths (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

## Radon

Radon is considered a Class A carcinogen, which indicates that it is known to cause cancer in humans. Radon is the leading cause of lung cancer among non-smokers and the second leading cause of lung cancer overall. An estimated 21,000 deaths per year are attributed to radon gas exposure; 13% of those deaths are among people who never smoked (EPA 2010n).

Inhalation of radon and radon decay products (RDPs) is the method of exposure known to increase the risk of lung cancer. When the radon is exhaled, some of the RDPs are trapped in the lungs. As the trapped RDPs undergo radioactive decay and emit alpha energy, the particles can strike sensitive lung tissue, causing chemical and/or physical damage to the DNA. It is important to note that not everyone who breathes radon gas will develop lung cancer. Risk of developing lung cancer associated with radon exposure also includes 1) how much radon is in the indoor environment; 2) the amount of time spent in that indoor environment; and 3) whether the person smokes or has ever smoked.

The only known health effect of radon is an increased risk of lung cancer, and exposure to elevated radon levels does not result in any warning symptoms like headaches, nausea, fatigue, or skin rashes. The only way to know whether a person is being exposed to elevated radon levels is to test the indoor environment (National Research Council’s Commission on Life Sciences 1999).

### Ingestion of Wildlife Exposed to Uranium

As discussed in Sections 3.6 through 3.8 on vegetation, fish and wildlife, and special status species biota can be exposed to chemical and radiation hazards through various pathways, including ingestion (soil, food, and water), inhalation, and various cell absorption processes. The potential linkage between chemical and radiation hazards associated with mining operations and biota are considered in those sections. The potential linkage between human ingestion of contaminated vegetation, fish, and wildlife exposed to uranium and uranium decay series (radon and its progeny) is discussed below.

As with human exposure to uranium discussed above, wildlife can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer (see Sections 3.6–3.8 and 4.6–4.8).

Human consumption of contaminated vegetation and wildlife could result in human health risks; however, the transfer of uranium from the plants and animals to humans through ingestion has not been systematically studied.

Radon is not known to bioaccumulate in plants or animals; however, no systematic study has been completed.

## HUMAN SAFETY RISKS

As previously noted, there are also potential safety risks associated with the mining operations themselves. In general, public safety risks are mitigated by proposed safety mechanisms mandated by the land managing agencies such as BLM and Forest Service, as well as MSHA. In general, mine operations are secured with locking gates to prevent public access and are reclaimed to a standard to ensure that ground surface integrity is not compromised.

### Transportation Conflicts

The potential transportation conflicts associated with mine traffic include traffic accidents with other vehicles. As discussed in Section 3.15 (Recreation Resources; see Table 3.15-1), there is a total of 89.71 miles of paved roads and 3,360.91 miles of unpaved roads in the proposed withdrawal area. Recreation sites and visitation data are also discussed in Section 3.15 (Recreation Resources; see Table 3.15-2); visitation for recreation sites considered in this study (see Section 3.15), for which there are data, totaled 4.43 million visitors in 2009. Recreation sites were identified when located within a proposed withdrawal parcel, or when access through a proposed withdrawal parcel is required (see Table 3.15-2). Thus, an estimated 4.43 million visitors are using a network of 3,450.62 miles of paved and unpaved roads to access area recreation sites.

For existing and future mine sites in the proposed withdrawal area, no processing facilities would be located at the mine sites and all ore would be hauled off-site. Because of the decentralized nature of breccia pipe deposits, ore would be hauled by truck. All of the routes described below are heavily traveled by local, national, and international tourists visiting the region. Specific mine locations are unknown, and therefore the specific routes of haul traffic are unknown. Both the BLM and Forest Service require a detailed plan of operation for proposed mine development projects, which would include a transportation plan. Regardless of the parcel being mined, all haul routes are assumed to traverse some portion of Navajo Nation land; and all of the haul routes for potential mines located west of Kanab Creek pass through the Kaibab Reservation. The Navajo Nation does not support ore transportation through reservation land. Through development of future mine-specific plans of operation, BLM and the Forest Service would consult with ADOT or UDOT to determine road condition/road suitability, weight limits, and other factors to be considered in identifying specific haul routes.

Potential access routes for haul traffic from the North Parcel include use of SR 98, SR 389, U.S. 89A, U.S. 89, U.S. 160, U.S. 191, and SR 163 passing through Fredonia, Page, Kaibito, and Kayenta, Arizona, and Kanab, Mexican Hat, and Bluff, Utah, terminating in Blanding, Utah.

Potential access routes for haul traffic from the East Parcel include use of U.S. 89A, U.S. 89, U.S. 160, U.S. 191, and U.S. 163 passing through Marble Canyon, Page, Kaibito, and Kayenta, Arizona, and Mexican Hat, and Bluff, Utah, terminating in Blanding, Utah. Although UDOT has indicated they encourage truck traffic not to use U.S. 163 between Kayenta and Bluff, Utah (Rick Bailey, personal communication, 2011), there is no known regulatory requirement to avoid, or explicitly not use this highway, therefore it is analyzed as a potential haul route.

Potential access routes for haul traffic from the South Parcel are divided between the east and west halves of the parcel. Haul traffic from the west half of the South Parcel use SR 64, U.S. 89, U.S. 160, U.S. 191, and SR 163 through Cameron, Tuba City, Tonalea, Cow Springs, and Kayenta, Arizona, and Bluff, Utah. Haul traffic from the east half of the South Parcel use SR 64, I-40, U.S. 89, U.S. 160, U.S. 191, and SR 163 through Tusayan, Red Lake, Williams, Parks, Bellemont, Flagstaff, Gray Mountain, Cameron, Tuba City, Tonalea, Cow Springs, and Kayenta, Arizona, and Bluff, Utah.

Average Annual Daily Traffic (AADT) counts were compiled, using ADOT traffic data (ADOT 2009b) and Utah Department of Transportation traffic data (Utah Department of Transportation 2009) for each of the transportation routes with potential to be used for ore hauling. AADT is typically measured at points within designated segments of a roadway indicated by mileposts. For the purposes of comparing current traffic conditions to proposed traffic conditions, a maximum/minimum AADT range was established for the aggregated traffic counts along each of the roadways likely to be used by ore haul trucks. Generally, AADT counts indicated that I-40, U.S. 89, and U.S. 89A are the most traveled roads, while SR 398 is generally the least traveled road (Appendix K).

Currently, ore trucks cannot exceed 25 mph on unpaved roads.

#### *Haul Route Radiation Exposure*

Ore is transported by haul trucks from the mine to the mill; the haul trucks and ore are covered to prevent the release of fugitive dust from the ore, as it is transported. There is no regulatory requirement for radiation monitoring along haul routes, however many mining companies voluntarily conduct gamma monitoring (gamma rays are emitted by uranium as it decays and forms its radioactive progeny). The dose of radiation an individual is exposed to is directly proportional to the amount of time spent in a radiation field and the distance from the radiation.

Based on a U.S. Department of Energy (2007) study, Table 3.16-3 illustrates potential radiological dose exposure from routine transportation of uranium ore. The U.S. Department of Energy study calculated that after 10 years of 120–150 haul trucks of ore pass per day, a nearby resident (within 33 feet of a haul route) would have an increased life time probability of developing cancer. The probability would increase from the national average of 220,000 in one million to 220,001 in one million.

**Table 3.16-3.** Individual Exposure from Uranium-related Hauling

| Exposure scenario | Estimate dose |
|---|---|
| Traffic jam | 0.026 mrem |
| Passing vehicle | $7.4 \times 10^{-6}$ |
| Vehicle intersection | $1.5 \times 10^{-5}$ |
| Nearby resident | 0.22 mrem/year |

Source: U.S. Department of Energy (2007).

Denison Mines Corporation provided gamma monitoring results to the ADEQ, for the Arizona 1 haul route (from the Arizona 1 Mine to the White Mesa Mill) (Woodward 2011). The monitoring data spanned January 2008 to July 2010; hauling for Arizona 1 began in late 2009, thus data provided shows pre-hauling and during hauling millirems per hour, day and week. Based on data from 10 monitors, gamma exposure prior to any hauling activities ranged from 1.95–3.63 mrem/week in 2008. From late 2009 to mid 2010, gamma exposure during hauling ranged from 2.17 mrem/week to 3.63 mrem/week; there was a spike at one of the monitors from March to July 2010, where mrem/week reached 6.18, measured over a 3 month period.

As discussed previously (see Table 3.16-2), nationwide, people are exposed to an average of about 300 mrem/year of natural background radiation (National Council on Radiation Protection and Measurements 1987). Therefore, these gamma exposure rates are consistent with exposure to natural background radiation.

#### *Haul Route Accident Procedures*

The potential frequency of haul truck accidents is discussed above. In terms of accident clean-up, uranium ore is regulated as a Class 7 radioactive material under the hazardous materials regulations in 49 CFR 172. Uranium ores and concentrates of uranium ore are classified as Low Specific Activity Group – 1 material. Because of their low specific activity, ore shipments are generally exempt from most of the packaging and labeling requirements of other Class 7 radioactive materials.

Mine operators typically hire a transportation contractor to handle all ore hauling and shipping. The transportation contractor would be responsible for preparing and implementing an emergency response plan, per Title 49 CFR 172, Subpart G. The plan would address response protocol in the event of an accident that results in the spillage of uranium ore on public roads, including traffic control, clean-up procedures, clean-up verification, and decontamination of equipment and tools.

Typical cleanup procedures would depend on the size of the spill; however, in general spilled ore can be cleaned up with a loader, hand shovels, rakes, and shop brooms (Energy Fuels Resources 2008). If the spill is larger, ore can be transferred to another truck approved for hauling uranium ore. Post clean-up, a gamma meter can be used to identify residual radiation spots on surfaces. Recovered materials are typically transported to the mill. In Washington State in 2005, the clean-up of 12 ore debris sites attributed to uranium ore spillage from haul trucks, included excavating the ore debris, transporting and placing the excavated material in a repository at the mine, performing radiological surveys to confirm the removal of the ore debris, and backfilling and/or regrading of the excavations (MFG, Inc. 2005).

## *Environmental Justice*

The EPA's Office of Environmental Justice defines environmental justice as

> the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group[s] should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

Meaningful involvement means that 1) community residents in the potential impact area have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; 2) the public's contribution can influence the regulatory agency's decision; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) the decision-makers seek out and facilitate the involvement of those in the potential impact area (EPA 2003b). Environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards and has equal access to the decision-making process, in order to have a healthy environment in which to live, learn, and work (EPA 2003b).

EO 12898 (February 11, 1994) and its accompanying memorandum have the primary purpose of ensuring 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." To meet this goal, EO 12898 specified that each agency develop an agency-wide environmental justice strategy.

This environmental justice analysis follows the guidance and methodologies recommended in the federal CEQ's Environmental Justice Guidance under the National Environmental Policy Act (December 1997) (CEQ 1997).

### DEFINING MINORITY AND/OR LOW-INCOME POPULATION

### Minority Communities

Minority or low-income communities that may be addressed in the scope of NEPA analysis are generally considered as follows:

1. Minority—Individual(s) classified by Office of Management and Budget Directive No. 15 as Black/African American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other non-white persons.
2. Minority Population—Minority populations should be identified where either:
    - the minority population of the affected area exceeds 50%; or
    - the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

### Low-Income Population

Low-income populations in an affected area are populations below the annual, statistical poverty thresholds from the U.S. Census Bureau's current population reports on income and poverty. Families and persons are classified by the U.S. Census Bureau as "below poverty level" if their total family income or unrelated individual income is less than the poverty threshold specified for the applicable family size, age of householder, and number of related children under 18 that are present. A low-income population exists where either the low-income population of the affected area exceeds 50%; or the low-income population percentage of the affected area is meaningfully greater than the low-income population percentage in the general population or other appropriate unit of geographic analysis.

### Disproportionately High and Adverse Human Health and Environmental Effects

Under Executive Order 12898, when determining whether human health effects are disproportionately high and adverse, agencies must consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant, unacceptable, or above generally accepted norms (adverse health effects may include bodily impairment, infirmity, illness, or death).
- Whether the risk or rate of hazard exposure by a minority population or low-income population to an environmental hazard is significant and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

Similarly, when determining whether environmental effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

- Whether there is or would be an impact to the natural or physical environment that significantly 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;
- Whether environmental effects are significant and are or may have an adverse impact to minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and
- 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.

## MINORITY AND/OR LOW-INCOME POPULATIONS IN THE STUDY AREA

### Minority Communities

Census data from 2010 are available for identifying minority populations. Based on the criteria presented above, there are five tribal communities in the study area in which the minority population exceeds 50%. These five communities are the Havasupai Indian Reservation, Hopi Reservation, Navajo Nation, Kaibab Band of Paiutes, and Hualapai Tribe (see Table 3.16-4). The Navajo Nation is directly adjacent to the East and South parcels. Additionally, as discussed in the Transportation Conflicts section, all potential haul routes pass through the Navajo Nation, and all of the haul routes for potential mines west of Kanab Creek pass through the Kaibab Reservation, en route to the mill in Blanding, Utah. The Kaibab Band of Paiutes is directly adjacent to the North Parcel, and the Havasupai are directly adjacent to the South Parcel.

Additionally, the populations of the Bitter Springs CDP and Kaibab CDP are 98.9% and 83.1% American Indian, respectively; it is important to note that the Bitter Springs CDP is located on the Navajo Nation and the Kaibab CDP is located on the Kaibab Reservation. San Juan County also includes a minority population of over 50.4%. Approximately 1.2 million acres of land within the Navajo Nation extends into San Juan County (San Juan County 2008).

**Table 3.16-4.** Data for Minority (2010 Census) and Low-Income (2000 Census) Populations in the Study Area

| Location | Minority % of 2010 Population, Hispanic or Latino (More than 50%) | Minority % of 2010 Population, American Indian (More than 50%) | Poverty % of 2005–2009 Population, Living Below Poverty Level (Individuals) Meaningfully greater than general population | Poverty % of 2005–2009 Population, Living Below Poverty Level (Families) Meaningfully greater than general population |
|---|---|---|---|---|
| **U.S.** | 16.3 | 0.9 | 13.5 | 9.9 |
| **Arizona** | 29.6 | 4.6 | 14.7 | 10.5 |
| **Coconino County** | 13.5 | 27.3 | 17.4 | 11.3 |
| Bitter Springs CDP** | 0.9 | 98.9 | 33.7 | 27.4 |
| Fredonia | 3.7 | 7.7 | 7.6 | 3.3 |
| Havasupai Indian Reservation | 4.3 | 93.8 | 48.6 | 30.1 |
| Hopi Reservation | 1.9 | 95.4 | 33.8 | 32.9 |
| Navajo Nation[¶] | 2.0 | 96.1 | 38.8 | 33.6 |
| Page | 7.3 | 34.0 | 13.3 | 10.9 |
| Tusayan CDP** | 40.7 | 8.1 | 11.5 | 0 |
| **Mohave County** | 14.8 | 2.2 | 15.5 | 10.7 |
| Kaibab Band of Paiutes | 5.4 | 84.6 | 55.5 | 52.1 |
| Kaibab CDP | 6.5 | 83.1 | 43.1 | 21.6 |
| Hualapai Tribe | 3.8 | 94.7 | 48.6 | 46.6 |
| Colorado City | 0.6 | 0.0 | 32.7 | 33.8 |
| **Utah** | 13.0 | 1.2 | 10.4 | 7.2 |
| **Kane County** | 3.7 | 1.5 | 10.6 | 8.0 |
| Kanab | 4.2 | 1.0 | 9.0 | 6.4 |
| **San Juan County** | 4.4 | 50.4 | 28.7 | 22.6 |
| Blanding | 3.8 | 29.4 | 23.8 | 14.4 |
| **Washington County** | 9.8 | 1.4 | 9.8 | 7.1 |
| **Garfield County** | 4.5 | 1.6 | 10.8 | 6.7 |

Source: American Community Survey data 2005–2009 (Census Bureau 2009, 2010)

**CDP = Census Designated Place

[¶] Navajo Nation Chapters within the study area were combined for the total Navajo Nation population in Coconino County.

### Low-Income Population

Only 2005–2009 American Community Survey census data are available for identifying low-income populations (Census Bureau 2009); the 2010 census has not released this level of detail yet. Of the communities in the study area (see Table 3.16-4), only the Kaibab Band of Paiutes (55.5%) has more than 50% of its population (individuals) living below the poverty level. Other communities with a high occurrence of individuals living below the poverty level, compared to the U.S. and state averages, include the Bitter Springs CDP (33.7%), Kaibab CDP (43.1%), Havasupai Indian Reservation (48.6%), Hopi Reservation (33.8%), Navajo Nation (38.8%), Hualapai Tribe (48.6%), Colorado City (32.7%), San Juan County, Utah (28.7%), and Blanding (23.8%).

### Environmental Justice Communities

In summary, the following tribes, communities, and counties meet the criteria for identification as an “Environmental Justice community:” all five tribes in the study area, including the Havasupai, Hopi, Navajo, Kaibab and Hualapai; and the communities of Bitter Springs CDP, Kaibab CDP, Colorado City, Blanding, and San Juan County.

## 3.16.2 Social Condition Indicators

Mineral exploration and construction, operation, and maintenance of proposed uranium mine facilities and/or the proposed withdrawal of mineral estates and the associated reduction in mineral development have the potential to affect social conditions resources. Resource indicators include those conditions listed below and described in Section 3.16:

- Demographics;
- Stakeholder Values;
- Public Health and Safety; and
- Environmental Justice.

### *Demographics*

Indicators of potential effects to demographics will be measured in terms of projected population and historical trends in growth. Changes in demographics can also be attributed to potential employment opportunities and will be analyzed concurrently with effects on employment.

### *Stakeholder Values*

Indicators of potential effects on stakeholder values could be affected by changes in land management related to the proposed withdrawal parcels; impacts would result if local or non-local individuals’ or community’s values and beliefs are compromised. As discussed in Section 3.16, stakeholder values are assessed using two basic perspectives: mineral exploration and development support, or withdrawal support. Accordingly, impacts to stakeholder values are assessed qualitatively.

### *Public Health and Safety*

Indicators of potential effects on public health and safety are described in terms of where known health risks from exposure to uranium and uranium decay products would occur. Risks include health effects resulting from inhalation of, ingestion of, or skin exposure to uranium; health issues can involve cancer, lung toxicity, and kidney disease. Effects will be measured by indicators that establish the likelihood that mineral exploration and development could result in human exposure to uranium ore and the likelihood that that exposure could manifest itself as health impacts.

### *Environmental Justice*

Indicators of potential environmental justice conditions would be evaluated by assessing the presence, and percentage of, minority and/or low-income populations in the study area and the distribution of benefits versus anticipated effects.

The following resource condition indicators apply to social conditions in the study area (Table 3.16-5).

**Table 3.16-5.** Social Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Demographics | There could be changes in population levels associated with decreased mineral exploration and development under a proposed withdrawal. Likewise, the continued mineral development in the absence of a proposed withdrawal could involve local population increases as additional workers are required. | *Indicator:* The current and projected population for counties and communities in the study area. |
| Stakeholder Values | Stakeholder values may be affected by changes in land management related to the proposed withdrawal areas. | *Indicator:* Public comments during scoping indicating general support for the withdrawal or support for mineral exploration and development (and no withdrawal). |
| Public health effects | The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport. | *Indicator:* Estimated number of haul trips through local communities.<br>*Indicator:* Potential exposure, public health risk, from single incident, effectiveness of cleanup, and total anticipated incidents. |
| Environmental justice | The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. Environmental justice is the equitable distribution of proposed withdrawal benefits and risks with respect to low-income or minority populations. In the case of uranium mining in the proposed withdrawal area, it is the distribution of the proposed withdrawal benefits, primarily economic, compared with the distribution of the proposed withdrawal impacts, such as pollution or risk of pollution that is the issue. | *Indicator:* Identification of populations considered low income and/or minority in the proposed withdrawal area that would either be adversely affected or benefit from the activity.<br>*Indicator:* Distribution of proposed withdrawal risks or adverse effects on the above populations.<br>*Indicator:* Distribution of proposed withdrawal benefits to the above populations.<br>*Indicator:* Comparison of minority/low-income populations' risks and benefits with those for non-minority/non-low-income populations. |

## 3.17 ECONOMIC CONDITIONS

Important general economic metrics for the study area include economic output and value-added; industry employment and earnings; unemployment rates; personal income; and taxes and revenues. This section also provides additional information regarding mining, tourism and recreation and environmental economics. The economic study area is generally rural, with two major urban centers (Flagstaff, Arizona, and St. George, Utah) within 75 miles of the proposed withdrawal area. Federal lands constitute the majority of the area and all five counties have a large land area with a dispersed population. The study area for economic conditions is the same as the study area described for social conditions (see Section 3.16).

The Grand Canyon is a substantial natural barrier which effectively divides the study area into two separate geographic and economic sub-areas. In order to effectively capture this distinction, the economic analysis describes economic conditions and the potential effects of the alternatives by sub-area: the area north of the Grand Canyon (North Study Area) and the area south of the Grand Canyon (South Study Area). All of the Utah counties (Garfield, Kane, San Juan and Washington) are located in the North Study Area, along with small portions of Coconino and Mohave counties of Arizona. The majority of the land area and population of Coconino and Mohave counties lie in the South Study Area.

Most economic data are only reported at the county level. Consequently, historical economic information provided for the North Study Area in this section does not include the portions of Coconino County and Mohave County that are located north of the Grand Canyon; economic data for those areas are included in historical data for the South Study Area. Using 2009 IMPLAN data files for individual zip codes, we are able to describe some economic metrics for the northern portions of Mohave County and Coconino County specific to that year and that information is provided in the discussion, where available.

## 3.17.1 Regional Economic Background

### *North Study Area*

Southern Utah and Northern Arizona were settled in the mid-nineteenth century by members of the Church of Jesus Christ of Latter-day Saints. Initially, farming and ranching were the primary economic drivers of the settlements, along with some silver mining in Washington County and copper, gold and vanadium mining in San Juan County. In 1909 Mukuntuweap National Monument (later named Zion National Park) was established, marking the beginning of tourism as a significant sector in the local economy, particularly in the southwestern Utah counties (San Juan County 2011; Washington County 2011).

In recent years, portions of the North Study Area (particularly the City of St. George and nearby communities) have experienced substantial economic growth and development, while other areas have seen relatively little growth or new economic development. In the area closest to the North Parcel, the Town of Fredonia has struggled economically since losing the mining and timber related jobs that once supported its economic base. Today, the primary employment base in the town is the Forest Service regional center. Many of the remaining residents in Fredonia commute to work in Kanab, Utah (personal communication, Carl Taylor and Bill Towler, Coconino County 2011). Kane County has experienced similar economic struggles as natural resource extraction jobs diminished and were replaced by lower-paying hospitality jobs (personal communication, Matt Brown, Kane County Economic Development Director 2011). Although farther from the withdrawal area, San Juan County's economy is the most dependent on mineral and energy resources of the study area counties and it currently supports the nearest active uranium mill to the withdrawal areas.

### *South Study Area*

The area south of the Grand Canyon had been sparsely settled in the nineteenth century but began to grow dramatically after the Atlantic & Pacific Railroad was established in 1883. Flagstaff soon became the population and economic hub of the area and was named the county seat when Coconino County was formed in 1891. Mohave County, which was initially populated by gold miners and Mormon settlers, also experienced growth as a result of the railroad. Early industries of both counties included farming, ranching, logging and stone quarrying. Tourism became a major economic driver with the establishment of Grand Canyon National Park in 1919. The area's tourism sector was further solidified with the construction of Route 66 and the dawn of American highway travel (ADOC 2009a).

Today, tourism continues to be the largest economic driver in Flagstaff and Coconino County. Northern Arizona University (NAU), regional services provided to a large trade area including the western portions of the Navajo Reservation, and a number of medium-sized manufacturing operations are other important components of the local economic base in Coconino County (personal communication, Carl Taylor and Bill Towler, Coconino County 2011). Mohave County also maintains a focus on recreation and tourism with 1,000 miles of shoreline (Lake Havasu, Lake Mohave and the Colorado River) and the longest stretch of historic U.S. Route 66 (ADOC 2009c).

# 3.17.2 Existing Conditions

## *Economic Activity*

### ECONOMIC OUTPUT AND GROSS REGIONAL PRODUCT

Economic output is a measure of the value of industry production over a given period of time and, for most sectors, reflects gross receipts. For example, in manufacturing, output is equal to sales plus/minus change in inventory; in service industries, output is equal to sales. Gross Regional Product (GRP) measures the overall size of the economy of a specified region and is defined as gross economic output minus intermediate inputs (purchases from other sectors). Each sector's contribution to GRP is called "value added." Thus the value added for each sector reflects that sector's economic output net of purchases of intermediate inputs.

### North Study Area

The 2009 industry breakdown of output and value added for the North Study Area (including the northern portions of Coconino and Mohave counties) is shown in Table 3.17-1. In 2009, the sum of value added across all industries (the GRP for the North Study Area) was almost $4 billion.

**Table 3.17-1.** North Study Area Output and Value-Added (GRP) by Sector, 2009

| Description | Output | Value Added (GRP) | Sector Share of GRP |
|---|---|---|---|
| Agriculture, Forestry, Fishing, and Hunting | $41,904,892 | $12,442,475 | 0.3% |
| Mining | $215,065,598 | $109,019,639 | 2.7% |
| Utilities | $110,160,498 | $57,549,284 | 1.4% |
| Construction | $661,938,688 | $270,174,963 | 6.8% |
| Manufacturing | $636,984,949 | $171,910,934 | 4.3% |
| Wholesale Trades | $157,745,575 | $99,839,367 | 2.5% |
| Retail Trades | $532,630,031 | $449,342,345 | 11.3% |
| Transportation and Warehousing | $527,082,798 | $268,199,803 | 6.7% |
| Information | $182,511,691 | $84,681,527 | 2.1% |
| Finance and Insurance | $376,174,687 | $157,310,315 | 3.9% |
| Real Estate and Rentals | $712,743,267 | $500,593,963 | 12.5% |
| Professional, Scientific, and Technical Services | $247,586,895 | $159,642,623 | 4.0% |
| Management of Companies | $14,599,524 | $5,942,541 | 0.1% |
| Administrative and Waste Services | $149,047,098 | $81,878,468 | 2.1% |
| Educational Services | $33,626,778 | $15,696,788 | 0.4% |
| Health and Social Services | $789,247,975 | $436,896,241 | 10.9% |
| Arts, Entertainment, and Recreation | $85,919,051 | $48,243,035 | 1.2% |
| Accommodations and Food Services | $506,140,951 | $256,458,548 | 6.4% |

**Table 3.17-1.** North Study Area Output and Value-Added (GRP) by Sector, 2009 (Continued)

| Description | Output | Value Added (GRP) | Sector Share of GRP |
|---|---|---|---|
| Other Services | $300,785,473 | $176,654,961 | 4.4% |
| Government and non-NAICs | $693,976,178 | $628,896,156 | 15.8% |
| **Total Output and GRP** | **$6,975,872,597** | **$3,991,373,976** | |

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

The government sector contributed the most total value added to the North Study Area, accounting for 16% of GRP, followed by real estate (13% of GRP), retail (11% of GRP), and health and social services (10% of GRP).

## South Study Area

Table 3.17-2 shows output and value added by sector for the South Study Area. Gross regional product for the South Study Area was approximately $8 billion in 2009. The top five sectors, in terms of value added were government (19% of GRP), real estate (15% of GRP), health and social services (12% of GRP), retail (11% of GRP), and manufacturing (10% of GRP).

**Table 3.17-2.** South Study Area Output and Value-Added (GRP) by Sector, 2009

| Description | Output | Value Added (GRP) | Sector Share of GRP |
|---|---|---|---|
| Agriculture, Forestry, Fishing, and Hunting | $84,804,767 | $26,729,780 | 0.3% |
| Mining | $137,781,971 | $75,689,409 | 0.9% |
| Utilities | $201,072,956 | $97,962,037 | 1.2% |
| Construction | $803,370,560 | $346,517,359 | 4.2% |
| Manufacturing | $2,334,560,738 | $824,651,720 | 10.1% |
| Wholesale Trades | $254,063,705 | $163,893,473 | 2.0% |
| Retail trades | $1,070,262,931 | $901,896,980 | 11.0% |
| Transportation and Warehousing | $489,478,086 | $221,681,606 | 2.7% |
| Information | $246,281,029 | $118,001,787 | 1.4% |
| Finance and Insurance | $478,533,665 | $221,961,318 | 2.7% |
| Real Estate and Rentals | $1,739,290,641 | $1,198,131,054 | 14.6% |
| Professional, Scientific, and Technical Services | $376,336,270 | $238,955,633 | 2.9% |
| Management of Companies | $35,368,416 | $17,717,177 | 0.2% |
| Administrative and Waste Services | $330,164,266 | $192,975,791 | 2.4% |
| Educational Services | $52,238,598 | $33,840,610 | 0.4% |
| Health and Social Services | $1,760,333,136 | $1,005,244,758 | 12.3% |
| Arts, Entertainment, and Recreation | $198,084,054 | $119,115,193 | 1.5% |
| Accommodations and Food Services | $1,048,513,180 | $547,858,448 | 6.7% |
| Other Services | $490,203,804 | $271,730,072 | 3.3% |
| Government and non-NAICs | $1,900,429,085 | $1,564,857,549 | 19.1% |
| **Total Output and GRP** | **$14,031,171,857** | **$8,189,411,754** | |

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

## TOTAL EMPLOYMENT AND EMPLOYMENT BY SECTOR

As previously noted, existing economic conditions were evaluated for two sub-areas: north of the Grand Canyon and south of the Grand Canyon. Historical employment trends, measured by number of jobs, along with annual percentage change are presented for the Utah portions of the study area in Table 3.17-3 and for the Arizona portions of the study area in Table 3.17-6.

**Table 3.17-3.** Utah Counties Employment History

| Year | Garfield County (No. of Jobs) | Garfield County (Annual Change) | Kane County (No. of Jobs) | Kane County (Annual Change) | San Juan County (No. of Jobs) | San Juan County (Annual Change) | Washington County (No. of Jobs) | Washington County (Annual Change) | Utah Counties of Interest Total (No. of Jobs) | Utah Counties of Interest Total (Annual Change) | Utah State Total (No. of Jobs) | Utah State Total (Annual Change) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 1,532 | | 1,073 | | 2,818 | | 4,819 | | 10,242 | | **454,612** | |
| 1980 | 2,322 | 4.2% | 1,557 | 3.8% | 4,204 | 4.1% | 9,442 | 7.0% | 17,525 | 5.5% | **687,159** | **4.2%** |
| 1990 | 2,206 | -0.5% | 2,374 | 4.3% | 4,548 | 0.8% | 21,258 | 8.5% | 30,386 | 5.7% | **938,218** | **3.2%** |
| 2000 | 2,985 | 3.1% | 3,678 | 4.5% | 5,508 | 1.9% | 47,170 | 8.3% | 59,341 | 6.9% | **1,377,859** | **3.9%** |
| 2007 | 3,465 | 2.2% | 4,583 | 3.2% | 6,495 | 2.4% | 74,964 | 6.8% | 89,507 | 6.0% | **1,674,854** | **2.8%** |
| 2009 | 3,394 | -1.0% | 4,395 | -2.1% | 6,376 | -0.9% | 68,930 | -4.1% | 83,095 | -3.6% | **1,622,518** | **-1.6%** |

Source: Bureau of Economic Analysis (BEA) Regional Economic Information System (BEA 2009a)

Note: Number of jobs includes full-time and part-time jobs.

### North Study Area

As a group, the Utah study area counties saw positive growth from 1970 through 2007, but lost jobs between 2007 and 2009 due to the economic downturn. Washington County had the largest number of jobs among the Utah counties, accounting for 83% of all jobs in the Utah study area. Washington County also saw more total employment growth than any county in either the North Study Area or South Study Area through 2007, but experienced large job losses from 2007 through 2009.

As noted at the outset of this section, there is no comparable historical employment data specific to the portions of Coconino and Mohave counties located north of the Grand Canyon. The IMPLAN zip code level data files indicate there were approximately 1,202 jobs in the portions of Coconino County and Mohave County located north of the Grand Canyon in 2009. Employment in these areas is included in the county totals discussed subsequently for the South Study Area.

A more in-depth evaluation of 2009 employment conditions in the North Study Area is displayed in Table 3.17-4, which shows the share of jobs by industry in each county.

The largest industry, in terms of number of jobs, in both Garfield and Kane counties was accommodation and food services at 28% and 21% respectively, with government as the second largest in both cases. In San Juan County, the reverse is true with the government sector as the largest employer (29%) followed by accommodation and food services (12%). In Washington County, which provided the greatest number of total jobs in the Utah study area, the largest employment sectors were retail (13%), health care (12%) and government (11%). San Juan County is the only county in the North Study Area (or the South Study Area) that had a relatively large mining sector (6% of county jobs) in 2009.

**Table 3.17-4.** Utah Employment by Industry

| | Garfield County | Kane County | San Juan County | Washington County | Utah Counties of Interest Total | Utah State Total |
|---|---|---|---|---|---|---|
| Forestry, Fishing, and Related Activities | 6.9%* | 3.2%* | 8.1%* | 0.5%* | 1.4%* | 0.2% |
| Mining | 0.5%* | 0.7%* | 6.4% | 0.6% | 1.0%* | 0.9% |
| Utilities | 1.1%* | 0.7%* | 0.3%* | 0.2% | 0.3%* | 0.3% |
| Construction | 3.7% | 5.3% | 5.2% | 8.9% | 8.3% | 6.2% |
| Manufacturing | 2.2% | 3.5% | 3.5% | 3.6% | 3.6% | 7.4% |
| Wholesale Trade | 1.5% | 1.0% | 0.4%* | 2.1% | 1.9%* | 3.2% |
| Retail Trade | 8.8% | 11.1% | 8.2% | 12.9% | 12.4% | 11.0% |
| Transportation and Warehousing | 0.7%* | 1.1%* | 1.9% | 4.8% | 4.2%* | 3.3% |
| Information | 5.0%* | 0.6% | 0.2% | 1.2%* | 1.2%* | 2.2% |
| Finance and Insurance | 1.4%* | 3.6% | 2.8% | 6.3% | 5.8%* | 7.0% |
| Real Estate, Rentals, and Leasing | 0.5%* | 5.2% | 2.6% | 6.9% | 6.3%* | 5.7% |
| Professional, Scientific, and Technical Services | 2.2% | 2.6% | 0.6%* | 5.3% | 4.7%* | 6.7% |
| Management of Companies and Enterprises | 0.0% | 0.0% | 0.7%* | 0.5% | 0.5%* | 1.3% |
| Administrative and Waste Services | 1.6%* | 2.0% | 2.9% | 4.5% | 4.2%* | 5.3% |
| Educational Services | 0.3%* | 0.9%* | 0.7%* | 1.2% | 1.1%* | 2.9% |
| Health Care and Social Assistance | 9.7%* | 3.0%* | 8.3%* | 12.2% | 11.3%* | 8.4% |
| Arts, Entertainment, and Recreation | 2.6% | 1.9% | 1.2% | 2.3% | 2.3% | 2.2% |
| Accommodation and Food Services | 28.0% | 21.1% | 11.7% | 9.1% | 10.6% | 6.2% |
| Other Services, except Public Administration | 3.7% | 15.1% | 5.2% | 5.6% | 6.0% | 5.2% |
| Government and Government Enterprises | 19.4% | 17.5% | 29.1% | 11.1% | 13.0% | 14.5% |

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA Regional Economic Information System (REIS) data were used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 are used instead. Generally speaking, employment data from IMPLAN are approximately comparable to BEA REIS data.

* Indicates the use of IMPLAN 2009 data.

In the portions of Coconino County and Mohave County located north of the Grand Canyon, government, retail trade, construction and accommodation and food services were the largest employment sectors in 2009 and accounted for 65% of all employment in this area.

Table 3.17-5 presents the major employers (both public and private) for the North Study Area counties.

**Table 3.17-5.** Utah Counties Major Employers

| County | Public Sector | Private Sector |
|---|---|---|
| Garfield | Garfield School District | Ruby's Inn |
| | United States Government | South Central Utah Telephone |
| | Garfield County | Garfield Memorial Hospital |
| | State of Utah | Silverado Boy's Ranch (Residential Care) |
| | Panguitch City | Turn About Ranch (Residential Care) |

**Table 3.17-5.** Utah Counties Major Employers (Continued)

| County | Public Sector | Private Sector |
|---|---|---|
| Kane | Kane County School District | Best Friends Animal Sanctuary |
| | United States Government | Aramark (Lake Powell Resorts) |
| | Kane County | Kane County Hospital |
| | State of Utah | Stampin' Up |
| | Kanab City | Honey IGA Supercenter |
| San Juan | San Juan School District | College of Eastern Utah - San Juan |
| | State of Utah | Denison Mines |
| | San Juan County | Libson Valley Mining |
| | The Navajo Nation | San Juan Hospital |
| | Blanding City | Montezuma Creek Community Health |
| Washington | Washington County School District | Intermountain Health Care |
| | St. George City | Wal-Mart |
| | United States Government | Dixie College |
| | Washington County | SkyWest Airlines |
| | City of Washington | Cross Creek Manor |

Source: Utah Department of Workforce Services (2009)

## South Study Area

The historical employment trend in the Arizona study area counties was similar to the Utah counties, showing positive growth through 2007, but a decrease in jobs by 2009. Since 1980, Mohave County has seen faster job growth than Coconino County, but experienced a more substantial job loss (5%) than Coconino County (2%) during the economic downturn. The Arizona counties, as a group, are larger in both size and population and therefore offer more total jobs (148,802) than the Utah study area counties (83,095).

**Table 3.17-6.** Arizona Counties Employment History

| Year | Coconino County (No. of Jobs) | Coconino County (Annual Change) | Mohave County (No. of Jobs) | Mohave County (Annual Change) | Arizona Counties of Interest Total (No. of Jobs) | Arizona Counties of Interest Total (Annual Change) | Arizona State Total (No. of Jobs) | Arizona State Total (Annual Change) |
|---|---|---|---|---|---|---|---|---|
| 1970 | 20,148 | | 9,297 | | 29,445 | | 746,653 | |
| 1980 | 35,165 | 5.7% | 21,285 | 8.6% | 56,450 | 6.7% | 1,282,615 | 5.6% |
| 1990 | 48,543 | 3.3% | 36,930 | 5.7% | 85,473 | 4.2% | 1,894,104 | 4.0% |
| 2000 | 69,647 | 3.7% | 54,170 | 3.9% | 123,817 | 3.8% | 2,795,770 | 4.0% |
| 2007 | 85,673 | 3.0% | 74,140 | 4.6% | 159,813 | 3.7% | 3,465,578 | 3.1% |
| 2009 | 82,367 | -1.9% | 66,435 | -5.3% | 148,802 | -3.5% | 3,217,666 | -3.6% |

Source: BEA (2009a)

Note: Number of jobs includes full-time and part-time jobs.

The 2009 share of jobs by industry for the Arizona study area counties is displayed in Table 3.17-7.

**Table 3.17-7.** Arizona Counties Employment by Industry

| | Coconino County | Mohave County | Arizona Counties of Interest Total | Arizona State Total |
|---|---|---|---|---|
| Forestry, Fishing, and Related Activities | 0.3% | 0.7%* | 0.5%* | 0.5% |
| Mining | 0.4% | 0.8% | 0.6% | 0.6% |
| Utilities | 0.1% | 0.5% | 0.3% | 0.4% |
| Construction | 4.7% | 7.6% | 6.0% | 5.7% |
| Manufacturing | 5.2% | 4.8% | 5.0% | 5.1% |
| Wholesale Trade | 1.5% | 1.7% | 1.6% | 3.5% |
| Retail Trade | 11.2% | 15.7% | 13.3% | 11.3% |
| Transportation and Warehousing | 2.7% | 2.7% | 2.7% | 2.8% |
| Information | 0.9% | 1.6% | 1.2% | 1.5% |
| Finance and Insurance | 2.7% | 2.9% | 2.8% | 6.1% |
| Real Estate, Rentals, and Leasing | 5.9% | 8.0% | 6.8% | 6.0% |
| Professional, Scientific, and Technical services | 4.8% | 3.5% | 4.2% | 6.5% |
| Management of Companies and Enterprises | 0.1% | 0.3%* | 0.2%* | 0.9% |
| Administrative and Waste Services | 3.1% | 5.4% | 4.2% | 7.8% |
| Educational Services | 1.3% | 1.1% | 1.2% | 1.9% |
| Health Care and Social Assistance | 11.0% | 12.3% | 11.6% | 10.3% |
| Arts, Entertainment, and Recreation | 3.8% | 1.7% | 2.9% | 2.1% |
| Accommodations and Food Services | 14.1% | 9.1% | 11.9% | 7.5% |
| Other Services, except Public Administration | 5.0% | 6.5% | 5.6% | 5.1% |
| Government and Government Enterprises | 21.1% | 13.1% | 17.5% | 14.2% |

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA REIS data were used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 are used instead. Generally speaking, employment data from IMPLAN are comparable to BEA REIS data.

*indicates the use of IMPLAN 2009 data.

The government sector also played an important role in the South Study Area as the largest employer in Coconino County (21%) and the second largest in Mohave County (13%). Accommodation and food services accounts for 14% of all jobs in Coconino County; retail and healthcare are also significant employment sectors with each accounting for 11% of Coconino County jobs. In Mohave County, retail trade provided the most jobs at 15% of total jobs.

Table 3.17-8 presents the major employers (both public and private) for the South Study Area counties.

**Table 3.17-8.** Arizona Counties Major Employers

| County | Public Sector | Private Sector |
|---|---|---|
| Coconino | City of Flagstaff | ARA Leisure Services |
| | Coconino County | Coconino Community College |
| | Flagstaff Unified School District | Flagstaff Medical Center |
| | Kaibab National Forest | Grand Canyon Railway |
| | National Park Service | Navajo Generating Station (Utilities) |

**Table 3.17-8.** Arizona Counties Major Employers (Continued)

| County | Public Sector | Private Sector |
|---|---|---|
| Mohave | Mohave County | American Woodmark Corp. |
| | | Western Arizona Regional Medical Center |
| | | Ford Proving Grounds |
| | | Goodyear Tire and Rubber Co. |
| | | Guardian Fiber Glass |

Source: ADOC (2009a)

## TOTAL EARNINGS AND EARNINGS BY SECTOR

Tables 3.17-9 and 3.17-11 display the average annual compensation per job[4] for workers in the study area for selected years from 1970 to 2009. Compensation includes both wages and benefits and all estimates have been adjusted for inflation and are shown in 2010 dollars.[5] Throughout the study area as a whole, average compensation per job has historically been below the state averages. In general, workers in the Arizona study area earn higher compensation than those in the Utah study area. A breakdown of 2009 earnings by sector for each county in the study area is provided below in Tables 3.17-10 and 3.17-12.

### North Study Area

Of the Utah counties, workers in San Juan County received the highest average compensation from 1970 through 1990, but Garfield County has had the highest average earnings since 2000. Overall, average compensation per job in the Utah counties in the study area was over 28% below the Utah state average in 2009. Average compensation per job in the Utah counties has historically been lower than average compensation per job in the Arizona counties in the South Study Area.

**Table 3.17-9.** Utah Earnings History

| Year | Garfield County (Average Compensation per Job) | Garfield County (Annual Change) | Kane County (Average Compensation per Job) | Kane County (Annual Change) | San Juan County (Average Compensation per Job) | San Juan County (Annual Change) | Washington County (Average Compensation per Job) | Washington County (Annual Change) | Utah Counties of Interest Total (Average Compensation per Job) | Utah Counties of Interest Total (Annual Change) | Utah State Total (Average Compensation per Job) | Utah State Total (Annual Change) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | $33,919 | | $25,581 | | $35,830 | | $24,971 | | $32,233 | | $37,539 | |
| 1980 | $30,506 | -1.1% | $24,916 | -0.3% | $40,542 | 1.2% | $31,378 | 2.3% | $32,532 | 0.1% | $38,730 | 0.3% |
| 1990 | $29,528 | -0.3% | $23,945 | -0.4% | $30,706 | -2.7% | $26,304 | -1.7% | $29,034 | -1.1% | $36,352 | -0.6% |
| 2000 | $30,421 | 0.3% | $26,208 | 0.9% | $30,080 | -0.2% | $26,637 | 0.1% | $29,938 | 0.3% | $41,338 | 1.3% |
| 2007 | $32,825 | 1.1% | $28,540 | 1.2% | $28,718 | -0.7% | $25,583 | -0.6% | $32,027 | 1.0% | $42,898 | 0.5% |
| 2009 | $31,091 | -2.7% | $28,133 | -0.7% | $29,493 | 1.3% | $25,739 | 0.3% | $30,593 | -2.3% | $42,464 | -0.5% |

Source: BEA (2009a, 2009b)

Note: All estimates are shown in 2010 dollars (adjusted for inflation).

[4] Compensation per job was calculated by dividing total compensation for the county (or state) by total jobs for that county (or state). The number of jobs, and average compensation per job, includes both full- and part-time jobs.

[5] Inflation adjustments were made according to the Bureau of Labor Statistics Inflation Calculator (BLS 2011).

In 2009, average compensation per job in the portions of Coconino County and Mohave County located north of the Grand Canyon was $42,819.

In 2009, the highest paying sector in Utah as a whole, and in the study area counties, was utilities (see Table 3.17-10). The sectors providing the second highest compensation per job were government in Garfield and Washington counties and the mining industry in both Kane and San Juan counties.

**Table 3.17-10.** Utah Earnings by Industry

| Industry | Garfield County | Kane County | San Juan County | Washington County | Utah Counties of Interest Total | Utah State Total |
|---|---|---|---|---|---|---|
| Forestry, Fishing, and Related Activities | $6,841* | $4,543* | $2,140* | $6,532* | $4,577* | $21,512 |
| Mining | $39,308* | $52,521* | $66,932 | $28,192 | $46,892* | $78,896 |
| Utilities | $85,676* | $92,014* | $77,266* | $80,335 | $82,618* | $110,060 |
| Construction | $22,720 | $19,482 | $27,267 | $33,432 | $32,501 | $45,952 |
| Manufacturing | $19,152 | $44,654 | $22,764 | $44,142 | $42,077 | $64,129 |
| Wholesale Trades | $27,295 | $37,833 | $28,140* | $37,615 | $37,163* | $61,541 |
| Retail Trades | $14,719 | $19,053 | $15,326 | $27,566 | $26,227 | $28,588 |
| Transportation and Warehousing | $16,129* | $24,066* | $27,110 | $44,033 | $43,050* | $54,288 |
| Information | $47,069* | $29,516 | $48,025 | $34,990* | $36,895* | $55,083 |
| Finance and Insurance | $18,875* | $20,453 | $10,353 | $15,819 | $15,807* | $35,907 |
| Real Estate, Rentals, and Leasing | $21,899* | $8,435 | $2,439 | $9,297 | $9,099* | $12,579 |
| Professional, Scientific, and Technical Services | $12,329 | $14,414 | $26,885* | $31,851 | $30,951* | $56,099 |
| Management of Companies and Enterprises | 0 | 0 | $50,506* | $7,100 | $11,884* | $70,608 |
| Administrative and Waste Services | $10,804* | $7,788 | $20,669 | $19,806 | $19,420* | $29,310 |
| Educational Services | $2,277* | $24,226* | $14,244* | $13,990 | $14,320* | $27,631 |
| Health Care and Social Assistance | $26,518* | $35,326* | $35,692* | $45,964 | $44,635* | $45,628 |
| Arts, Entertainment, and Recreation | $26,274 | $25,956 | $3,910 | $11,440 | $12,422 | $16,798 |
| Accommodations and Food Services | $20,263 | $21,607 | $24,238 | $19,098 | $19,882 | $19,663 |
| Other Services, except Public Administration | $31,123 | $38,870 | $41,397 | $35,084 | $35,885 | $38,499 |
| Government and Government Enterprises | $52,754 | $47,565 | $47,200 | $49,557 | $49,221 | $58,232 |

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA REIS data were used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 are used instead. Generally speaking, employment data from IMPLAN are comparable to BEA REIS data. All estimates are shown in 2010 dollars (adjusted for inflation).

* indicates the use of IMPLAN 2009 data.

In 2009, the highest-paying sectors in the portions of Coconino County and Mohave County located north of the Grand Canyon were finance and insurance; mining; government; transportation and warehousing; and health and social services. Average compensation in each of these sectors was more than $50,000 per job.

## South Study Area

Average compensation per job was about 10% higher in Coconino County in 2009 than in Mohave County and average compensation has been higher in Coconino County since 1980. Compensation per job in both Arizona counties, however, has traditionally been 10%–20% lower than the statewide average in Arizona (Table 3.17-11).

**Table 3.17-11.** Arizona Earnings History

| Year | Coconino County (Average Compensation per Job) | Coconino County (Annual Change) | Mohave County (Average Compensation per Job) | Mohave County (Annual Change) | Arizona Counties of Interest Total (Average Compensation per Job) | Arizona Counties of Interest Total (Annual Change) | Arizona State Total (Average Compensation per Job) | Arizona State Total (Annual Change) |
|---|---|---|---|---|---|---|---|---|
| 1970 | $36,833 | | $40,575 | | $38,014 | | $41,387 | |
| 1980 | $36,218 | -0.2% | $34,110 | -1.7% | $35,423 | -0.7% | $40,958 | -0.1% |
| 1990 | $34,246 | -0.6% | $31,617 | -0.8% | $33,110 | -0.7% | $38,866 | -0.5% |
| 2000 | $36,579 | 0.7% | $35,913 | 1.3% | $36,288 | 0.9% | $46,857 | 1.9% |
| 2007 | $38,700 | 0.8% | $36,005 | 0.0% | $37,450 | 0.5% | $48,714 | 0.6% |
| 2009 | $38,382 | -0.4% | $34,680 | -1.9% | $36,729 | -1.0% | $47,926 | -0.8% |

Source: BEA (2009a, 2009b)

Note: All estimates are in shown in 2010 dollars (adjusted for inflation).

The Arizona counties of interest offered higher compensation in most sectors than the Utah counties, except for jobs in the mining, utilities and "other" sectors. In Coconino County, the highest paying sector was manufacturing, followed by government. In Mohave County, the utilities sector had the highest compensation per job followed by the health care and social assistance sector.

**Table 3.17-12.** Arizona Earnings by Industry

| Industry | Coconino County | Mohave County | Arizona Counties of Interest Total | Arizona State Total |
|---|---|---|---|---|
| Forestry, Fishing, and Related Activities | $9,793 | $15,760* | $13,671* | $28,382 |
| Mining | $15,670 | $37,404 | $28,799 | $62,519 |
| Utilities | $57,330 | $82,042 | $75,344 | $123,300 |
| Construction | $38,130 | $29,666 | $33,303 | $52,075 |
| Manufacturing | $71,084 | $48,867 | $61,520 | $79,313 |
| Wholesale Trades | $40,715 | $41,713 | $41,205 | $72,414 |
| Retail Trades | $26,683 | $29,679 | $28,288 | $32,580 |
| Transportation and Warehousing | $47,757 | $39,890 | $44,183 | $53,158 |
| Information | $28,116 | $34,547 | $31,864 | $63,223 |
| Finance and Insurance | $22,549 | $32,418 | $27,243 | $50,540 |
| Real Estate, Rentals, and Leasing | $12,891 | $10,285 | $11,524 | $21,063 |
| Professional, Scientific, and Technical Services | $32,116 | $35,319 | $33,327 | $62,424 |
| Management of Companies and Enterprises | $51,072 | $49,729* | $50,273* | $78,848 |
| Administrative and Waste Services | $22,382 | $22,754 | $22,601 | $34,518 |
| Educational Services | $14,988 | $25,827 | $19,412 | $37,439 |
| Health Care and Social Assistance | $55,785 | $55,941 | $55,860 | $56,158 |
| Arts, Entertainment, and Recreation | $18,234 | $16,362 | $17,731 | $25,506 |
| Accommodation and Food Services | $23,485 | $17,816 | $21,524 | $23,583 |
| Other Services, except Public Administration | $28,897 | $29,508 | $29,213 | $33,143 |
| Government and Government Enterprises | $61,056 | $54,440 | $58,820 | $63,982 |

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA REIS data was used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 is used instead. Generally speaking, employment data from IMPLAN is comparable to BEA REIS. All estimates are shown in 2010 dollars (adjusted for inflation).

* Indicates the use of IMPLAN 2009 data.

## TOURISM-RELATED ECONOMY

The tourism "sector" is not a clearly defined, specific industry within a local economy, but rather reflects the portions of the economic activity of multiple sectors (such as retail trade; accommodation and food services; and arts, entertainment and recreation) that can be attributed to expenditures by tourist visitors. Consequently, standardized data on the tourism-related economy are not typically available. However, a substantial portion of tourism within the study area is due to nature-based travel to visit public lands. As shown in Tables 3.17-13 and 3.17-14 on the following pages, facilities managed by the NPS, including national parks, national monuments and national recreation areas, generated nearly 12 million recreational visits to the study area in 2008. NPS data regarding visitation, visitor spending and the economic impacts of park activities in the local area were applied to provide a baseline for evaluating the tourism-related economy of the study area.

The data provided in this section were obtained from a 2009 study sponsored by the NPS that estimated the visitation and economic impact of National Parks and National Monuments across the United States. It should be noted that assessing the economic impact of tourism within the study area based on NPS managed lands provides only an order of magnitude, minimum representation of the total tourism-based economy. Examples of other tourist activities that are not included in this measure include Route 66 historic/scenic travel, National Forest visitation, and "snowbird" visits to St. George, Utah.

Figure 3.17-1 provides a map of the study area showing the locations of NPS managed parks and monuments included in the 2009 NPS study.

### North Study Area

Table 3.17-13 displays the visitation and estimated economic impacts for the National Parks and National Monuments located within the North Study Area. The jobs, labor income, and value added include the direct and secondary (multiplier) effects from visitor spending and National Park payroll. According to a 2005 NAU tourism study, 17% of visitors access the Grand Canyon from the north rim. Based on this visitation distribution, 17% of Grand Canyon impacts were attributed to the North Study Area, and the remaining 83% were attributed to the South Study Area (NAU 2005).

Glen Canyon National Recreation Area (GCNRA) sits atop the historical channel of the Colorado River and, consequently, is physically located in both the North and South Study Areas. The North Study Area community of Lees Ferry is largely supported by visitors to the GCNRA. However, since the data do not exist to apportion visitor spending between the two study areas, and the city of Page in the South Study Area is the larger gateway community to the GCNRA, these economic benefits are reflected in the data for the South Study Area.

Based on the data summarized in Table 3.16-13, the tourism industry in the North Study Area supported 8,306 jobs (approximately 10% of total jobs in the area) and contributed over a quarter of a billion dollars to GRP in 2008, not including any tourist visits unrelated to NPS managed facilities. Zion National Park, located in Washington County, is the most visited NPS facility in the North Study Area and also generates the most jobs and value added for the area. Collectively, Zion and Bryce Canyon account for approximately two thirds of recreation visits and value added within the North Study Area.

Average labor income from tourism-based jobs was relatively low ($21,879) compared to the average compensation per job data provided earlier in this section. Also, tourism in the North Study Area is more seasonal than tourism in the South Study Area (personal communication, Carl Taylor and Bill Towler, Coconino County 2011).

**Table 3.17-13.** North Study Area Tourism Impacts, 2008

| Park Unit | Recreation Visits | Non-local Visitor Spending ($000's) | Total Jobs‡ | Total Labor Income‡ ($000's) | Total Value Added‡ ($000's) |
|---|---|---|---|---|---|
| **Utah** | | | | | |
| Zion National Park | 2,690,154 | $141,446 | 3,253 | $84,028 | $118,667 |
| Bryce Canyon National Park | 1,043,321 | $89,983 | 1,875 | $35,717 | $53,239 |
| Grand Staircase-Escalante National Monument | NA | NA | NA | NA | NA |
| Rainbow Bridge National Monument | 95,567 | $4,604 | 94 | $1,959 | $2,982 |
| Capitol Reef National Park | 604,811 | $28,198 | 607 | $12,430 | $18,045 |
| Canyonlands National Park† | 174,686 | $14,196 | 346 | $7,820 | $10,807 |
| Natural Bridges National Monument | 91,838 | $4,435 | 98 | $2,253 | $3,294 |
| **Arizona (North of Grand Canyon National Park)** | | | | | |
| Grand Canyon National Park* | 752,303 | $72,774 | 1,967 | $35,586 | $52,923 |
| Pipe Spring National Monument | 47,418 | $2,285 | 66 | $1,936 | $1,412 |
| Grand Canyon-Parashant National Mondument | NA | NA | NA | NA | NA |
| Vermilion Cliffs National Monument | NA | NA | NA | NA | NA |
| **Study Area Total** | **5,500,098** | **$357,921** | **8,306** | **$181,728** | **$261,368** |

Source: Stynes (2009).

Note: All estimates are in 2010 dollars (adjusted for inflation). Numbers may not add to total due to rounding.

* Based on the results of the 2005 NAU tourism study of Grand Canyon National Park, 83% of the visitation, visitor spending, and economic impacts of the park were allocated to the south study area and 17% to the north study area (corresponding to relative visitation of the two rims).

† The northern portion of Canyonlands National Park lies outside the study area. Visitors accessing the northern portion (Island in the Sky District) of the Park were assumed to base their visit from Moab, in Grand County. Based on the visitation distribution of Island in the Sky District relative to the Maze and Needles Districts, 40% of the visitation and economic impact was assumed to occur within the study area and was included in the table.

‡ Total Jobs, Total Labor Income, and Total Value Added include both visitor impacts and NPS payroll impacts.

## South Study Area

Visitation and estimated economic impacts for National Parks and National Monuments located within the South Study Area are displayed in Table 3.17-14. As discussed previously, 83% of the Grand Canyon impacts were attributed to the South Study Area. It should also be noted that while portions of the GCNRA, lie on the north side of the Colorado River, most visitors access the park from the city of Page, so the tourism impacts were considered to occur in the South Study Area.

**Table 3.17-14.** South Study Area Tourism Impacts, 2008

| Park Unit | Recreation Visits | Non-local Visitor Spending ($000's) | Total Jobs‡ | Total Labor Income‡ ($000's) | Total Value Added‡ ($000's) |
|---|---|---|---|---|---|
| **Arizona (South of Grand Canyon National Park)** | | | | | |
| Grand Canyon National Park* | 3,673,011 | $355,309 | 9,603 | $173,741 | $258,390 |
| Wupatki National Monument | 239,157 | $11,522 | 301 | $8,275 | $11,321 |
| Sunset Crater Volcano National Monument | 209,399 | $10,088 | 200 | $4,029 | $6,236 |
| Walnut Canyon National Monument | 101,833 | $4,906 | 97 | $1,960 | $3,032 |
| Glen Canyon National Recreation Area | 1,947,507 | $133,559 | 2,667 | $66,433 | $101,098 |
| **Study Area Total** | **6,170,907** | **$515,385** | **12,868** | **$254,438** | **$380,077** |

Source: Stynes (2009).

Note: All estimates are in 2010 dollars (adjusted for inflation). Numbers may not add to total due to rounding.

* Based on the results of the 2005 NAU tourism study of Grand Canyon National Park, 83% of the visitation, visitor spending and economic impacts of the park were allocated to the south study area and 17% to the north study area (corresponding to relative visitation of the two rims).

‡ Total Jobs, Total Labor Income, and Total Value Added include both visitor impacts and NPS payroll impacts.

Tourism associated with NPS-managed lands in the South Study Area is a significant contributor to the overall regional economy. Visitors and NPS payroll generated 12,868 jobs (9% of total jobs) and added $380 million to GRP in 2008. Not surprisingly, Grand Canyon National Park creates the largest economic impact supporting 9,600 jobs and generating $258 million in value added in the South Study Area. As was the case in the North Study Area, average labor income from tourism-based jobs in the South Study Area was relatively low ($19,773) compared to the average compensation per job data provided earlier in this section.

## MINING-RELATED ECONOMY

The mining industry has played a role in the history and development of the entire study area, with the cultural and economic effects of mining being most pronounced in the North Study Area. In 2009, the mining industry accounted for 1% of all jobs in the North Study Area and less than 0.5% of all jobs in the South Study Area (IMPLAN 2009). It is important to note, however, that the discussion of current and historical mining-related employment in this section reflects only direct mining jobs. These data cannot be directly compared to the previous discussion regarding the economic contribution of tourism, which included indirect and induced employment (multiplier effects).

Among all study area counties, the mining sector is largest in San Juan County, Utah, where it accounted for over 6% of all jobs. San Juan County has an extensive mining history, including uranium and other minerals. Uranium has been mined and milled in the County since the early 1900s (San Juan County 2011). Across the study area, the share of jobs in the mining industry is relatively low but the average compensation per mining job has historically been higher than the industry-wide averages shown in Table 3.17-10.

### North Study Area

Table 3.17-15 depicts the history of mining-related employment in Utah study area from 1970 through 2009. Until the early 2000s, mining was most prevalent in San Juan County, which accounted for over three-fourths of the mining jobs in the study area throughout the 1970s and 1980s. The data shown in Table 3.17-15 are from the Bureau of Economic Analysis. Data from the BLS and the Utah Department of Workforce Solutions (which are available only from 2001 forward) provide similar estimates of mining employment over the most recent decade. It should be noted, however, that the older historical data for mining in Garfield County and Kane County are frequently suppressed due to BEA's concerns about disclosing data when there are few employers reporting job counts. Consequently, historical mining jobs in these counties—and particularly uranium mining employment attributable to Energy Fuels during the 1980s—are not well documented in the public data sources.

**Table 3.17-15.** Utah Mining Sector Employment History (number of jobs)

| Decade | Garfield County | Kane County | San Juan County | Washington County | Utah Counties of Interest Total | Utah State Total |
|---|---|---|---|---|---|---|
| 1970s (average) | NA | NA | 751 | 31 | 782 | 14,311 |
| 1980s (average) | 104 | 19 | 702 | 75 | 900 | 13,788 |
| 1990s (average) | NA | NA | 332 | 186 | 517 | 9,546 |
| 2000s (average) | NA | 11 | 289 | 368 | 668 | 11,065 |

Source: BEA (2009a)

Note: Calculations of job averages for each decade based only on years for which data were disclosed.

Table 3.17-16 provides greater detail for the current mining-related economy of the North Study Area. In 2009, mining sand and gravel supported the most jobs, but copper mining contributed the most to GRP.

Jobs in the coal mining industry averaged the highest compensation, followed by jobs in oil and gas. According to the RFD, the primary mineral commodity located in the withdrawal area is uranium, which is classified as a metal ore. Mining gold, silver, and metal ore (including uranium) supported 56 jobs making an average of $75,542 per year in 2009.

**Table 3.17-16.** North Study Area Mining Detail, 2009

| Description | Jobs | Labor Income | Average Compensation per Job | Value Added |
|---|---|---|---|---|
| Extraction of Oil and Natural Gas | 93 | $7,851,679 | $84,444 | $17,703,467 |
| Mining Coal | 3 | $261,258 | $103,707 | $516,714 |
| Mining Iron Ore | 0 | $0 | $0 | $0 |
| Mining copper, Nickel, Lead, and Zinc* | 128 | $9,882,023 | $77,019 | $39,873,130 |
| Mining Gold, Silver, and other Metal Ore** | 56 | $4,226,860 | $75,542 | $20,903,081 |
| Mining and Quarrying Stone | 32 | $1,077,825 | $33,406 | $2,506,104 |
| Mining and Quarrying Sand, Gravel, Clay, and Ceramic and Refractory Minerals | 176 | $6,698,279 | $38,004 | $9,831,786 |
| Mining and Quarrying other Nonmetallic Minerals | 57 | $2,757,423 | $48,069 | $7,363,364 |
| Drilling Oil and Gas Wells | 31 | $1,335,309 | $42,974 | $5,800,388 |
| Support Activities for Oil and Gas Operations | 65 | $3,158,669 | $48,352 | $3,358,413 |
| Support Activities for other Mining | 11 | $581,823 | $51,074 | $1,163,192 |
| **Total** | **653** | **$37,831,147** | **$57,896** | **$109,019,639** |

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

* Standard NAICS description for this sector. Only copper occurs in the region near the Grand Canyon.

** Includes uranium mining and milling.

## South Study Area

The mining sector in Coconino and Mohave counties has historically supported fewer jobs than in the Utah counties in the North Study Area (Table 3.17-17). In recent decades, the number of mining jobs has been evenly distributed between the two study area counties. Although mining jobs declined after the 1970s, the most recent decade has seen an increase in mining employment in both Coconino County and Mohave County.

**Table 3.17-17.** Arizona Mining Sector Employment History (number of jobs)

| Decade | Coconino County | Mohave County | Arizona Counties of Interest Total | Arizona State Total |
|---|---|---|---|---|
| 1970s (average) | 55 | 478 | 533 | 24,109 |
| 1980s (average) | 108 | 369 | 477 | 17,943 |
| 1990s (average) | 171 | 169 | 339 | 15,870 |
| 2000s (average) | 266 | 279 | 545 | 14,118 |

Source: BEA (2009a)

Note: Calculations of job averages for each decade based only on years for which data were disclosed.

Mining sector details by type of mining in the South Study Area are displayed in Table 3.17-18. Mining copper accounted for 71% of mining jobs and 81% of value added from mining in 2009. Mining gold, silver, and other metal ore, which includes uranium mining, supported only two jobs in the South Study Area in 2009, with an average annual compensation of $56,364.

**Table 3.17-18.** South Study Area Mining Detail, 2009

| Description | Jobs | Labor Income | Average Comp per Job | Value Added |
|---|---|---|---|---|
| Extraction of Oil and Natural Gas | 15 | $279,477 | $19,227 | $660,095 |
| Mining Coal | 5 | $519,076 | $103,708 | $1,026,625 |
| Mining Iron Ore | 0 | $0 | $0 | $0 |
| Mining Copper, Nickel, Lead, and Zinc* | 244 | $15,110,495 | $62,049 | $61,038,796 |
| Mining Gold, Silver, and other Metal Ore** | 2 | $90,183 | $56,364 | $448,624 |
| Mining and Quarrying Stone | 17 | $827,491 | $50,129 | $1,926,565 |
| Mining and Quarrying Sand, Gravel, Clay, and Ceramic and Refractory Minerals | 14 | $725,061 | $50,444 | $1,065,001 |
| Mining and Quarrying other Nonmetallic Minerals | 32 | $1,883,340 | $59,267 | $5,029,327 |
| Drilling Oil and Gas Wells | 11 | $760,292 | $68,100 | $3,401,548 |
| Support Activities for Oil and Gas Operations | 0 | $0 | $0 | $0 |
| Support Activities for other Mining | 6 | $551,475 | $87,034 | $1,092,829 |
| **Total** | **345** | **$279,477** | **$60,166** | **$75,689,410** |

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

* Standard NAICS description for this sector. Only copper occurs in the region near the Grand Canyon.

** Includes uranium mining and milling.

## PERSONAL INCOME

Tables 3.17-19 and 3.17-20 depict median household income (MHI) for the North and South study areas in 2000 and 2009. All income is adjusted for inflation and shown in 2010 dollars. Median income data was only available by county so the North Study Area includes only the Utah counties, and the South Study Area comprises the Arizona counties.

### North Study Area

The state of Utah had a higher MHI than the nation in both 2000 and 2005–2009,[6] but the Utah counties in the study area all had a MHI below both the state and national medians. However, this gap narrowed between 2000 and 2005–2009 in all counties in the South Study Area except Kane County. Washington County had the highest MHI at $49,527 and San Juan County had the lowest MHI in the North Study Area at $36,803 per year.

The communities in closest proximity to the North Parcel are Fredonia, Arizona; Colorado City, Arizona; the Kaibab Paiute Tribe; and Kanab, Utah. According to the 2005–2009 American Community Survey 5-year estimate (Census Bureau 2009), Colorado City had the highest MHI ($46,268) of these communities, followed by Kanab ($41,149) and then Fredonia ($39,244). The MHI for the Kaibab Paiute Tribe was $26,750. Blanding, Utah, where uranium mined in the region is most likely to be processed, had an MHI

[6] The most recent available personal income data is from the American Community Survey and reflects the 5-year average for the 2005–2009 period.

of $38,182.[7] Colorado City and Blanding both show median incomes above their county averages, but the median incomes of both Fredonia and Kanab are below their counties' averages. The MHI for the Kaibab Paiute Tribe was considerably lower than the MHI for the other communities in close proximity to the North Parcel.

**Table 3.17-19.** Utah Median Household Income

| | 2000 | 2005–2009 | Annual Change |
|---|---|---|---|
| United States | $53,177 | $52,269 | -0.2% |
| Utah | $57,903 | $56,555 | -0.3% |
| Garfield County | $44,548 | $45,597 | 0.3% |
| Kane County | $43,367 | $41,991 | -0.4% |
| San Juan County | $35,630 | $36,803 | 0.4% |
| Washington County | $47,121 | $49,527 | 0.6% |

Sources: Census Bureau (2000, 2009)
Note: All estimates are in 2010 dollars (adjusted for inflation).

## South Study Area

The 2009 median household income in Coconino County ($49,051) was slightly below the state median of $51,121, while MHI in Mohave County ($40,816) was about 14% below the state average. Despite a decrease in MHI on the state and national level, both Coconino and Mohave counties showed positive small increases in MHI between 2000 and 2005–2009.

**Table 3.17-20.** Arizona Median Household Income

| | 2000 | 2005–2009 | Annual Change |
|---|---|---|---|
| United States | $53,177 | $52,269 | -0.2% |
| Arizona | $51,358 | $51,121 | -0.1% |
| Coconino County | $48,443 | $49,051 | 0.1% |
| Mohave County | $39,915 | $40,816 | 0.2% |

Sources: Census Bureau (2000, 2009)
Note: All estimates are in 2010 dollars (adjusted for inflation).

The communities proximate to the East and South parcels include Bitter Springs CDP, Page, and Tusayan—all in Coconino County, Arizona. In 2005–2009, the MHI in Bitter Springs CDP was $42,369, which was $6,000 lower than Coconino County. The MHI in both Page ($55,967) and Tusayan ($51,513) exceeded the Coconino County MHI.[8]

# LABOR FORCE AND UNEMPLOYMENT

The labor force of an area is the population of working-age residents that are currently employed or are unemployed but actively seeking work. It is important to note that "unemployed" is specifically defined

[7] These figures were adjusted for inflation and are shown in 2010 dollars for comparison to the county level data in Tables 3.17-19 and 3.17-20.

[8] Median household incomes reflect U.S. Census Bureau, 2005–2009 American Community Survey 5-year estimates (Census Bureau 2010a) and were adjusted for inflation (shown in 2010 dollars) for comparison to the county level data in Tables 3.16-19 and 3.16-20.

and does not include the entire non-working population. According to the BLS, unemployed individuals are "persons aged 16 years and older who had no employment during the reference week, were available for work, except for temporary illness, and had made specific efforts to find employment sometime during the 4-week period ending with the reference week. Persons who were waiting to be recalled to a job from which they had been laid off need not have been looking for work to be classified as unemployed" (BLS 2010). The unemployment rate reflects the number of unemployed persons as a percentage of the total labor force.

As a result of the economic recession that began in late 2008, unemployment in communities across the United States rose sharply and the study area counties were no exception. In 2009, the U.S. unemployment rate rose to 9.3%, an increase of 3.5 percentage points over the previous year; and in 2010 it rose again, though not as dramatically, to 9.6%. Of the entire study area, the only counties with unemployment rates below the 2010 national average were Kane County, Utah (8.2%), and Coconino County, Arizona (8.9%).

## North Study Area

Figure 3.17-2 illustrates the unemployment trends in the United States, Utah, and the counties of interest from 2000 to 2010.

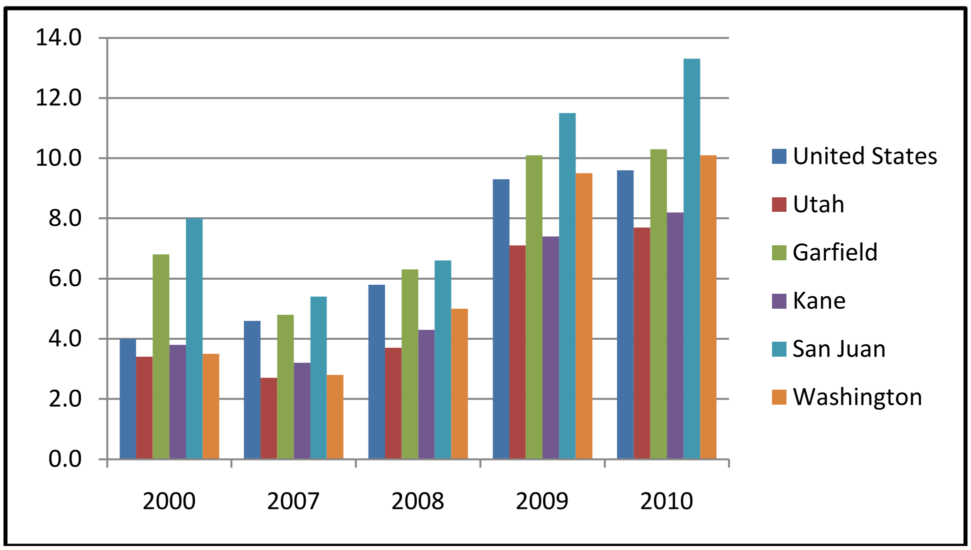


**Figure 3.17-2.** Utah unemployment rates, compared with rates in United States and counties of interest, 2000–2010 (Source: BLS 2010).

The state of Utah has consistently maintained unemployment rates at or below than the national average. While unemployment rates in Kane and Washington counties have typically been similar to the state average, Garfield and San Juan counties have generally had unemployment rates two to three percentage points higher than Utah's average. From 2008 to 2009, unemployment rates in all of the Utah counties in the study area rose by three to five percentage points. As of 2010, San Juan County had the highest unemployment rate (13.3%), not only of the Utah counties of interest, but of the entire study area. Kane County had the lowest unemployment rate of the study area at 8.2%.

## South Study Area

Unemployment rates for Arizona and the South Study Area counties of interest are displayed graphically in Figure 3.17-3.

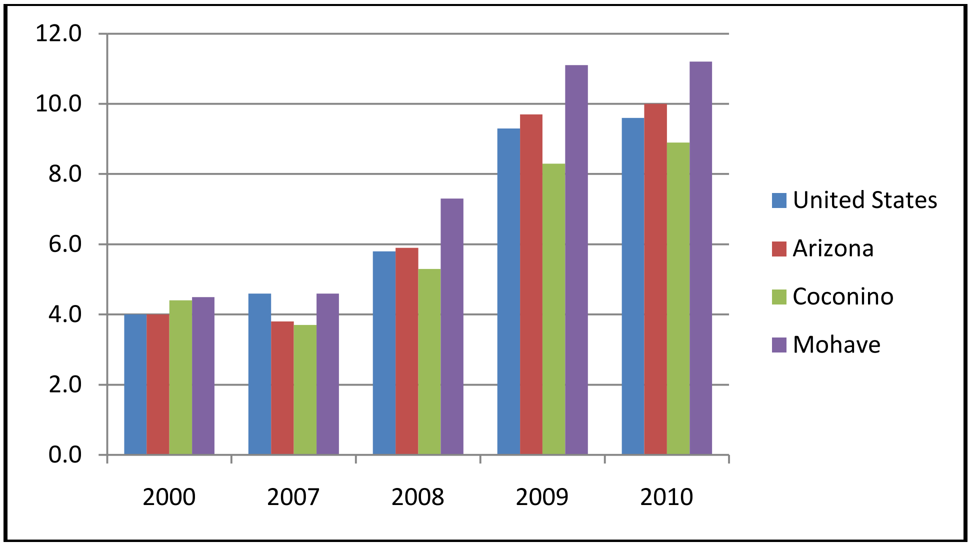


**Figure 3.17-3.** Arizona unemployment rates, compared with rates in United States and counties of interest, 2000–2010 (Source: BLS 2010).

Arizona experienced trends in unemployment similar to Utah and the United States as a whole in response to the economic crisis of 2008. Though often showing historical unemployment rates higher than Utah, Arizona's unemployment rate stayed below the U.S. average until 2008. In 2009 the Arizona unemployment rate increased by almost four percentage points to reach 9.7%, and by 2010 the unemployment rate had risen to 10%. Unemployment in Coconino County reached 8.9% in 2010 and Mohave County had 11.2% unemployment in 2010, higher than both the state and national unemployment rates.

## *Taxes and Revenues*

The states of Arizona and Utah, as well the counties and cities within the study area, raise revenues from a variety of different sources. At the state level, income taxes and sales-related taxes (termed transaction privilege taxes in Arizona) are the largest sources of revenue. At the local government level, sales-related taxes and property taxes are typically the largest sources of revenue for cities and counties.

The different levels of future mining activity anticipated to result from the alternatives considered in this EIS would directly affect severance tax revenues in Arizona. The alternatives would also likely affect state income tax revenues and sales-related taxes at both the state and local levels.

Property tax revenues are also a significant source of revenue for local governments. Although the uranium mines would be located on federal lands, they would be subject to centrally assessed property taxes based on the present value of the discounted cash flow of their operations. Denison Mines, which owns and operates the White Mesa Mill in San Juan County (where uranium mined from the proposed withdrawal areas would be anticipated to be processed), is one of that county's largest taxpayers (personal communication, Rick Bailey, County Administrator 2011). Unlike some other resources that are extracted from public lands (e.g., oil, natural gas and coal), uranium mines operating on federal lands do not pay royalties to the federal government.

The historical tax revenues described in this section are as reported by official sources and are in nominal dollars (not updated for inflation to 2010 dollars).

## North Study Area (Utah)

The following discussion focuses on potentially affected State of Utah revenues and revenues for local governments in the Utah portion of the study area. Although the northern portions of Coconino County and Mohave County (in Arizona) are also located in the North Study Area, those areas are discussed later in conjunction with other Arizona areas because of differences in the revenue mechanisms, terminology, and accounting between the two states.

Table 3.17-21 depicts annual state income tax revenues and state sales and use tax revenues for the State of Utah for the fiscal years from 2005 through 2010. In 2010, the State's general fund received about $2.4 billion in income tax revenue and $1.4 billion in sales and use tax revenues. The combined total from these two major revenue sources ($3.8 billion) was about 21% less than the State received from these sources in 2007 ($4.8 billion), reflecting the impact of the recent recession and slow recovery.

**Table 3.17-21.** State of Utah Income Tax and Sales Tax Revenues 2005–2010

| Year | State Income Tax* Revenue | State Income Tax* Annual Change | Sales and Use Tax** Revenue | Sales and Use Tax** Annual Change |
|---|---|---|---|---|
| 2005 | $2,137,477,300 | | $1,634,522,084 | |
| 2006 | $2,653,331,323 | 24% | $1,806,264,423 | 11% |
| 2007 | $2,984,750,333 | 12% | $1,857,813,410 | 3% |
| 2008 | $3,006,720,826 | 1% | $1,739,384,630 | -6% |
| 2009 | $2,587,970,200 | -14% | $1,547,472,747 | -11% |
| 2010 | $2,387,593,439 | -8% | $1,402,678,571 | -9% |

Sources: State of Utah (2009); Utah State Tax Commission (2010).

*Includes personal and corporate income taxes.

**General fund unrestricted sales tax revenue. Excludes earmarked revenues and local sales tax revenues.

Utah's local governments within the North Study Area have also been substantially affected by the recession. Table 3.17-22 depicts annual sales-related tax revenues for the counties within the study area and the communities of particular focus identified in Section 3.16. These figures include the local sales and use tax distribution from the State of Utah; county option sales taxes; tourism, recreation, cultural and convention facilities tax revenues; State-collected county transient room tax revenues; municipality transient room tax revenues; and resort community tax revenues.

Except for Kane County, which added the county option sales tax in FY2008, the Utah counties have experienced substantial reductions in sales-related tax revenues since 2008. This trend is somewhat exaggerated in Table 3.17-22, because Garfield County began collecting county transient room tax revenues locally in 2007 and these local collections are not included in the data shown in the table.

The fiscal effects of the recession have been even more pronounced for the City of Blanding and the City of Kanab. Blanding's sales-related tax revenues have declined by over 20% since 2008, while Kanab's sales-related tax revenues have diminished by about 16% during the same period.

**Table 3.17-22.** Sales-related Tax Revenues for Utah Communities in the Study Area: 2005–2010

| County/City | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Garfield County* | $1,146,182 | $1,283,957 | $1,272,839 | $782,764 | $729,052 | $703,965 |
| *Annual Change* | | *12%* | *-1%* | *-39%* | *-7%* | *-3%* |
| Kane County** | $733,773 | $846,704 | $884,696 | $1,220,315 | $1,524,124 | $1,591,769 |
| *Annual Change* | | *15%* | *4%* | *38%* | *25%* | *4%* |
| San Juan County | $1,403,797 | $1,573,582 | $2,014,513 | $2,396,665 | $2,122,529 | $2,054,751 |
| *Annual Change* | | *12%* | *28%* | *19%* | *-11%* | *-3%* |
| Washington County | $8,022,474 | $9,527,703 | $10,370,372 | $11,518,035 | $10,861,989 | $10,484,565 |
| *Annual Change* | | *19%* | *9%* | *11%* | *-6%* | *-3%* |
| **County Totals** | **$11,306,226** | **$13,231,946** | **$14,542,420** | **$15,917,779** | **$15,237,694** | **$14,835,050** |
| ***Annual Change*** | | ***17%*** | ***10%*** | ***9%*** | ***-4%*** | ***-3%*** |
| City of Blanding | $397,096 | $459,346 | $555,627 | $578,278 | $526,662 | $451,781 |
| *Annual Change* | | *16%* | *21%* | *4%* | *-9%* | *-14%* |
| City of Kanab | $950,092 | $1,107,955 | $1,239,816 | $1,287,368 | $1,184,224 | $1,085,337 |
| *Annual Change* | | *17%* | *12%* | *4%* | *-8%* | *-8%* |

Source: Utah State Tax Commission (2007, 2010)

Note: Includes local sales and use tax distribution from State of Utah (State of Utah 2009); county option sales taxes; tourism, recreation, cultural and convention facilities tax revenues; State-collected county transient room tax revenues; municipality transient room tax revenues and resort communities tax revenues.

* Garfield County began collecting county transient room taxes locally in 2007. Local collections are not reflected in this table.

** Kane County added the county option sales tax beginning in FY2008.

## South Study Area (Arizona)

Table 3.17-23 depicts annual state income tax revenues and the sales-related tax revenues (transaction privilege and use tax revenues) supporting the State of Arizona's general fund for the fiscal years from 2005 through 2010. In 2010, the State's general fund received about $2.2 billion in income tax revenue and $3.4 billion in sales-related tax revenues. The combined total from these two major revenue sources ($5.6 billion) was about 35% less than the State received from these sources in 2007 ($8.6 billion), reflecting the severe impact of the recent recession in the State of Arizona.

Table 3.17-23 also depicts the severance taxes the State of Arizona has collected from mining operations over the 2005 through 2010 period. The State collected about $29 million in mining severance taxes in 2010, an increase of about 60% over the $18 million collected in 2009. However, mining severance tax collections in 2010 remained substantially lower than the $44 million collected in 2007 and in 2008. About 80% of the severance tax revenues collected by the State of Arizona are distributed back to cities and towns throughout the state using the same formula employed to distribute transaction privilege tax revenues (sales tax revenues) to local governments.

Annual sales-related tax revenues for the Arizona counties within the study area, and the communities of particular focus identified in Section 3.16, are shown in Table 3.17-24. These figures include the transaction privilege, use and severance tax revenues distributed to local governments by the State of Arizona; municipal privilege tax collection program revenues (optional taxes that have been enacted by most Arizona cities); and specific excise taxes that have been enacted by Coconino and Mohave counties. Note that Bitter Springs and Tusayan were Census Designated Places (CDPs), not municipalities, and did not have taxing authority.[9] Revenue data for the Kaibab Paiute Tribe was not available from the Arizona Department of Revenue Annual Reports.

[9] In May 2010, Tusayan voters elected to incorporate their community. Tusayan will have municipal taxing authority in future years.

**Table 3.17-23.** State of Arizona Income Tax and Sales-related Tax Revenues, and Mining Severance Tax Collections, 2005–2010

| Year | State Income Tax* Revenue | State Income Tax* Annual Change | Transaction Privilege, Use and Severance Tax** Revenue | Transaction Privilege, Use and Severance Tax** Annual Change | Mining Severance Tax Collections*** Revenue | Mining Severance Tax Collections*** Annual Change |
|---|---|---|---|---|---|---|
| 2005 | $3,170,987,163 | | $3,674,989,952 | | $16,399,086 | |
| 2006 | $4,089,641,855 | 29% | $4,291,363,227 | 17% | $30,439,973 | 86% |
| 2007 | $4,089,906,556 | 0% | $4,550,828,973 | 6% | $43,549,005 | 43% |
| 2008 | $3,506,425,271 | -14% | $4,378,075,201 | -4% | $43,751,613 | 0% |
| 2009 | $2,432,366,069 | -31% | $3,774,696,057 | -14% | $18,210,071 | -58% |
| 2010 | $2,200,844,986 | -10% | $3,444,458,834 | -9% | $29,098,554 | 60% |

Source: Arizona Department of Revenue (2005, 2006, 2007, 2008, 2009, 2010)

* Includes personal and corporate income tax revenues.

** Includes revenues to state general fund only. Excludes revenues distributed to local governments.

*** Reflects total severance taxes collected from mining operations. Approximately 80% of this revenue is distributed back to cities and counties.

The effects of the recession on the fiscal conditions of the Arizona counties in the study area, and the communities of particular focus, are evident from the data shown in Table 3.17-24. The percentage reduction in local government revenues has not been as dramatic as the decrease in State revenues described previously. Combined sales-related tax revenues for the two counties were about $61.4 million in FY2010, approximately 16% lower than their peak of $73.2 million in 2008. Sales-related tax revenues in Colorado City were about $175,000 less in FY2010 than in FY2007 (a 25% decrease), while FY2010 revenues in Fredonia were about $85,000 lower than their peak in 2008 (a 23% decrease). The City of Page has fared the best from a fiscal standpoint, with sales-related tax revenues continuing to increase through 2009 before dropping by about 8% in FY2010.

**Table 3.17-24.** Sales-related Tax Revenues for Arizona Communities in the Study Area: 2005–2010

| County/City | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Coconino County | $34,019,665 | $38,283,734 | $42,065,640 | $45,126,208 | $41,600,577 | $38,490,726 |
| *Annual Change* | | *13%* | *10%* | *7%* | *-8%* | *-7%* |
| Mohave County | $23,870,257 | $28,158,529 | $29,769,338 | $28,116,730 | $25,516,764 | $22,950,000 |
| *Annual Change* | | *18%* | *6%* | *-6%* | *-9%* | *-10%* |
| **County Totals** | **$57,889,922** | **$66,442,263** | **$71,834,978** | **$73,242,938** | **$67,117,341** | **$61,440,726** |
| ***Annual Change*** | | ***15%*** | ***8%*** | ***2%*** | ***-8%*** | ***-8%*** |
| Bitter Springs CDP** | NA | NA | NA | NA | NA | NA |
| *Annual Change* | | *NA* | *NA* | *NA* | *NA* | *NA* |
| Colorado City | $550,485 | $637,559 | $706,633 | $612,817 | $592,131 | $529,850 |
| *Annual Change* | | *16%* | *11%* | *-13%* | *-3%* | *-11%* |
| Town of Fredonia | $168,313 | $216,260 | $245,509 | $373,328 | $325,885 | $288,870 |
| *Annual Change* | | *28%* | *14%* | *52%* | *-13%* | *-11%* |
| Kaibab Paiute Tribe | NA | NA | NA | NA | NA | NA |
| *Annual Change* | | *NA* | *NA* | *NA* | *NA* | *NA* |
| City of Page | $5,119,945 | $6,337,522 | $6,535,415 | $7,295,794 | $7,687,621 | $7,098,600 |
| *Annual Change* | | *24%* | *3%* | *12%* | *5%* | *-8%* |
| Tusayan CDP** | NA | NA | NA | NA | NA | NA |
| *Annual Change* | | *NA* | *NA* | *NA* | *NA* | *NA* |

Source: Arizona Department of Revenue (2005, 2006, 2007, 2008, 2009, 2010)

Note: Includes transaction privledge and severance tax distributions to municipalities and counties, municipal privledge tax collection program revenues and specific exise taxes levied by the counties.

* Bitter Springs and Tusayan are Census Designated Places, not municipalities, and do not levy taxes.

## *Recreation and Environmental Economics*

The economic benefit of recreation is a different concept from the economic impact of spending on recreation (or other tourism) activities. Earlier, this section summarized the economic contribution from spending by visitors to recreation sites on NPS managed lands, including National Parks and National Monuments in the study area. The following discussion, however, considers the additional value of the recreation experience to the visitors themselves.

The term “economic benefits” describes how much people value their own participation in recreation activities, over and above what they have to pay to participate. This concept can also be described in terms of “consumer’s surplus,” or the amount that individuals would be willing to pay to be able to participate in particular recreation activities (or how much they would be willing to accept to forego participation in those activities).

Economists consider outdoor recreation, and other types of “environmental amenities,” to be examples of what are termed “non-market goods,” meaning that they are things that people value but that do not have explicit prices determined by markets. Other examples of non-market goods include improvements in air or water quality, reductions in crime rates, and living in proximity to beaches or protected natural areas.

Economists have developed a variety of techniques for establishing the value of non-market goods, including both “stated preference” and “revealed preference” models. In stated preference models, such as the contingent valuation method, a value is ascertained directly through surveys intended to identify a person’s willingness to pay (WTP). In revealed preference models, such as the Travel Cost Method, a value is inferred based on consumer behavior. The economic benefit is a function of the activity cost and the participant’s WTP. For example, if someone is willing to pay $55 to go fishing for a day, but the actual cost of their fishing trip is only $30, they receive a net economic benefit of $25 per day from their fishing experience.

### RECREATION BENEFITS IN AND NEAR THE PROPOSED WITHDRAWAL AREAS

The volume of non-consumptive recreational use in and near the proposed withdrawal is taken from visitor data provided by BLM, Forest Service, and NPS. Tables 3.17-25 and 3.17-26 summarize recreation visitor days (where available), per recreation site, located within and adjacent to the proposed withdrawal parcels. There are 23 recreation sites within the proposed withdrawal parcels; these include campsites, trailheads, scenic vistas, overlooks, etc. Values per visitor day are also included in the tables. An additional 17 sites are located in areas outside the proposed withdrawal parcels; these recreation sites were identified through consultation with BLM, Forest Service, and NPS staff.

Data presented and summarized in Tables 3.17-25 and 3.17-26 include valuation for recreation activities, estimated using the Travel Cost Method or Contingent Valuation Method. For a full discussion of both methods, see Loomis and Walsh (1997). Both recreation valuation methods have been used for over 30 years by federal agencies such as the USACE and U.S. Bureau of Reclamation (U.S. Water Resources Council 1979). The USFWS has also used these valuation methods since the 1980s.

Based on known visitor data and estimated value per visitor day, the annual benefit of recreation sites in and near the proposed North and E parcels is $6.3 million (see Table 3.17-25). Known visitor days are just over 81,000.

According to the known visitor data shown in Table 3.17-26, the annual benefit of recreation sites in and near the South Parcel is $444 million. Of the 4.7 million visitors counted, 94% were entering Grand Canyon National Park through the Grand Canyon Gateway. Ninety-nine percent of the South Study Area annual benefit can also be attributed to the gateway. Excluding the Grand Canyon, the estimated annual benefit of recreation sites in and near the South Parcel is about $5.1 million and known visitor days are about 280,000.

**Table 3.17-25.** Inventory of Recreation Sites in and Near the North Withdrawal Area

| Proposed Withdrawal Parcel | Land Manager | Recreation Site | Site Type | Visitor Counts (2009) | Recreation Activity | Value Per Visitor Day | Annual Benefits[h] |
|---|---|---|---|---|---|---|---|
| North | BLM | Hack Canyon | Trailhead | 402 | Hiking[f] | $43.91 | $17,652 |
| North | BLM | Swapp Trail | Trailhead | Not Available | Hiking[f] | $43.91 | – |
| North | Forest Service | Gunsight Point | Overlook | Not Available | Sightseeing[d] | $18.07 | – |
| North | Forest Service | Hatch Cabin | Cabin | Not Available | Sightseeing[d] | $18.07 | – |
| North | BLM | Rock Canyon | Trailhead | Not Available | Hiking[f] | $43.91 | – |
| East | Forest Service | House Rock Valley Overlook | Overlook | Not Available | Sightseeing[b] | $18.07 | – |
| East | Forest Service | House Rock Overlook Interpretive Site | Interpretive Site | 5,371 | Interpretive[c] | $21.66 | $116,335 |
| East | BLM | Navajo Trail | Trailhead | Not Available | Hiking[d] | $43.91 | – |
| East | BLM | Soap Creek | Trailhead | 338 | Hiking[f] | $43.91 | $14,841 |
| East | BLM | Rider Canyon | Trailhead | 36 | Hiking[f] | $43.91 | $1,580 |
| East | BLM | North Canyon Creek | Trailhead | 36 | Hiking[f] | $43.91 | $1,580 |
| East | BLM | Badger Creek | Trailhead | 120 | Hiking[f] | $43.91 | $5,269 |
| East | BLM | Dominquez-Escalante Interpretive Site | Historic site | 10,635 | Interpretive[e] | $21.66 | $230,354. |
| East | BLM | Condor Interpretive Site | Wildlife/Overlook | 4,200 | Wildlife Viewing[e] | $69.42 | $291,564 |
| *Outside Withdrawal Parcel* | Forest Service | Snake Gultch | Trailhead | Not Available | Hiking[f] | $43.91 | – |
| *Outside Withdrawal Parcel* | Forest Service | Saddle Mountain Wilderness | Wilderness Area | Not Available | Hiking[f] | $43.91 | – |
| *Outside Withdrawal Parcel* | Forest Service/ NPS | South Canyon | Trailhead | 54 | Hiking[f] | $43.91 | $2,371 |
| *Outside Withdrawal Parcel* | NPS | Kanab Point | Overlook | 16 | Sightseeing[d] | $18.07 | $289 |
| *Outside Withdrawal Parcel* | NPS | 150 Mile Canyon | Trailhead | Not Available | Hiking[f] | $43.91 | – |
| *Outside Withdrawal Parcel* | NPS | SB Point | Overlook | Not Available | Sightseeing[d] | $18.07 | – |
| *Outside Withdrawal Parcel* | NPS | Lees Ferry | Historic Site | Not Available | Interpretive[e] | $21.66 | – |
| *Outside Withdrawal Parcel* | NPS | Point Sublime | Overlook | Not Available | Sightseeing[d] | $18.07 | – |
| *Outside Withdrawal Parcel* | NPS | Swamp Point | Overlook/Picnic Area | Not Available | Picnicking[e] | $32.22 | – |
| *Outside Withdrawal Parcel* | NPS | Tiyo Point | Overlook | Not Available | Sightseeing[d] | $18.07 | – |
| *Outside Withdrawal Parcel* | NPS | Cape Royal | Overlook | Not Available | Sightseeing[d] | $18.07 | – |
| *Outside Withdrawal Parcel* | NPS/BLM | Tuckup Point | Overlook | 2 | Sightseeing[d] | $18.07 | $36 |

**Table 3.17-25.** Inventory of Recreation Sites in and Near the North Withdrawal Area (Continued)

| Proposed Withdrawal Parcel | Land Manager | Recreation Site | Site Type | Visitor Counts (2009) | Recreation Activity | Value Per Visitor Day | Annual Benefits[h] |
|---|---|---|---|---|---|---|---|
| *Outside Withdrawal Parcel* | BLM | Toroweap | Campground/ Overlook | 3,859 | Camping[g] | $20.87 | $80,537 |
| *Outside Withdrawal Parcel* | BLM | Vermilion Cliffs National Monument | National Monument | 26,080[a] | General Recreation[g] | $99.34 | $2,590,787 |
| *Outside Withdrawal Parcel* | BLM | Grand Canyon Parashant National Monument | National Monument | 29,674[a] | General Recreation[g] | $99.34 | $2,947,815 |
| *Outside Withdrawal Parcel* | BLM | Kanab Creek Wilderness | Wilderness Area | Not Available | Hiking[f] | $43.91 | – |
| *Outside Withdrawal Parcel* | NPS | Bass Trail | Trailhead | 243 | Hiking[f] | $43.91 | $10,670 |
| ***North Withdrawal Area Total*** | | | | **81,066** | | | **$6,311,680** |

Sources: BLM (2010g); Forest Service (2009e); NPS (2009b).

[a] BLM (2009b) Arizona Strip Field Office Traffic Counts.

[b] Haspel and Johnson (1982).

[c] Loomis et al. (2005).

[d] Loomis (2005).

[e] Connelly and Brown (1988).

[f] Data from Brown et al. (1989); Richards and Brown (1992); Sublette (1975).

[g] Duffield et al. (2009).

[h] Annual benefit estimate included only when visitor counts are available.

**Table 3.17-26.** Inventory of Recreation Sites in and Near the South Withdrawal Area

| Proposed Withdrawal Parcel | Land Manager | Recreation Site | Site Type | Visitor Counts (2009) | Recreation Activity | Value Per Visitor Day | Annual Benefits[g] |
|---|---|---|---|---|---|---|---|
| South | Forest Service | Ten-X Family Campground | Family Campground | 25,300[f] | Camping[c] | $20.87 | $528,011 |
| South | Forest Service | Charlie Tank Group Campground | Group Campground | 3,500[f] | Camping[e] | $20.87 | $73,045 |
| South | Forest Service | Bike Trail | Trailhead | Not Available | Mountain Biking[e] | $210.26 | – |
| South | Forest Service | Arizona Trail | Trailhead | Not Available | Hiking[f] | $43.91 | – |
| South | Forest Service | Red Butte | Trailhead | Not Available | Hiking[f] | $43.91 | – |
| South | Forest Service | Russell Tank Fishing Parking Area | Fishing Site | Not Available | Fishing[g] | $92.91 | – |
| *Outside Withdrawal Parcel* | NPS | Camper Village | Campsite/Tent/ Trailer/ Recreational Vehicle | Not Available | Camping[h] | $20.87 | – |
| *Outside Withdrawal Parcel* | NPS | Grand Canyon Gateway | Park Entrance | 4,418,773 | General Recreation[h] | $99.34 | $438,960,909 |
| *Outside Withdrawal Parcel* | NPS | Grandview Point | Overlook | Not Available | Sightseeing[d] | $18.07 | – |
| *Outside Withdrawal Parcel* | NPS | Yaki Point | Overlook | 250,088 | Sightseeing[a] | $18.07 | $4,519,090 |
| ***South Withdrawal Area Total*** | | | | **4,697,661** | | | **$444,081,055** |

Sources: BLM (2010g); Forest Service (2009e); NPS (2009b).

[a] Loomis (2005).

[b] Connelly and Brown (1988).

[c] Data from Brown et al. (1989); Richards and Brown (1992); Sublette (1975).

[d] USFWS (2006b).

[e] Duffield et al. (2009).

[f] Annual estimates received from the Forest Service.

[g] Annual benefit estimate included only when visitor counts are available.

In terms of the annual benefit of each proposed withdrawal parcel, based on known data, the annual benefit of recreation in the North Parcel is $17,652. However, no visitor data are available for four recreation sites in this parcel. The estimated annual benefit in the South Parcel is $601,056. As with the North Parcel, visitor data are lacking for several sites in the parcel. The annual benefit of recreation in the East Parcel is $661,526; no visitor data are available for several recreation sites in this parcel.

In terms of the annual benefit of recreation sites based on agency ownership, recreation sites in the study area on BLM lands amount to an estimated $6.1 million; of this, $562,842 can be attributed to the withdrawal parcels, and the remainder can be attributed to recreation sites in the overall study area, outside the proposed withdrawal parcels. Recreation sites in the study area on NPS lands amount to an estimated $443 million; none of the NPS recreation sites are located within proposed withdrawal parcels. Forest Service visitor data are more limited; therefore, it is difficult to estimate the benefit of recreation sites on Forest Service lands. However, using the data that are available, Forest Service recreation sites in the study area contribute an estimated $719,763 each year.

## HUNTING

Hunting is a popular activity within the study area; this activity occurs on both BLM and Forest Service lands. Large areas of undeveloped lands in northern Arizona provide habitat for many species, including big and small game. Big-game hunting use was estimated from AGFD data by game management unit (GMU), as this agency regulates the sport and records data on hunting use by animal and by area throughout Arizona. In Table 3.17-27, deer hunting was used as a proxy for estimating economic values from this activity in the study area.

**Table 3.17-27.** Big Game Hunting Use, Success Rate, and Economic Values in GMUs Overlapping the Proposed Withdrawal Areas (Averages 2004–2008)

| AGFD GMU | Average Success Rate | Deer Average Annual Hunter Days | Elk Average Annual Hunter Days | $ Value/ Hunter Day | Annual Value for Each Entire GMU | % GMU in Study Area | Annual Value for % GMU in Study Area |
|---|---|---|---|---|---|---|---|
| 9 | 29% | 2,205 | 4,361 | $81.00 | $531,814 | 47.70% | $253,675 |
| 12A | 59% | 4,319 | 0 | $165.76 | $715,917 | 11.00% | $78,751 |
| 12B | 69% | 1,213 | 0 | $192.00 | $232,896 | 38.80% | $90,364 |
| 13A | 74% | 258 | 0 | $204.00 | $52,632 | 35.00% | $18,421 |
| **State Average** | **45%** | **–** | **–** | **$125.00** | | | |
| **Total** | | | | | **$1,533,259** | | **$441,211** |

Sources: AGFD (2008b); USFWS (2006b).

Four GMUs in Arizona overlap the three proposed withdrawal parcels (GMU 9 in the South Study Area, and GMUs 12A, 12B, and 13A in the North Study Area). Based on available data for deer hunting, the value per hunter day is tailored to the hunting quality of each GMU, using the percent harvest success rate of the unit relative to the state average success rate. The state average value of hunting is $125 per day, according to USFWS (2006b). This statewide average value is associated with the statewide average success rate of 45%. Thus, GMU 9, with a success rate of 29%, has about two-thirds (64%) of the state average success rate. Using this ratio, the state average hunter day of $125 was adjusted downward for GMU 9 to reflect its lower success rate. Likewise, GMUs 12A, 12B, and 13A have higher success rates than the state average, so the implicit quality of the hunting trip would be higher than the state average, at $192 and $204, respectively. No data on the value per hunter day for elk hunting are available for Arizona. For this analysis, it was assumed that the value per hunter day for elk hunting is at least the same as for deer hunting.

Table 3.17-27 summarizes big-game hunting use, success rates, and values per day for each GMU in the study area. Based on the average success rates, average annual hunter days, and values per hunter day, the total estimated annual value is $1.53 million. The North Study Area (GMUs 12A, 12B, and 13A) accounts for approximately $1 million of this total value. The South Study Area (GMU 9) contributes the remaining $0.5 million. Hunting within the proposed withdrawal areas account for 29%, or about $440,000per year, of the economic benefit of hunting in these four GMUs.

## EXISTENCE VALUE

Apart from the effects that visitor spending has on the regional economies in the area surrounding the Grand Canyon, and the benefits that visitors receive from recreating at the Grand Canyon, previous studies have documented that many people place a value simply on the existence of unique and pristine places like the Grand Canyon, whether they have ever visited it or not. Research indicates that existence value of a resource is most likely to be greater when the resource is unique (e.g., Grand Canyon National Park or Old Faithful Geyser in Yellowstone National Park) (Harpman et al. 1994).

A 1995 study estimated the existence value of the Grand Canyon at between $2.3 billion and $3.4 billion per year (Welsh et al. 1995). This study has not been updated, but presumably the effects of inflation and population growth continue to increase this value over time. This type of “existence value” is further demonstrated by the donations and funding received by environmental organizations dedicated to preserving places like the Grand Canyon.

## ECOSYSTEM SERVICES

Grand Canyon National Park is not only a stunning natural wonder enjoyed by hundreds of thousands of tourists each year, it is also one of the largest areas of pristine wilderness in the Southwest (and in the lower 48 states). In its natural condition, the Canyon supports numerous species of flora and fauna, which are the subject of other parts of the EIS. The Colorado River is also one of the most important river systems in the United States and is heavily relied on by a large portion of the population of the Southwest for public drinking water, agricultural production, and other services.

While economists are beginning to develop tools to estimate the monetary value of some ecosystem services, at this time it is not possible to estimate the overall value of the ecological services provided by an area as complex as the Grand Canyon in monetary terms.

## ECONOMIC ASPECTS OF ENVIRONMENTAL QUALITY AT GRAND CANYON NATIONAL PARK

The region’s visual quality is closely related to recreationists’ choices and levels of visitation. Two studies have looked at the value that visitors get from the current visibility conditions at Grand Canyon National Park (the Park is a Class I airshed) and how much they would pay to avoid a reduction in visibility.

One study (conducted by McFarland et al. in 1983) surveyed visitors at Grand Canyon National Park to estimate how much they would pay to avoid a reduction in visual range. This study found that the WTP was $2.64 per visitor day. A second study (by Brookshire and Schulze, also in 1983) asked households that visited Grand Canyon National Park what they would pay in higher daily park entrance fees to avoid a decrease in visibility from current conditions to poor conditions. These per-day visitor values ranged from $5.79 for visitors from Albuquerque, New Mexico, to $9.34 for visitors from Los Angeles, California. These values and references are summarized in Table 3.17-28. These values reflect adjustment using the Consumer Price Index from the original study year dollars to 2010 dollars.

In addition to these WTP values, the McFarland et al. (1983) study also asked whether visitors would change their length of stay at Grand Canyon National Park as a result of deterioration of visual range or visibility. About 80% of visitors said they would shorten their length of stay at the Park. A reduction in visitation would have the effect of reducing visitor spending, thereby changing impacts of recreation on the regional economy.

**Table 3.17-28.** Summary of Values to Visitor to Prevent a Decrease in Visibility (Visual Range) at Grand Canyon National Park

| Study | Sample | WTP per Visitor Day ($2010) |
|---|---|---|
| McFarland et al. (1983) | On-site visitors | $2.64 |
| Brookshire and Schulze (1983) | | |
| Albuquerque, New Mexico | Visiting households | $5.79 |
| Denver, Colorado | Visiting households | $6.69 |
| Los Angeles, California | Visiting households | $9.34 |

Sources: Brookshire and Schulze (1983); McFarland et al. (1983).

This previous research demonstrates visitor sensitivity to changes in environmental quality at the Grand Canyon. No studies have been identified that examined visitor responses to changes in water quality, soundscape quality, or other environmental attributes of the area, but it is possible that changes in other environmental attributes of the Grand Canyon could also have quantifiable effects.

## *Energy Resources*

The major mining commodity of interest in the proposed withdrawal area is uranium. Other precious metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium. However, recovery of these metals is assumed to not be significant enough to drive mine development and thus is not considered in this study as part of the mineral economics discussion (see Appendix B).

### RESERVES AND RESOURCES

Northern Arizona is known to be an area with high potential for uranium mining. Not only have reserves been confirmed through drilling, but the USGS (Finch et al. 1990) has also estimated the undiscovered uranium endowment to have a mean value of about 1.3 million short tons (2.6 billion pounds) $U_3O_8$. A more recent USGS report (Otton and Van Gosen 2010) states that the proposed withdrawal parcels are estimated to contain 12% of the estimated undiscovered endowment. The estimate of undiscovered endowment comprises all mineralized material containing at least 0.01% $U_3O_8$ and no consideration is made whether any or all of this material could be economic to mine. As discussed in the RFD (see Appendix B), for the purposes of this analysis it was assumed that 15% of the undiscovered endowment would be mined. The total mean undiscovered endowment in the withdrawal area is 163,380 short tons (326.8 million pounds) $U_3O_8$, of which 24,508 short tons (49 million pounds) $U_3O_8$ is considered mineable. In addition to this mineable portion of the undiscovered uranium resource, there are 15,158 short tons (30.3 million pounds) $U_3O_8$ of known uranium reserves in the withdrawal parcels.

Known reserves, the portion of undiscovered endowment assumed to be economic to mine, and total estimated undiscovered endowment can be compared with global and national reserves and estimates to total U.S. endowment. There have been no estimates made of global undiscovered uranium endowment. Total estimated reserves and resources for the withdrawal area are 178,538 short tons (357 million pounds) $U_3O_8$ of which 39,666 short tons (79.3 million pounds) are estimated to be economic to mine. The Energy Information Administration (EIA) reports uranium reserves and resources in the United States in two forward-cost categories of $50 or less and $100 or less per pound $U_3O_8$ (Table 3.17-29).

**Table 3.17-29.** Uranium Reserves and Resources in the United States, Year-End 2008 (in million pounds $U_3O_8$)

| Category | Forward-Cost Category ($ per pound) $50 or less | Forward-Cost Category ($ per pound) $100 or less |
|---|---|---|
| Reserves | 539 | 1,227 |
| Estimated Additional Resources | 3,310 | 4,850 |
| Speculative Resources | 2,230 | 3,480 |
| **Total** | **6,079** | **9,557** |

Source: EIA (2010b).

Forward-costs are future expenditures that would be required produce uranium from undeveloped reserves and resources, including development costs. Some or all of undiscovered endowment estimated by the USGS for Northern Arizona and other regions of the United States are included in the category of speculative resources, depending on estimated development and production costs. The USGS estimate for undiscovered endowment is not based on economic criteria, thus the figure for total estimated uranium reserves and resources for the United States that best compares with the estimate of reserves and resources for the withdrawal area is the total at a forward-cost of $100 or less per pound $U_3O_8$. The OECD Nuclear Energy Agency (2010) reports reasonably assured and inferred global uranium "resources" at a price of $130 per kilogram uranium (about $70 per pound $U_3O_8$) of 14 billion pounds $U_3O_8$. This figure is not directly comparable to the either of the EIA forward-cost categories and comprises the EIA reserves and part of the EIA estimated additional resources categories but can be assumed to broadly represent world reserves. There are no global estimates for speculative resources (Table 3.17-30).

**Table 3.17-30.** Comparison of World, United States, and Withdrawal Area Reserves and Resources of Uranium, Year-End 2008 (in million pounds $U_3O_8$)

| Category | Withdrawal Area | United States | World |
|---|---|---|---|
| Reserves | 79[a] | 1,227 | 14,000[c] |
| Estimated Additional Resources | | 4,850 | |
| Speculative Resources | 278[b] | 3,480 | |
| **Total** | **357** | **9,557** | |

Source: EIA (2010b)

[a] Known reserves plus 15% of undiscovered endowment.

[b] Balance of undiscovered endowment.

[c] Includes indicated resources.

From Table 3.17-29, estimated total reserves for the withdrawal area, including 15% of estimated endowment, are about 6% of U.S. reserves and 0.6% of world reserves. Total estimated uranium endowment for the withdrawal area is about 4% of national estimated resource endowment.

The World Nuclear Association (2010a) reports uranium production in 2010 for the largest 30 uranium mines in the world. These mines collectively account for 74% of world production. Mines with sufficient reserves to produce at the rates of these mines are highly important to world uranium supply. The 10 largest mines, accounting for 55% of world uranium production, operated in 2010 at rates ranging from 4 to 20 million pounds $U_3O_8$ per year. The next 20 largest mines, accounting for 19% of world uranium production, operated in 2010 at rates ranging from 1.5 to 4 million pounds $U_3O_8$ per year. Although individual breccia pipe uranium deposits in Northern Arizona are too small operate at a capacity as large as 1.5 million pounds $U_3O_8$ per year, Alternative A forecasts a collective annual production of about 4 million pounds $U_3O_8$ per year from about 6 mines.

### DEMAND AND POTENTIAL FUTURE PRODUCTION

Forecast production from the withdrawal area under Alternative A is about 4 million pounds $U_3O_8$ per year. This compares with total United States production of uranium in 2010 of 4.2 million pounds $U_3O_8$ (EIA 2011b). Over the past 20 years U.S. production has averaged 4.4 million pounds $U_3O_8$ per year but during the 1960s to 1980s, production averaged about 28 million pounds $U_3O_8$ per year (EIA 2011b).

In 2010, U.S. nuclear power plants purchased 47 million pounds of $U_3O_8$ equivalent, of which 92% was imported and 8% was of U.S. origin (EIA 2011b). U.S. production of uranium in 2010 was equivalent to 9% of U.S. demand. Domestic demand is generally forecast to rise over the next decade, fluctuating between 46 and 56 million pounds $U_3O_8$ per year through 2020 (EIA 2010c). Global uranium demand is also expected to rise, with a forecast increase of 33% between 2010 and 2020 and 16% from 2020 to 2030 (World Nuclear Association 2010b).

## *Road Condition and Maintenance*

Access routes to the proposed withdrawal area along with average daily traffic volume are discussed in Section 3.16.1 under Transportation Conflicts. On BLM lands on the Arizona Strip, paved roads are rare and account for less than 3% of the transportation system (including roads, primitive roads, and trails) (BLM 2008b). Of the total transportation system (8,032 miles), 6,675 miles (84.5%) consist of primary, secondary, and tertiary unpaved roads. Various federal, state, and/or county agencies and private groups or individuals maintain these roads. The road network provides access to area destinations, including mining and livestock operations, utility and communication facilities, and range and wildlife developments, etc. (BLM 2008b). The road network is also valuable to the recreating public for access.

In terms of Forest Service lands, nationally, most of the existing roads on Forest Service lands were built over the past 50 years for harvesting timber. As with BLM roads, forest roads provide access for recreation, research, fish and wildlife habitat management, grazing, resource extraction, fire protection, insect and disease control, and private land use, among other things. A revised travel management rule is currently being developed for the Tusayan Ranger District. Under the selected alternative for the new travel management rule, there will be 566 miles of roads open for public use in the district and 143 additional miles of roads to be used only for administrative purposes (Forest Service 2011).

The BLM Arizona Strip Field Office is currently revising its route designations through a separate NEPA process. These route designations will likely result in changes to the existing route network and mileages discussed above.

After using unpaved roads on federal lands in proximity to potential future uranium mines, ore haulers taking uranium ore to the White Mesa Mill in Blanding may next make use of county roads before ultimately travelling on state and federal highways for most of the travel distance to the mill. County roads are maintained by Coconino County and Mojave County (depending on their location), primarily using funds obtained from State of Arizona distributions of Highway User Revenue Funds (which are in turn generated primarily by fuel taxes and vehicle licensing fees). Coconino County spent $19.4 million on road maintenance and construction in FY2010, about $6.3 million more than it received in revenues to fund such operations (Coconino County 2010). Mohave County spent $22.4 million for road construction and maintenance in 2010, about $10.3 million more than it received in revenues to fund highway and road operations (Mohave County 2010b).

The Arizona and Utah Departments of Transportation (ADOT and UDOT) would be responsible for managing and funding maintenance on state highways. ADOT budgeted $94 million for road maintenance in FY2010, a 28% decrease from FY2008 due to revenue shortages (ADOT 2009a). UDOT maintains over 5,800 miles of highways and expended approximately $136 million for state highway maintenance in FY2010 (Utah State Legislature 2011).

## 3.17.3 Economic Condition Indicators

Mineral exploration and construction, operation, and maintenance of uranium mine facilities and/or the proposed withdrawal of mineral estates and the associated reduction in future mineral exploration and development have the potential to impact economic conditions within the study area. Resource condition indicators include those listed below (Table 3.17-31).

**Table 3.17-31.** Economic Condition Indicators

| | Description of Relevant Issue | Resource Condition Indicator(s) |
|---|---|---|
| Effects on economic activity related to mineral development | Future mining activity in the proposed withdrawal areas would be directly affected by the alternatives. This could lead to changes in future economic conditions. | *Indicator:* Direct and indirect changes in output, value-added, employment and earnings due to changes in mining activity.<br>*Indicator:* Changes in state and local government revenues due to changes in mining activity. |
| Road condition and maintenance | The use of road systems to service mine operations could require increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. | *Indicator:* Number of haul trips anticipated on major public use roads over the next 20 years relative to existing usage levels. |
| Effects on economic activity from tourism | The public lands in the study area are a key component of regional tourism and the tourism-related economy. If the alternatives lead to changes in visitation, there would be impacts on future economic conditions. | *Indicator:* Visitor user days and value per visitor user days to tourist destinations, primarily Grand Canyon National Park but also National Forest System and BLM lands. |
| Effects on existence values and value of ecosystem services | Prior studies indicate the public places a large value on maintaining environmental quality at Grand Canyon National Park. The Park also provides important ecological services such as providing habitat for numerous species and protecting water quality in the Colorado River. | *Indicator:* Environmental conditions at Grand Canyon National Park. |
| Energy resources available | The withdrawal of uranium deposits in the study area would remove a potential source of U.S. uranium production for use in generating electricity. | *Indicator:* Change in uranium production from the study area relative to overall U.S. and global production. |

### *Economic Activity*

Economic activity can be described in terms of various metrics, including output, value added, employment, and employee compensation. IMPLAN 2009 software and data will be used to model potential changes in economic activity under the alternatives, reflecting different levels of future mining activity based on the RFD (see Appendix B). Should the alternatives be determined to have quantifiable effects on tourist activity, these effects can also be modeled with IMPLAN. The IMPLAN modeling system captures direct, indirect, and induced economic effects (multiplier effects).

### Taxes and Revenues

Indicators used to determine the economic conditions in the study area include state and local revenues potentially affected by the alternatives, including severance taxes in Arizona, state personal and corporate income taxes in Arizona and Utah, and sales-related tax revenues for both state and local governments.

IMPLAN 2009 software and data will be used to model potential changes in taxes, except for Arizona severance tax revenues which will be modeled based on IMPLAN estimates of the taxable value of mining activity under each alternative and the current severance tax code in Arizona.

### Road Condition and Maintenance

Indicators used to determine conditions regarding road condition and maintenance include the number of haul trips for existing mines over the next 20 years and potential effects on future maintenance requirements.

### Recreation and Environmental Economics

Indicators used to determine the economic conditions in the study area with respect to recreation economic and environmental quality include the tourist visits, expenditures and corresponding economic activity; recreation visitor days and the estimated economic benefit of non-consumptive and consumptive recreation activities; and the environmental attributes of Grand Canyon National Park.

Effects on the tourism-related economy and benefits to recreationists will be evaluated by considering the potential for changes in visitation or visitor values per day based upon the recreation resource analysis. Monetary effects on existence values or ecological services related to Grand Canyon National Park cannot be quantified based on available information.

### Energy Resources

Indicators used to determine conditions regarding the availability of energy resources include the amount of mineable undiscovered uranium resources and uranium reserves within the proposed withdrawal areas and the magnitude of these resources relative to other domestic and international uranium reserves, as well as domestic and international demand.