

The secured storage area at Hite would be expanded by up to 53 spaces (for a total of up to 160 spaces) and include construction of a boat wash-down facility for visitor and concessioner use.

## **Utility Systems**

Under Alternative B, the existing utility supply and distribution systems at Bullfrog, Halls Crossing and Hite would be expanded as needed to provide adequate service for increased development. At Hite, a 100,000-gallon underground water storage tank for potable water would replace the existing aboveground water storage tank in the same general location. Because soils in this area are shallow, blasting may be required to bury the underground tank. Any blasting would conform to specifications in NPS 65, *Explosives Use and Blasting Program* (1991). All blasting would use the minimum amount of explosives necessary to accomplish the task. Upon completion of installation of the water tank, the area would be covered with conserved topsoil, regraded to match natural contours and revegetated.

## **Roads and Parking**

Under Alternative B, at Halls Crossing, a new road would be constructed to access the relocated secured storage. At Hite, an unimproved road would provide access to primitive low water designated shoreline camping.

## **Fee Collection System**

Under Alternative B, the existing fee collection booth at Bullfrog would be upgraded for accessibility and administrative services.

## **School**

Under Alternative B, the Lake Powell School would be expanded to include a library building.

## **Boat Wash-Down Area**

Under Alternative B, the boat wash-down facility at Bullfrog would be expanded to provide additional wash-down facilities in the same location (at the former concessioner maintenance area at the Village Center) for public access. Boat wash-down facilities would be constructed at Halls Crossing in the old secured storage area and at Hite at the concessioner maintenance facility.

## **Marina Facilities**

Under Alternative B, as outlined in Table 5, the total number of slips and buoys available for long-term private rental would be increased to 1094. The concessioner, in conjunction with the National Park Service, would determine how to allocate this total between the two sites based on customer preference, season, water level and other factors. The docking space for the concessioner's rental fleet; houseboats, PWCs and powerboats would be increased as needed to accommodate up to 330 houseboats and 330 powerboats and/or PWCs. The existing water-based facilities at Halls Crossing would be upgraded under Alternative B to include a fishing dock. Both the fuel docks and sewage pumpouts at Bullfrog

<b>Table 5. Comparison of Marina Facilities in Alternative A and Alternative B (Combines Halls Crossing and Bullfrog).</b>		
Type of Marina Facility	Alternative A	Alternative B
Long-term Private Rental Slips/Buoys	875	1094
Transient Over Night Slips	34	72
Interagency Slips	16	16
Executive Services Slips	6	36
Concessioner Rental Dock Facility (Houseboats, PWC, Powerboats). Slips are not used for houseboats; rather they are backed into the dock and tied off to cleats. There are slips for the rental powerboats and slip inserts for PWCs.	Docking facility can currently accommodate 100 houseboats and 56 powerboats and PWCs.	Docking facility would be increased in size to accommodate up to 330 houseboats and slips/PWC inserts would be increased to accommodate up to 330 powerboats and PWCs
Fuel Docks	2	2
Tour Boat Slips	0	3
Sewage Pumpout	2	2

## Water-Based Food Service

Under Alternative B, an 80-seat water-based restaurant would be provided at the Bullfrog Marina. An additional water-based food service facility would be added at Halls Crossing.

## Public Boat Launch Capabilities

### Bullfrog

Under Alternative B, the existing Bullfrog launch ramp would be maintained at its current width (ranging from 80- to 150-feet wide). Any new additional lengths needed to reach lower water levels would be constructed at a maximum of 80-feet wide. If the existing launch ramp becomes unusable due to extreme low water, a new launch ramp no more than 80-feet wide would be constructed within the developed area (see figure 21), which would require additional environmental evaluation and consultation at that time. The environmental consequences of construction of a new launch ramp in a new location will not be evaluated as part of this DCP.

### Halls Crossing

The existing launch ramp at Halls Crossing would be maintained at its current configuration. Any additional length necessary to reach low water would be 80 feet in width. As no other launch sites are available at Halls Crossing once the water level recedes below an elevation of 3,550 feet, launching would revert to “ramp closed—launch at your own risk.”

### Farley Canyon

In conjunction with the State of Utah Department of Natural Resources, a feasibility study and appropriate NEPA documentation would be completed before a primitive type of launch ramp would be constructed at Farley Canyon. A primitive launch ramp generally consists of graded dirt or gravel covered road, which ends at the water; and is capable of supporting small watercraft on a “launch at your own risk” basis. It is likely that the graded road would start at the existing graded parking lot and extend to the water level, which ranges from full

pool to about 3570 feet in elevation. Because water level is largely dependent on weather conditions and water withdrawal from the lake, it is likely that the graded road would need to be extended during times of low water.

Figure 23. Farley Canyon



## Ferry Service Facilities

Under Alternative B, ferry services at Bullfrog would continue to be provided by a docking wedge and associated access. The docking wedge would continue to be moved within the developed area (figure 21) to accommodate lower water levels. At Halls Crossing, the ferry would either be launched at its current location or moved to the main launch ramp as the water level recedes. Once the water level has receded lower than 3,550 feet and the main launch ramp is closed, a new primitive site, which includes the use of a wedge and gravel access road (similar to Bullfrog), would be located within the developed area (figure 22).

## ALTERNATIVE SUMMARY INFORMATION

### Comparison to Project Objectives

Six project objectives outlined in the purpose and need section of this document provide benchmarks for measuring the ability of each alternative to meet the purpose and need of the project. Alternatives B (the preferred alternative) would achieve the six project objectives, while Alternative A would not completely meet all six project objectives. A comparison of alternatives and planning objectives is illustrated in table 5.

### Environmentally Preferred Alternative

In accordance with Director's Order – 12, the National Park Service is required to identify the “environmentally preferred alternative” in all environmental documents, including environmental assessments. The environmentally preferred alternative is determined by applying the criteria suggested in NEPA, which is guided by the Council on Environmental Quality. The Council on Environmental Quality provides direction that “[t]he environmentally preferred alternative is the alternative that will promote the national environmental policy as expressed in section 101 of NEPA, which considers the following criteria:

7. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
8. Assure for all generations safe, healthful, productive and esthetically and culturally pleasing surroundings.
9. Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
10. Preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
11. Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
12. Enhance the quality of renewable resources and approach the maximum attainable recycling of non-renewable resources” (NEPA, section 101).

Alternative A (No-Action Alternative) represents the current status of the uplake developed areas and would permit no modification from the existing conditions to address anticipated changes in visitor numbers and expectations, or relocation of facilities to accommodate changing lake elevations. In addition, existing facilities in less-than-ideal locations would continue to adversely affect the visitor experience, operational efficiency and overall visual quality. Alternative A (No-Action Alternative) meets criterion 1 (Table 6) because it would not result in any expansion that could degrade the environment. Criteria 2 and 3 are not met by Alternative A (No-Action Alternative) because locations of existing developments adversely impact overall visual quality. Because no expansion would be provided under Alternative A (No-Action Alternative), criterion 4 is met because natural and cultural resources would not be adversely impacted by lack of action and would continue to be preserved. Criterion 5 would not be met by Alternative A (No-Action Alternative) because visitation is projected to return to pre-drought levels (if not increase above them), further impacting congested facilities and limiting the variety of services offered. Criterion 6 would also not be met by Alternative A (No-Action Alternative) because there are no provisions under this alternative for expanded use of technology to enhance the quality of renewable resources.

**Table 6. Analysis of Project Objectives**

<b>Project Objectives</b>	<b>Alternative A (No-Action)</b>	<b>Alternative B (preferred alternative)</b>
7. Continue to provide visitor access to the uplake areas and tributaries.	<b>Partially Meets Objectives.</b> The existing launch ramps provide limited access and in some cases, do not provide access to the lake at lower lake elevations.	<b>Meets Objectives.</b> Launch ramps would be lengthened and in some cases, constructed in new locations in order to provide access to the lake at lower lake elevations.
8. Provide opportunities for a variety of visitor experiences at the uplake areas.	<b>Partially Meets Objectives.</b> Campgrounds, restaurants and stores would remain in their present configurations and locations. Some variety in terms of stores and restaurants is available. Campgrounds offer limited experiences as campgrounds cannot accommodate a variety of sizes of vehicles and there are no group camping facilities. Day-use facilities are limited.	<b>Meets Objectives.</b> Stores and restaurants would be expanded and/or new facilities constructed, increasing the variety of experience available to visitors. Campgrounds would be expanded to accommodate a variety of vehicles and offer a variety of camping experiences including group camping. The number of day-use facilities would be increased.
9. Provide necessary and appropriate visitor services at the uplake areas, consistent with current and anticipated visitation.	<b>Partially Meets Objectives.</b> Occupancy rates for some facilities in some locations demonstrate that use of certain facilities is already maximized at reduced visitation levels.	<b>Meets Objectives.</b> Visitor services (numbers of buoys, lodging units, stores, restaurants, secured storage spaces, boat wash-down areas and campsites with and without hookups) would be expanded to provide increased levels and expanded variety of necessary and appropriate services at the uplake areas.
10. Accentuate different types of services at each developed area.	<b>Does Not Meet Objectives.</b> All developments would continue to offer similar services.	<b>Meets Objectives.</b> Development in the Hite area would focus more on river runner and backcountry use and less on water-based services. Allocation of slip, buoy and boat rental between Bullfrog and Halls Crossing would be flexible.
11. Design facilities and services within uplake developed areas to accommodate fluctuating lake levels.	<b>Partially Meets Objectives.</b> Existing facilities (such as launch ramps, parking areas and roads) have been extended to accommodate lower lake levels, but may not fully accommodate future lake level fluctuations.	<b>Meets Objectives.</b> Launch ramps, roads and parking areas would continue to be extended and sometimes constructed in new locations to provide visitor access at lower lake levels.
12. Guide efficient and effective organization within uplake developed areas.	<b>Does Not Meet Objectives.</b> No changes would be made to current organization or location of facilities within the uplake developed areas.	<b>Meets Objectives.</b> Like uses would be consolidated in one location and facilities relocated to allow for effective and efficient organization.

Alternative B (preferred alternative) represents the environmentally preferred alternative. Criteria 1 and 4 would be met under Alternative B through mitigation measures that would reduce or eliminate environmental impacts resulting from increased development. Alternative B would relocate facilities to improve the visitor experience, operational efficiency and visual quality, which would meet criteria 2 and 3. Additional visitor facilities such as visitor accommodations, camping facilities, food service facilities, visitor use areas and marina facilities would also improve the visitor experience, meeting criterion 3. Alternative B would meet criterion 5 by increasing the amenities available to visitors while protecting the environment. Alternative B would also meet criterion 6 through expanded use of renewable energy sources for the uplake developed areas.

Table 7 summarizes fulfillment of NEPA criteria for the environmentally preferred alternative for each alternative.

Table 7. NEPA Criteria Summary		
Criteria	Alternative A (No-Action)	Alternative B (preferred alternative)
1	Yes	Yes
2	No	Yes
3	No	Yes
4	Yes	Yes
5	No	Yes
6	No	Yes

## COSTS OF ALTERNATIVES

A cost comparison in the form of a class C cost estimate of each of the action alternatives is included as appendix B. Industry refers to these estimates as conceptual or order-of-magnitude estimates. A class C estimate is a conceptual cost estimate based on square-foot cost of similar construction. These estimates are generally prepared without a fully defined scope of work and have an accuracy range of -30% to +50%.

## MITIGATION MEASURES

To minimize resource impacts, the following mitigation measures would be followed during implementation of either action alternative. These mitigation measures are included in the analysis of impacts for each action alternative. The mitigation measures were developed to lessen potential adverse effects of the action.

### General Considerations

- The National Park Service project manager would ensure that each project remains confined within the parameters established in the compliance documents and that mitigation measures are properly implemented.
- Construction zones would be identified and flagged before beginning the activity and all disturbance would be confined to the flagged areas. All project personnel would be instructed that their activities must be confined to locations within flagged areas. Disturbance beyond the actual construction zone would be prohibited.

**Table 8. Summary and Comparison of Potential Environmental Consequences**

<b>Impact Topic</b>	<b>Alternative A (No-Action)</b>	<b>Alternative B (preferred alternative)</b>
Land Use	Because the existing uses conform to the land-use descriptions and no changes would be made under the No-Action Alternative, there would be no impacts to land use under Alternative A.	All proposed expansion and development would be consistent with the land-use descriptions in the 1979 GMP; therefore, there would be no impacts to land use.
Soils and Geology	There would be no impacts to geology. The impacts to soils would continue to be long-term, minor and adverse.	Impacts to geology would be localized, short and long-term, minor and adverse. Overall impacts to soils would be long-term, minor and adverse.
Paleontology	There would be no impacts to paleontology.	Impacts to paleontology would be localized, long-term, negligible to minor and adverse.
Air Quality	The impacts to air quality would continue to be short and long-term, minor and adverse.	Impacts to air quality would be short-term, minor and adverse and long-term, minor to moderate and adverse.
Water Resources	Overall water quality in the developed areas is adequately controlled through existing facilities and programs. As a result, the No-Action Alternative would continue to result in long-term negligible impacts to water quality.	Impacts to water quality would be short-term, negligible and adverse from runoff during construction. Long-term, minor, adverse impacts on surface water quality would occur from continued recreational uses, including potential leaks and spillage of boat fuels and continued use of watercraft. No violations of water quality standards would be expected.
Waters of the U.S. including Wetlands	There would be no changes to existing conditions under the No-Action Alternative And therefore no impacts to wetlands.	Impacts to waters of the United States would be expected to be short and long-term, negligible and adverse. There would only be negligible impacts to wetlands.
Floodplains	Under the No-Action Alternative, there would be no impacts to floodplains because new construction or expansion of existing operations would not occur.	Impacts to floodplains would be expected to be short and long-term, negligible and adverse.
Vegetation	Overall impacts to vegetation of the uplake developed areas under the No-Action Alternative would be long-term, minor to moderate and adverse, resulting from facility and infrastructure maintenance, increased visitation and introductions of nonnative plant species.	Overall impacts to vegetation would be long-term, moderate and adverse, resulting primarily from facility and infrastructure construction, more intense development of primitive campsites and long-term, negligible and beneficial due to restoration of previously disturbed plant communities.

**Table 8. Summary and Comparison of Potential Environmental Consequences**

<b>Impact Topic</b>	<b>Alternative A (No-Action)</b>	<b>Alternative B (preferred alternative)</b>
Wildlife	Existing impacts to wildlife in the developed areas are long-term, minor and adverse.	Impacts to wildlife species and habitat would be short and long-term, minor and adverse.
Threatened and Endangered Species and Species of Concern / Designated Critical Habitat	Impacts from the No-Action Alternative would continue to be long-term, localized, minor and adverse.	The short- and long-term impacts would be minor and adverse.
Visual Resources	Existing impacts to visual resources from facilities that visually detract from busy visitor use areas would continue to be long-term, minor and adverse.	Short-term, negligible to minor, adverse impacts to visual resources would result from construction activities. Overall long-term impacts under this alternative would be minor and beneficial due to the positive effects of relocating certain facilities outside visitor viewscales and reclaiming previously developed areas.
Soundscapes	Impacts would vary seasonally and would be long-term, localized and adverse and range from negligible to minor depending on the season of activity.	The short-term impacts to soundscapes from construction activities as a result of implementation of the alternative would be negligible to moderate and adverse. The long-term impacts to soundscapes as a result of human-caused sound from the implementation of the alternative would vary seasonally and be negligible to moderate and adverse.
Archeological Resources	Localized archeological resource impacts from visitor use and NRA operations would be long-term, adverse and range from negligible to minor.	Archeological resource impacts would be long-term, adverse and range from negligible to minor.
Ethnographic Resources	Ethnographic resource impacts related to visitor use would be long-term, adverse and negligible to minor in the developed areas. Impacts from NRA operations would have long-term, minor, adverse impacts.	With mitigation, impacts to ethnographic resources would be resource-specific and long-term and would range from negligible to minor.
Visitor Use and Experience	Overall impacts to visitor use and experience from the No-Action Alternative would be long-term, minor to moderate and adverse and result from the lack of increases in visitor services as visitor numbers increase and the aging of visitor accommodations.	Short-term impacts to visitor use and experience as a result of activities associated with expansion, relocation, or construction of facilities at the uptake areas would be minor and adverse. Long-term impacts to visitor use and experience would be minor and beneficial.



**Table 8. Summary and Comparison of Potential Environmental Consequences**

Impact Topic	Alternative A (No-Action)	Alternative B (preferred alternative)
Socioeconomic Environment	Under Alternative A, impacts to the economy and local government fiscal conditions in towns near the uptake developed areas and associated counties would be negligible to minor, long-term and adverse. Where effects to visitor use are greatest, impacts to the economy and to local government fiscal conditions would be long-term, minor and adverse.	Impacts to socioeconomics from planned construction projects as part of the alternatives would be short-term, minor and beneficial. The benefits to concessioners and to visitor-related business and public revenue would be long-term, minor to moderate and beneficial.
Park Operations	Overall impacts to NRA operations from Alternative A would be long-term, minor and adverse from meeting the ongoing maintenance needs of aging facilities and increased demands as a result of increased visitation.	Overall short-term, negligible to minor, adverse impacts would occur to NRA operations from construction activities; long-term, minor and adverse impacts would result from increased operational demands from facility expansion; and long-term, minor, beneficial impacts to NRA operations would result from reduced maintenance and repair requirements for upgraded facilities.
Public Health and Safety	Because no changes would occur to existing facilities at the uptake developed areas under the No-Action Alternative, there would be no impacts to health and safety.	Impacts to health and safety would be short-term, negligible and adverse and long-term, negligible to minor and beneficial.
Transportation	Because no changes would be made under the No-Action Alternative, there would be no impacts to transportation under Alternative A.	The overall impacts to transportation would be short-term, minor and adverse resulting from increased traffic and congestion during construction periods; and long-term, minor and beneficial impacts resulting from consolidation of like activities, centrally locating facilities to reduce traffic and improved circulation patterns.

- All protection measures would be clearly stated in the construction specifications and workers would be instructed to avoid conducting activities beyond the construction zone, as defined by the construction zone flagging. This does not exclude necessary temporary structures such as erosion-control fencing.
- All tools, equipment, barricades, signs and surplus materials would be removed from the project work limits upon project completion. Rubbish would be routinely removed from the project site. Any asphalt or concrete surfaces damaged due to work on the project would be repaired to original condition. All demolition debris would be removed from the project site.
- Staging for a construction office, construction vehicles and equipment and materials storage would be located in previously disturbed areas, outside of high visitor use areas and would be clearly identified in advance. All staging areas would be returned to pre-construction conditions once construction is complete.
- Contractors would be given orientation concerning proper conduct of operations. This orientation is provided in both written form and verbally at a preconstruction meeting. Orientation topics would include (and not limited to) the following:

- Wildlife should not be approached or fed.
- Collecting any park resources, including plants, animals and historic or prehistoric materials, is prohibited.
- Contractor must have a safety policy in place and follow it.
- A vehicle fuel leakage and spill plan would be developed and implemented for the project prior to construction.
- Other environmental concerns and requirements discussed elsewhere in this EA would be addressed, including relevant mitigation measures listed below.

## **Sediment Control**

- Utah Department of Environmental Quality requirements, industry standards and best management practices (BMPs) for drainage and sediment control would be implemented to prevent and/or control nonpoint source discharge to minimize soil loss and sedimentation in drainage areas. Use of BMPs for drainage area protection would include all or some of the following actions, depending on site-specific requirements:
  - Keep disturbed areas as small as practical to minimize exposed soil and the potential for erosion.
  - Locate waste and excess excavated materials outside of drainages to avoid sedimentation.
  - Install silt fences, temporary earthen berms, water bars, sediment traps, check dams, or other equivalent measures to control runoff, as necessary, prior to construction.
  - Conduct regular site inspections during the construction period to ensure that erosion-control measures are properly installed and are functioning effectively.
  - Store, use and dispose of chemicals, fuels and other toxic materials in the required and appropriate manner.
  - Revegetate disturbed areas as soon as possible after construction is completed.

## **Soils**

- Trenching grading operations using manual or heavy equipment would follow industry standard stabilization methods. After trenching and grading is completed, backfill, compaction and regrading operations would be initiated as soon as possible to establish and maintain stable soil surfaces. Soil surfaces would be treated and restoration within approved NPS guidelines and specifications would be performed.
- Vehicle or equipment tracks would be eradicated and “raked out” after construction activities to reduce visual impact and reduce the possibility of visitors driving through soil-disturbed areas.
- Dust and soil control measures, including surface water spraying and revegetation using hydro mulch, would be incorporated into construction activities to reduce soil loss from wind erosion.

## **Paleontology**

If previously unknown paleontological resources are discovered during construction activities, all work in the immediate area of the discovery would cease until the resources could be identified and documented. If

paleontological sites are discovered and cannot be avoided, the resource would be recorded and recovered using required compliance processes.

## **Air Quality**

- To reduce dust and fine particles from becoming airborne during construction activities, truck beds would be covered with tarps.
- To reduce tailpipe emissions, construction equipment would not be left idling any longer than is required for safety and mechanical operations.
- To reduce short-term construction dust, water sprinkling would be applied to problem areas. Construction limits would be established to minimize soil disturbance and blowing dust.
- Landscaping and revegetation would control long-term soil erosion and blowing dust. Mulch and plants would be used to stabilize the soil and reduce wind impacts across open areas where required.

## **Water Resources**

- A stormwater management plan would be developed in compliance with Utah Department of Environmental Quality requirements. Additional permitting would be managed to comply with mitigation measures required by state and federal water quality and pollution prevention regulations.
- All activities and projects that occur below 3,700 feet (amsl) would adhere to the requirements of the U.S. Army Corps of Engineers Regional General Permit Number 64 for Lake Powell and its tributaries above Glen Canyon Dam. Those projects not falling within the requirements of RGP 64 may require the park to seek an individual permit from the Corps.
- Measures from a hazardous spill plan would be in place and dictate preventive measures and required actions taken in the case of a hazardous materials spill.
- All equipment used within the NRA for operations and construction would be maintained in a clean and well-functioning condition to avoid leaks and contamination of resources from mechanical and automotive fluids.

## **Floodplains**

Appropriate state and federal regulatory permits and protection measures would be established prior to the start of any new construction projects.

## **Vegetation**

- In an effort to avoid introduction of nonnative/noxious plant species, imported topsoil would be certified free of weed seed contaminants.
- Most areas of new disturbance would be returned to native vegetation through revegetation or seeding. Natural restoration may be used, when appropriate and viable, based on seasonal rain patterns.

- Reclaimed areas would be monitored after construction to determine if revegetation efforts are successful with follow-up actions, as needed.
- Reclamation measures may include installation of erosion-control structures and reseeding with hydro-mulch stabilization.
- To avoid the introduction of nonnative plant species, hay bales would be limited in use because they often contain seeds of undesirable or harmful alien plant species. Straw wattles of appropriate plant species would be used to control soil erosion wherever possible. Application of NPS guidelines for noxious weed control measures would be incorporated into construction activities.
- Undesirable plant species would be controlled, as necessary. To prevent the introduction and minimize the spread of nonnative vegetation and noxious weeds, the following measures would be implemented during construction:
  - Minimize soil disturbance.
  - Pressure wash and/or steam clean all construction equipment to ensure that all equipment, machinery, rocks, gravel, or other materials are cleaned and weed free before entering Glen Canyon NRA.
  - Cover all haul trucks bringing asphalt or other fill materials from outside the recreation area to prevent seed transport.
  - Limit vehicle parking to existing disturbed areas where possible.
  - Obtain all fill, rock, or additional topsoil from the project area, if possible. If not possible, obtaining weed-free sources from NPS-approved sources outside the recreation area, as required.
  - Initiate restoration of disturbed sites immediately following construction activities.
  - Monitor disturbed areas following construction to identify growth of noxious weeds or nonnative vegetation. Treatment of nonnative vegetation would be completed in accordance with NPS – 13, *Integrated Pest Management Guidelines* and/or the Glen Canyon Integrated Pest Management Plan, which will be completed in 2006.

## Threatened and Endangered Species / State Species of Concern

Mitigation for impacts to threatened and endangered species and their designated critical habitat is based on consultation with the USFWS under section 7 of the Endangered Species Act and includes:

- Access road, restroom placement and any other incidental actions needed to develop the Hite shoreline camping area would occur outside the southwestern willow flycatcher breeding season.
- Use of the camping area would be restricted to the nonbreeding season for the southwestern willow flycatcher during low lake levels. These restrictions would be lifted should lake levels increase and inundate the habitat area. As the water rises and falls, the shoreline camping area would be adjusted accordingly.

Mitigation measures for Utah state species of concern would include:

- Mitigate for any impacts to bat species – all impacted buildings would be surveyed for bats prior to demolition or construction. Any bats found would be relocated per Utah Department of Natural Resource guidelines.

- Mitigation for the chuckwalla and the glossy snake would consist of surveys for species presence prior to disturbance, which may include relocation of detected individuals per Utah Department of Natural Resource guidelines, to prevent direct impacts from construction.
- Burrowing owl surveys would be completed and if found, will be relocated to artificial burrows away from construction areas.

## Visual Resources

Trenching for underground utilities would be limited to a 10-foot-wide fenced construction zone, if possible.

- All new construction would be consistent with established architectural themes and construction materials would complement natural colors and textures.
- The new stacked storage unit proposed for the Bullfrog secured storage area would be located outside the primary viewshed and would blend into the natural landscape.
- Overall, muted natural colors would be used to blend any human-made surfaces with the landscape.

## Soundscapes

- Contractors would be required to properly maintain construction equipment (i.e., mufflers) to minimize noise.
- Noise-generating construction activities would be limited to approved hours of operation to minimize visitor impacts.

## Archeological Resources

- Prior to implementation of any undertakings (actions), a SHPO file search would be conducted to determine the location of any existing historic or prehistoric resources. As necessary, an appropriate level of survey and/or data recovery would be completed before work begins. In the unlikely event that unknown archeological resources would be uncovered during construction, work would be halted in the discovery area, the site secured and Glen Canyon NRA staff experts would consult according to 36 CFR 800.13 and, as appropriate, provisions of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA).
- In compliance with NAGPRA, the National Park Service would notify and consult concerned American Indian tribal representatives for the proper treatment of human remains, funerary and sacred objects should these be discovered during the project.
- Archeological monitoring would be established onsite during any ground-disturbing activities in areas identified as culturally sensitive.
- Archeological specimens found within the construction area would only be removed by NPS archeologists or their designated representatives.

## Visitor Use and Experience

- The recreation area may restrict construction activities during peak use hours/days, such as holidays and weekends, to minimize disruption to visitors.
- Facilities that are relocated or are temporarily closed due to construction work would be signed with information on the location of the nearest similar facility or location for assistance.
- Unless otherwise approved by the National Park Service, construction operations would be restricted to the hours of 8:00 a.m. to 6:00 p.m. during the summer (May 1 through September 30) and 9:00 a.m. to 5:00 p.m. during the rest of the year to reduce visitor impacts.
- Information regarding construction projects or activities would be shared with the public upon entrance into the recreation area, or through other methods of informational distribution such as informational brochures, flyers, press releases, mailings and Web sites.
- Management strategies to address carrying capacity issues at various water levels would target better distribution of launch activities throughout a 24-hour day. Methods to reduce launch backup may include broadcasts of real-time launch ramp conditions using the recreation area information radio system, onsite NPS staff visitor contacts, Web site postings, or a launch-time reservation system.
- Methods to allocate visitor use of shoreline campsites may include a camping reservation system to reduce impacts to specific visitor use zones and coordinate length of stay to further address carrying capacity issues.
- The existing “trash tracker” program is well established and incorporates volunteer houseboat trips to clean up beaches. Additionally, visitor education promoting responsible behavior and awareness of water quality and pollution issues are offered through NPS and concessioner visitor contacts, brochures, onsite programs and Web site information. Trash bags are also made available to visitors at no charge in support of the “pack it in/pack it out” program. These combined mitigations substantially reduce the adverse impacts of litter on beaches and in the lake.

## Park Operations

- Concessions would be notified at least 24 hours in advance of temporary utility outages and construction work within their land assignments.
- Whenever possible, length of outages would be kept to a minimum and scheduled on nonpeak usage hours to reduce economic impacts on concessions and visitor inconvenience.

## Public Health and Safety

A safety plan for project work in drainages and washes would be formulated and implemented to protect public health and safety should these activities take place during the rainy season. Whenever possible, construction in floodplains and washes would be avoided during the rainy season.

- All construction work in visitor use areas (parking lots, campgrounds, launch ramps, etc.) would be barricaded and signed in order to keep visitors at a safe distance from the construction zone.
- Based on the Occupational Safety and Health Administration (OSHA) and NPS patrol and construction management monitoring systems for land- and water-based safety, some construction areas in flash flood-prone areas may be closed to reduce public health and safety risks.
- Water activities on Lake Powell are regulated by U.S. Coast Guard and NPS regulations. Measures to manage concentrated visitor boating may include increased water patrols and designation of wakeless zones based on water surface reduction at lower lake levels. These measures would mitigate adverse impacts of increased boat density in specific visitor use zones.

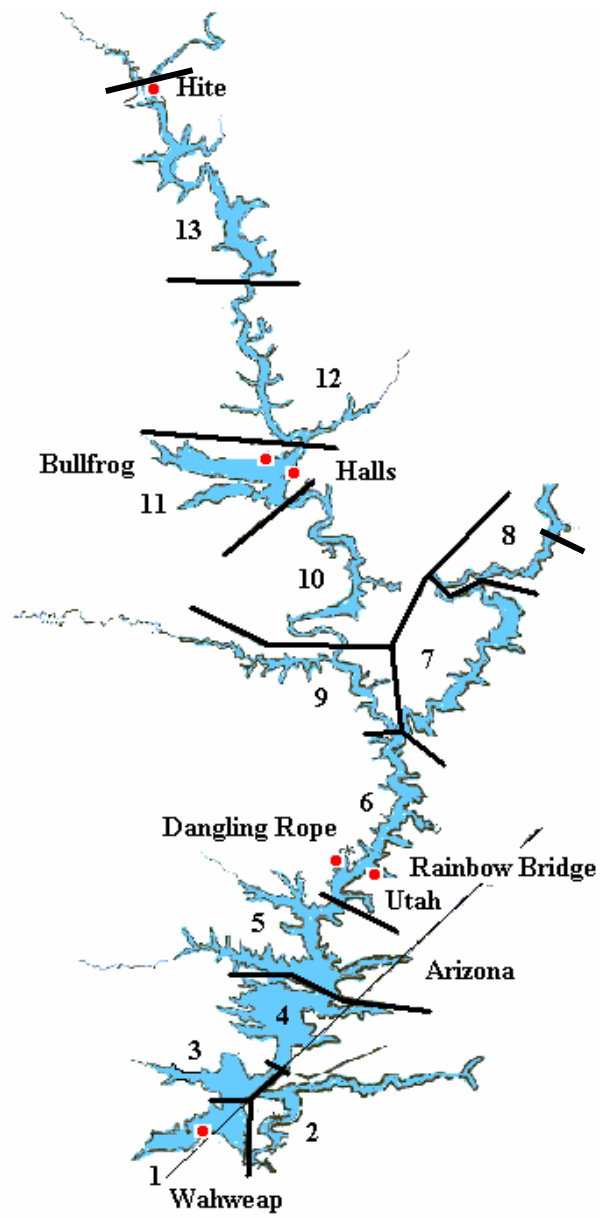
## **Transportation**

Traffic in any one direction would not be stopped for more than 20 minutes to minimize disruption of traffic flow. Projects that may impede navigation would be reviewed by the US Army Corps of Engineers for consistency with Section 10 of the Rivers and Harbor Act. Additional permits from the US Army Corps of Engineers may be required.

## **SUPPLEMENTAL CALCULATIONS AND ANALYSIS FOR LAKE POWELL CARRYING CAPACITY**

In 1987, a carrying capacity study was developed to quantify resource impacts and visitor distribution on Lake Powell during full pool conditions (+/- 3,680 to 3,700 feet amsl). For purposes of the study, Lake Powell was divided into 13 visitor use zones, which are identified in the GMP (figure 27). Impact factors were used to evaluate the relationship between visitor use areas and environmental impacts, such as shoreline pollution, water quality, availability of usable shoreline for recreation, boating safety and visitor experience qualities, that contribute to recreational opportunities.

Due to ongoing drought conditions that have impacted lake levels at Lake Powell, the DCP planning process prompted the need to prepare supplemental calculations and analyze carrying capacity for lower lake levels in the uplake areas. To accomplish this effort, updated data from ongoing resource monitoring projects and recent visitor surveys were input into carrying capacity calculations using the same methodology as the 1987 study.



(zones 6 through 13 considered uplake area)

**FIGURE 24. VISITOR USE ZONES**



Two limiting factors from the 1987 study were eliminated from the supplemental calculations: water quality and shoreline impacts. These factors were not considered in the updated calculations due to successful mitigation measures implemented since the original study, resulting in reduced impacts. The remaining factors used to calculate new numbers for carrying capacity were applied to the physical capacity (shoreline availability), safety (density/distribution of boats on lake surface) and recreational quality (measuring visitor experience) while visiting Lake Powell.

A detailed summary of calculations and findings for the supplemental analysis are available on request from Glen Canyon NRA. Additional analysis of the supplemental carrying capacity calculations and a description of impacts that relate to the DCP/EA can be found in the “Environmental Consequences” section of this document.

## Analysis of Carrying Capacity for Lake Powell

The concept of analyzing impacts based on limiting factors is flexible and can be used to produce quantifiable results to consider resource impacts, their causes and potential management strategies for mitigation. Limiting factors serve as a screen to determine the most constraining issue to trigger management changes.

The limiting factors at each lake elevation interval under consideration in the supplemental calculations are presented in tables 8 through 11. Maximum boats-at-one-time (BAOT) indicates the maximum number of boats at one time in that particular zone to meet the limitation of that particular limiting factor.

The shaded blocks with numbers in brackets indicate the limiting factor that is the controlling consideration for each zone. As previously discussed, water quality has been determined to be nonlimiting based on water quality. Data evaluated since 1998, indicate that water quality is not a limiting factor due to education, monitoring studies and practices implemented to control human waste.

**TABLE 9. 2005 LIMITING FACTOR MATRIX LAKE ELEVATION 3,500**

(Maximum Boats-At-One-Time)

Visitor Use Zone	Physical	Safety	Recreational Quality (Social)		
			Semi-Primitive	Rural / Natural	Urban / Natural
6	1,456	612	[459]	612	612
7	1,025	471	[353]	471	N/A
9	784	265	[199]	265	N/A
10	596	615	[461]	615	N/A
11	417	256	N/A	[192]	256
12	679	438	[329]	438	N/A
13	2,285	675	[506]	675	N/A

NA = The Recreational Opportunity Spectrum or ROS designation used in the 1987 study does not apply to this zone due to the concentration of marina facilities.

Shaded and bracketed numbers indicate the limiting factor for that particular zone at specific lake elevation.

**TABLE 10. 2005 LIMITING FACTOR MATRIX LAKE ELEVATION 3,550**

(Maximum Boats-At-One-Time)

Visitor Use Zone	Physical	Safety	Recreational Quality (Social)		
			Semi-Primitive	Rural / Natural	Urban / Natural
6	1,465	753	[565]	753	753
7	595	614	[460]	614	N/A
9	334	349	[261]	349	N/A
10	[394]	729	547	729	N/A
11	593	437	N/A	[328]	437
12	854	525	[394]	525	N/A
13	2,191	963	[722]	963	N/A

NA = The Recreational Opportunity Spectrum or ROS designation used in the 1987 study does not apply to this zone due to the concentration of marina facilities.

Shaded and bracketed numbers indicate the limiting factor for that particular zone at specific lake elevation.

**TABLE 11, 2005 LIMITING FACTOR MATRIX LAKE ELEVATION 3,600**

(Maximum Boats-At-One-Time)

Visitor Use Zone	Physical	Safety	Recreational Quality (Social)		
			Semi-Primitive	Rural / Natural	Urban / Natural
6	1,812	946	[710]	946	946
7	[537]	745	558	745	N/A
9	475	459	[344]	459	N/A
10	640	851	[639]	851	N/A
11	685	764	N/A	[573]	764
12	499	619	[465]	619	N/A
13	1,852	1,273	[955]	1,273	N/A

NA = The Recreational Opportunity Spectrum or ROS designation used in the 1987 study does not apply to this zone due to the concentration of marina facilities.

Shaded and bracketed numbers indicate the limiting factor for that particular zone at specific lake elevation.

**TABLE 12. 2005 LIMITING FACTOR MATRIX LAKE ELEVATION 3,700**

(Maximum Boats-At-One-Time)

Visitor Use Zone	Physical	Safety	Recreational Quality (Social)		
			Semi-Primitive	Rural / Natural	Urban / Natural
6	2,589	1,394	[1,045]	1,394	1,394
7	[779]	1,045	784	1,045	N/A
9	990	726	[544]	726	N/A
10	1,082	1,127	[846]	1,127	N/A
11	1,528	1,942	N/A	[1,456]	1,942
12	1,215	915	[686]	915	N/A
13	2,802	1,948	[1,461]	1,948	N/A

NA = The Recreational Opportunity Spectrum or ROS designation used in the 1987 study does not apply to this zone due to the concentration of marina facilities.

Shaded and bracketed numbers indicate the limiting factor for that particular zone at specific lake elevation.

The supplemental calculations in table 12 provide updated carrying capacity launch rates (CCLRs) at varying lake levels and compare them with the existing capacity of launch and marina facilities to launch boats onto the lake.

Table 13 provides a comparison of 2005 carrying capacity launch rates with current capacity of existing marinas and launch ramps to distribute boats onto the lake. Columns of information should be compared between those with the same lake elevations. Shaded blocks with bracketed numbers in the current capacity columns indicate when the capacity exceeds the recommended CCLR for that lake elevation.

As shown in table 12, the carrying capacity limits for combined Bullfrog and Halls Crossing areas may be exceeded based on limiting factors if maximum launch rates and boats from marinas put on the water at one time at the full pool lake elevation of 3,700. In addition, Halls Crossing existing carrying capacity may be exceeded at lake elevations of 3,550, 3,600 and 3,700 if maximum launch rates and boats from marinas put on the water at the same time.

The 1987 carrying capacity study and supplemental calculations assumed that 20% of boats in marina facilities would be out on the lake at any one time. Under Alternative B, increases in wet moorage would increase total launches by 11 launches per day and increases in rental boat fleets would increase total launches by 116 launches per day.

**TABLE 13. CARRYING CAPACITY LAUNCH RATES / CURRENT CAPACITY COMPARISON TABLE**

<b>Updated Carrying Capacity Launch Rate</b> (calculated using 1987 methodology and updated data to evaluate varying lake levels)					<b>Current Capacity</b> (combines 20% of existing buoy moorage and ramp capacity at each lake level)				
	<b>3,500 CCLR</b>	<b>3,550 CCLR</b>	<b>3,600 CCLR</b>	<b>3,700 CCLR</b>	<b>3,500</b>	<b>3,550</b>	<b>♦3,557–3,583</b>	<b>3,600</b>	<b>3,700</b>
<b>Bullfrog</b>	310	375	524	463	246	246	343	305	437
<b>Halls Crossing</b>	121	160	217	179	Unknown*	[223]	223	[275]	[266]
<b>Bullfrog/Halls Crossing Combined</b>	431	535	741	642	Unknown	469	566	580	[703]
<b>Hite</b>	0	0	0	377	N/A	N/A	N/A	N/A	210

\* There is no launch capacity at the existing Halls Crossing launch ramp below 3,550 lake elevation.

\*\*Numbers reflect a factor increase due to length of stay estimates from visitor survey information. Survey data suggests visitors stay twice as long at higher lake levels then at 3,600 and below lake levels.

♦ 3,557–3,583 lake levels shown due to launch capability of Bullfrog north ramp at those lake elevations.

For this planning effort, Bullfrog and Halls Crossing numbers are shown combined due to proximity of marinas within visitor use zone 11.

Table 13 compares updated carrying capacity launch rates with projected capacity to launch boats resulting from the implementation of Alternative B. Varying lake level shoreline capacity, safety and recreational quality factors are included in the updated carrying capacity launch rates. Alternative B adds 20% of proposed buoy moorage and increased rental boat fleet to the launch ramp capacity numbers. Shaded boxes with bracketed numbers highlight lake level projected capacities that may exceed carrying capacity if maximum numbers of launches occur within 24 hours. The 1987 carrying capacity study and supplemental calculations assumed that 20% of boats in marina facilities would be out on the lake at any one time.

**TABLE 14. CARRYING CAPACITY LAUNCH RATES  
(UPDATED CARRYING CAPACITY LIMITS COMPARED TO ALTERNATIVE B)**

<b>Updated Carrying Capacity Launch Rate</b> (calculated using 1987 methodology and updated data to evaluate varying lake levels)					<b>Alternative B Projected Capacity</b> (combines 20% of increased buoy moorage, rental boats and ramp capacity at each lake level)				
	<b>3,500 CCLR</b>	<b>3,550 CCLR</b>	<b>3,600 CCLR</b>	<b>3,700** CCLR</b>	<b>3,500</b>	<b>3,550</b>	<b>♦3,557–3,583</b>	<b>3,600</b>	<b>3,700</b>
<b>Bullfrog</b>	310	385	524	469	286	286	383	345	479
<b>Halls Crossing</b>	121	171	217	179	Unknown*	[274]	[274]	[326]	[326]
<b>Bullfrog/Halls Crossing Combined</b>	431	556	741	648	Unknown	560	657	671	[805]
<b>Hite</b>	0	0	0	377	N/A	N/A	N/A	N/A	219

\* There is no launch capacity at the existing Halls Crossing launch ramp below 3,550 lake elevation.

\*\*Numbers reflect a factor increase due to length of stay estimates from visitor survey information. Survey data suggests visitors

**TABLE 14. CARRYING CAPACITY LAUNCH RATES  
(UPDATED CARRYING CAPACITY LIMITS COMPARED TO ALTERNATIVE B)**

<b>Updated Carrying Capacity Launch Rate</b> (calculated using 1987 methodology and updated data to evaluate varying lake levels)					<b>Alternative B Projected Capacity</b> (combines 20% of increased buoy moorage, rental boats and ramp capacity at each lake level)				
	<b>3,500 CCLR</b>	<b>3,550 CCLR</b>	<b>3,600 CCLR</b>	<b>3,700** CCLR</b>	<b>3,500</b>	<b>3,550</b>	<b>◆3,557– 3,583</b>	<b>3,600</b>	<b>3,700</b>

stay twice as long at higher lake levels then at 3,600 and below lake levels.

◆ 3,557–3,583 lake levels shown due to launch capability of Bullfrog north ramp at those lake elevations.

For this planning effort, Bullfrog and Halls Crossing numbers are shown combined due to proximity of marinas within visitor use zone 11.

The updated calculations show management strategies may be needed to mitigate the resulting carrying capacity issues to address “physical capacity” and “recreational quality” factors. Some management actions that could mitigate the physical capacity issue include a reservation or permitting system to manage camping allocation in different zones, or regulating launch times and volume during peak demand.

Approaches to managing recreational quality factors may include providing information to visitors, prior to boating, about the characteristics and popularity of different visitor use zones to increase distribution and support a range of visitor experience opportunities as part of the Lake Powell recreational experience.

Affected Environment

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## **AFFECTED ENVIRONMENT**

### **INTRODUCTION**

This section describes the affected environment or physical and social conditions currently present within the analysis area, which includes the uptake developed areas (Bullfrog, Halls Crossing and Hite marinas). The analysis area for the affected environment and environmental consequences discussions includes the developed areas plus a 500-foot buffer as shown in the figures depicting the alternatives.

### **GENERAL DESCRIPTION**

Glen Canyon NRA is on the Colorado Plateau and extends more than 200 miles from the Green River in southern Utah downstream to Lees Ferry in Arizona (see figure 1). Lake Powell was formed by the construction of Glen Canyon Dam between 1956 and 1964. Congress authorized the dam construction in the Colorado River Storage Project Act of 1956 (PL 84-485). The primary objectives were to prevent flooding on the Colorado River, create a reservoir to meet downstream water demand and generate hydroelectric power.

Glen Canyon Dam is managed by the Bureau of Reclamation. It was designed to accommodate lake levels ranging from approximately 3,490 feet to approximately 3,700 feet amsl. As the water level changes, the surface of Lake Powell varies in size from 52,000 acres to 163,000 acres and the shoreline fluctuates from 990 miles to 1,960 miles in length. Annual fluctuations in lake levels typically are about 25 vertical feet.

The lake level rises in the spring as water from snowmelt runoff and spring storms collects behind the dam. The lake level then declines throughout the rest of the year, particularly during summer and early fall as water is released for electrical power generation and irrigation. In recent years, low snowmelt runoff and decreased rainfall from spring storms have resulted in a decreased lake water surface. By the end of 2006, water levels are predicted to be at an elevation of approximately 3,613 feet (USBR 2006).

In 1972, Congress established Glen Canyon NRA (PL 92-593) to provide public recreation on Lake Powell and adjacent lands. The National Park Service is responsible for managing all federal lands and waters within Glen Canyon NRA. Access to Lake Powell within Glen Canyon NRA is provided at five developed marinas (Bullfrog, Halls Crossing, Hite, Antelope Point and Wahweap [see figure 2]). The recreation area includes approximately 1,254,306 acres of land and water. At full pool, the water surface of Lake Powell encompasses approximately 13% of the total lands of Glen Canyon NRA; however, the lake and associated marinas and developed areas are the most extensively used portion of the recreation area.

### **LAND USE**

In the 1979 GMP, land use was defined through the creation of four distinct land management zones within the boundaries of Glen Canyon NRA. These zones were designated as natural, recreation and resource utilization, development and cultural.

The developed areas at Bullfrog, Halls Crossing and Hite fall into the development zone. The development zone designation allows development of more permanent and elaborate structures to support recreational activities. All types of visitor activities are permitted in this zone, with certain restrictions determined during management planning. Within the defined boundaries for this zone, all types of construction to support visitor services would be acceptable.

## **SOILS**

Soils in the uplake area consist primarily of alluvial or colluvial soils derived from water and wind erosion of the surrounding bedrock. As shown in figure 28, much of Bullfrog lies within the Moffat loamy fine sand and Monue loamy fine sand soils types. Figure 29 shows the soils at Halls Crossing, which include primarily the Moenkopi M warm complex and Bluechief L-N complex soils with minor incursions of the Piute-S rock complex soils. The Hite area includes soils from the Moenkopi rock outcrop and Moenkopi-M warm complex (figure 30). Soils descriptions for each soils type are as follows:

### ***Monue Series***

The Monue series soils consist of very deep, well-drained, moderately rapidly permeable soils on alluvial terraces and eolian deposits on structural benches. These soils form from the erosion of sandstone. Soils are loamy fine sand. Slopes range from 1% to 12%. These soils are typically deeper than 60 inches, but may have bedrock at depths of 40 to 60 inches. Soils are typically used for rangeland.

### ***Bluechief Series***

The Bluechief series consists of moderately deep, well-drained, moderately to rapidly permeable soils that formed in sandy eolian deposits and alluvium derived from sandstone. These soils are on benches and fan terraces. Soils are fine sandy loam. Slopes range from 1% to 15%. Soil depths are typically 30 to 40 inches, but bedrock can occur at 20 inches. Soils in this series are typically used for rangeland, wildlife habitat and recreation.

### ***Moenkopi Series***

The Moenkopi series consists of very shallow and shallow, well-drained, moderately to rapidly permeable soils that formed in alluvium and residuum from sandstone and shale. Moenkopi soils are on mesas, hill slopes on structural benches and plateaus. Soils are loamy sand. Slopes are 1% to 30%. Soil depths are typically 9 to 12 inches, but can range from 4 to 20 inches. Soils in this series are typically used for livestock grazing and wildlife habitat.

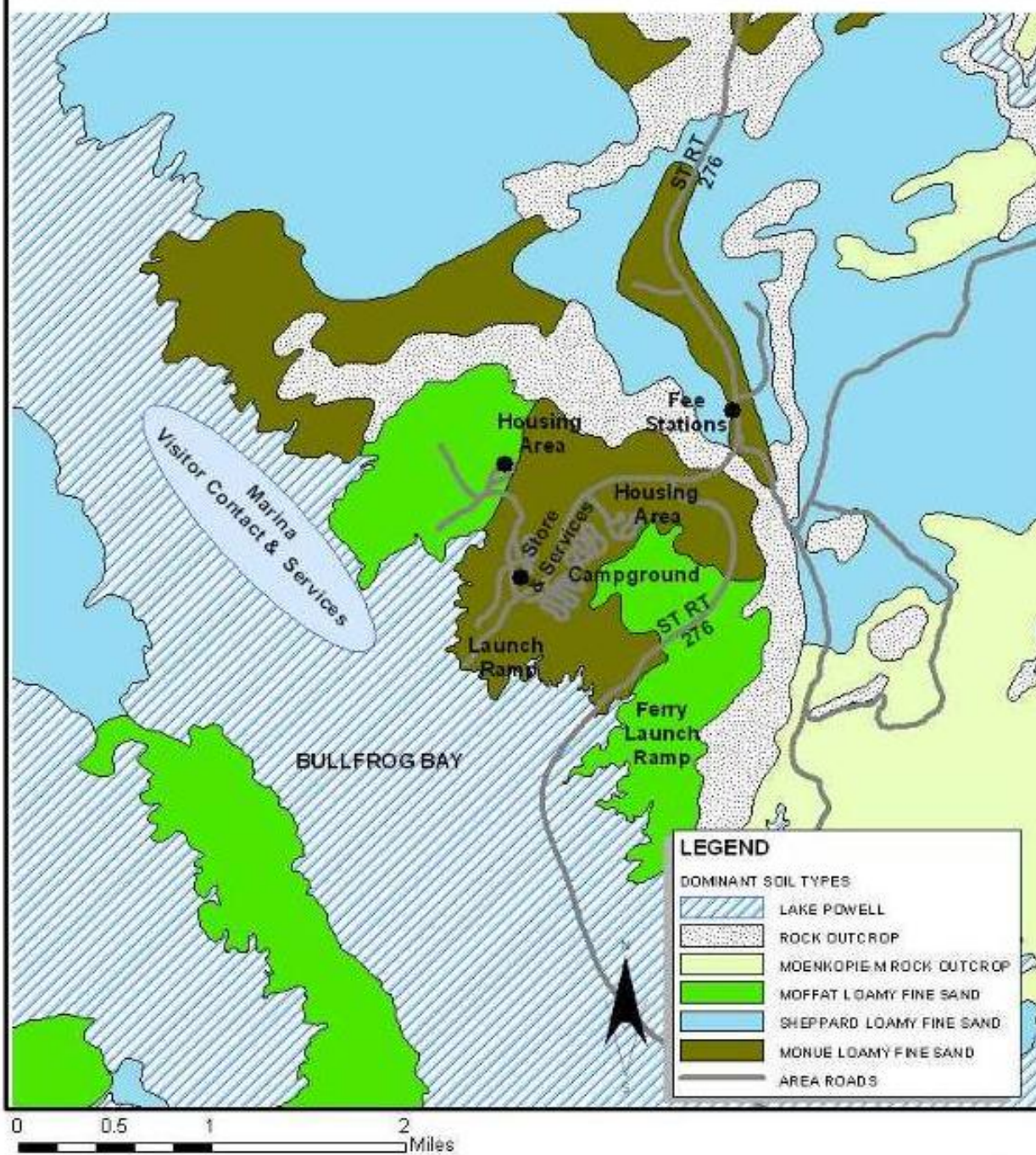
### ***Moffat Series***

The Moffat series consists of very deep, well-drained, moderately rapidly permeable soils that formed in eolian and alluvial sediments. These soils are on plains, plains on structural benches and alluvial fans and have slopes ranging from 1% to 25%. Soils are gravelly fine sand. Soil depths are typically 40 to 60 inches. Soils are typically used for rangeland.





## Bullfrog Soil Analysis Area



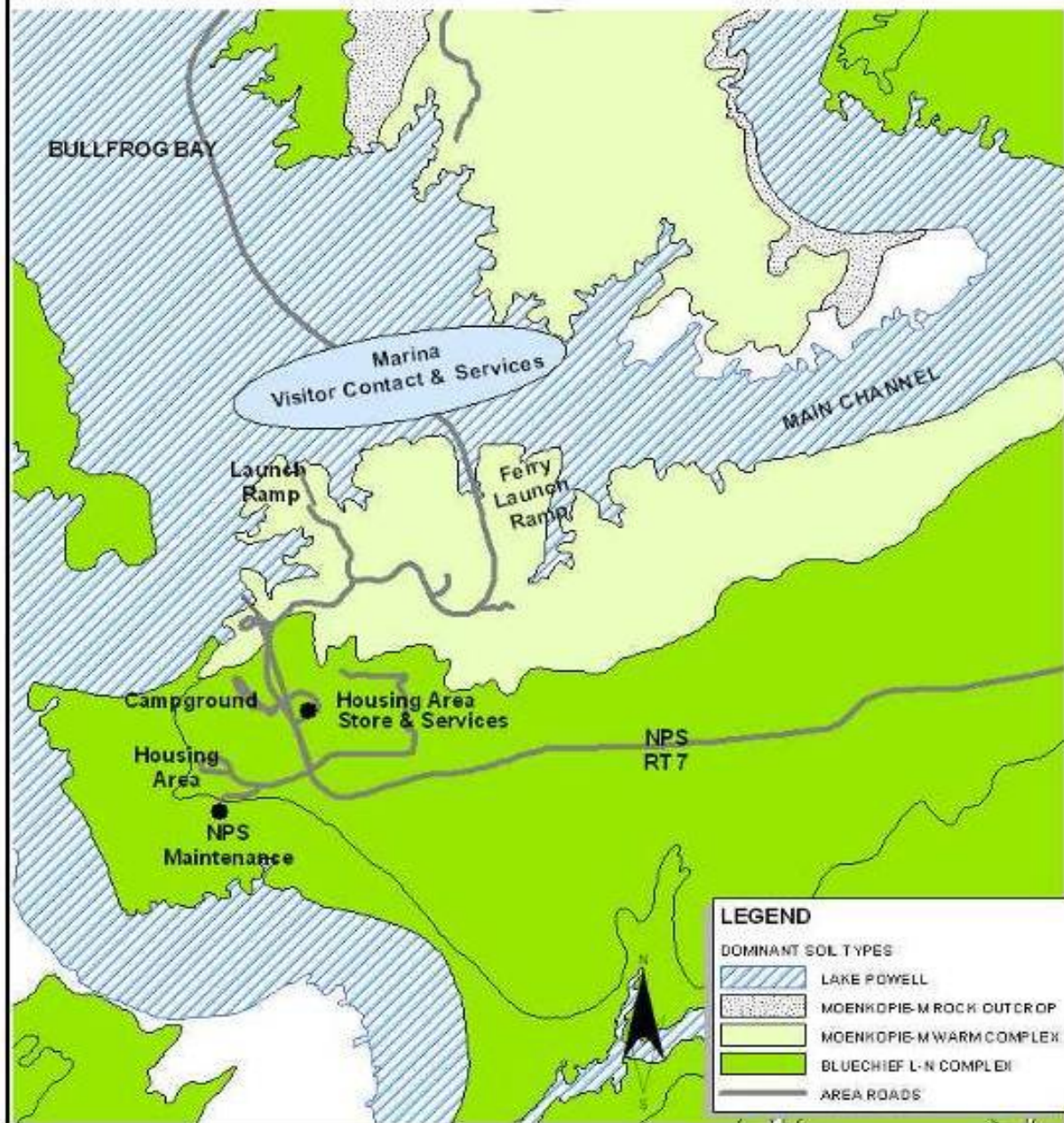
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FIGURE 25. SOILS OF BULLFROG DEVELOPED AREA





## Halls Crossing Soil Analysis Area



0 0.5 1 2 Miles

Produced by GLCA Facilities

April 200

FIGURE 26. SOILS OF HALLS CROSSING DEVELOPED AREA





### Hite Soil Analysis Area

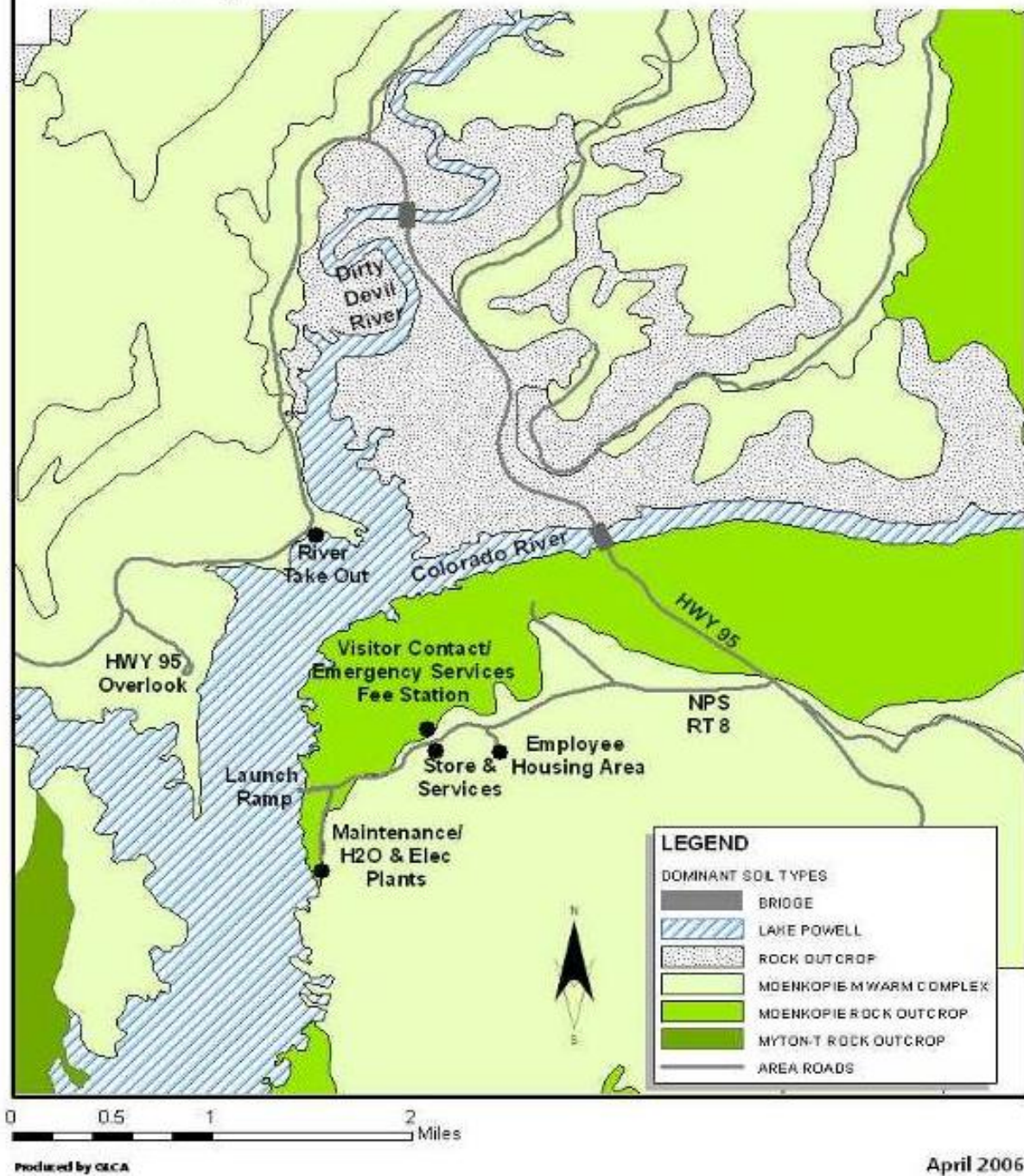


FIGURE 27. SOILS OF HITE DEVELOPED AREA

## **GEOLOGY**

### **Geology of the Bullfrog Area**

Upper Jurassic formation rocks dominate the landscape at Bullfrog. During the Jurassic period approximately 180 million years ago, ancient oceans began to retreat. The Carmel formation is present at Bullfrog in lower areas closer to the lake. The Carmel formation was deposited under shallow marine conditions and consists of beds of limestone and sandy limestone. Above the Carmel formation lays the Kayenta formation. Streams flowing into the shallow oceans deposited the limey, thinly layered sandstone of the Kayenta formation. The cliffs and ledges are present in the elevated segments of the developed area. At the highest points of the developed area, the Summerville formation may be exposed. The Summerville formation contains sedimentary rocks deposited primarily by river flows, with some thin layers that may have been deposited by wind. Rocks are typically thinly bedded siltstones and mudstones with occasional thin beds of white sandstone. Holocene gravels, dunes and soils are scattered in the area (Gillette 2004).

### **Geology of the Halls Crossing Area**

The geology of Halls Crossing and surrounding areas is dominated by Upper Jurassic age sandstones. Navajo sandstone resulted from a period of time when a massive windswept dunefield covered what is now the Colorado Plateau. Navajo sandstone is a colorful unit of red, orange and white sandstone that can be as thick as 2,400 feet. At Halls Crossing, the Navajo sandstone is believed to be approximately 1,200-feet thick, but not all of the formation is exposed. Navajo sandstone forms the lowest lying rocks in the area. Page sandstone may lie above the Navajo sandstone; however, this unit is difficult to distinguish because it is similar to Navajo sandstone. When Page sandstone is difficult to distinguish, geologists generally map this unit as part of the Navajo sandstone. The Navajo/Page sandstone layer can be found above the Carmel formation previously described, but it has limited exposure. Entrada sandstone lies above the Carmel formation. Like Navajo sandstone, the Entrada formation is a wind-driven deposit. However, the Entrada sandstone generally forms a thinner layer than the Navajo sandstone and is typically a white or off-white to cream color. Above the Entrada sandstone lie Quaternary sediments consisting of unconsolidated silts and sands deposited mainly by wind (Gillette 2004).

### **Geology of the Hite Area**

The rocks in the Hite area are older than the rocks at Bullfrog and Halls Crossing. The geology at Hite is dominated by rocks of Permian and early Triassic age. Cedar Mesa sandstone is the lowest formation present in the area. Cedar Mesa sandstone accumulated in a coastal dune system, which was periodically inundated by water. The Organ Rock formation overlies the Cedar Mesa sandstone and consists of shale, silt and sand deposited by rivers with occasional dry land sand deposits. White Rim sandstone forms the vertical cliffs in the area and is sandstone derived from both ocean and dry land wind deposits. The highest formation is the Moenkopi. This formation caps the exposures in the Hite vicinity. The Moenkopi formation is comprised of mudstones from a riverine environment (Gillette 2004).

## PALEONTOLOGY

In accordance with NPS *Management Policies 2001*, section 4.8.2.1, *Paleontological Resources and Their Contexts*, paleontological resources in national parks “will be protected, preserved and managed for public education, interpretation and scientific research.” The paleontological resources at the three uplake developed areas were evaluated as part of an initial site survey that provided a general overview of geologic formations in the analysis area and research into the paleontological resources that might be present in each formation. The following discussions describe the findings for each developed area (Gillette 2004).

### Potential Paleontological Resources at Bullfrog

Three formations are exposed at Bullfrog. The potential for paleontological resources at each site is described as follows:

- While fossils (mostly invertebrates) are occasionally found in the Carmel formation, finding any fossil in this formation is considered rare. The upper layers of the Entrada sandstone preserve abundant dinosaur tracks. Prior to the time of deposition of the Entrada sandstone, sauropod (long-neck) dinosaurs were absent in North America. There is some evidence in the Entrada sandstone track record that sauropod populations expanded from Asia to North America at this time, setting the stage for the spectacular evolution of dinosaurs found in great abundance in the Morrison formation.
- The Summerville formation seldom produces fossils; however, because of its stratigraphic position, it may contain fossils at Bullfrog.

### Potential Paleontological Resources at Halls Crossing

Five formations are exposed at Halls Crossing. The potential for paleontological resources in each formation is described as follows:

- The Navajo sandstone has extensive, but poorly recorded dinosaur tracks on horizontal bedding planes that represent ancient stabilized dune surfaces, perhaps temporary wet ground that would form shallow interdune lakes under the right climatic conditions. Some beds of very local extent in the Navajo sandstone have impressive petrified logs, occasionally associated with dinosaur tracks, under conditions generally interpreted as oasis deposits. The petrified logs can be substantial in size, but are likely to be broken and difficult to recognize where erosional effects caused by fluctuations of the lake have produced wave action and otherwise left the logs exposed.
- The Page sandstone has a poor fossil record, if any.
- The Carmel formation fossils are generally marine invertebrates with spotty distribution. Vertebrate fossils and plants are possible and, if found, would be considered rare.
- The uppermost beds of Entrada sandstone occasionally yield exceptional dinosaur footprints, in some places by the millions (e.g., in the vicinity of Arches National Park). These sites have been called dinosaur freeways and probably represent north-south migratory routes for herding species.

- Eolian Quaternary sediments, on rare occasion, yield extinct flora and fauna in association with early human occupation (e.g., Clovis and Folsom technologies), overlapping with archeological resources.

## Potential Paleontological Resources at Hite

Four formations are exposed at Hite. The potential for paleontological resources at each site is described as follows:

- Fossils are not common in the Cedar Mesa formation, but this formation has yielded critically important plant fossils that provide details of terrestrial plant species that existed here prior to the catastrophic extinction event at the end of the Permian period.
- The Organ Rock formation represents terrestrial conditions where Permian reptiles dominated the landscape and may contain reptile or reptile-related fossils.
- White Rim sandstone in the Hite area forms nearly vertical cliffs that are difficult to examine and are not likely to be disturbed during any construction.
- The Moenkopi formation contains the earliest record of Triassic flora and fauna of the southern Colorado Plateau. The fossil record represents the recovery stage following the catastrophic end-Permian extinction event that nearly extinguished all life on earth. Reptilian ancestors to dinosaurs and all other reptiles are contained in the Moenkopi formation. There is some evidence that the oldest dinosaurs in the world occur in this formation.

## AIR QUALITY

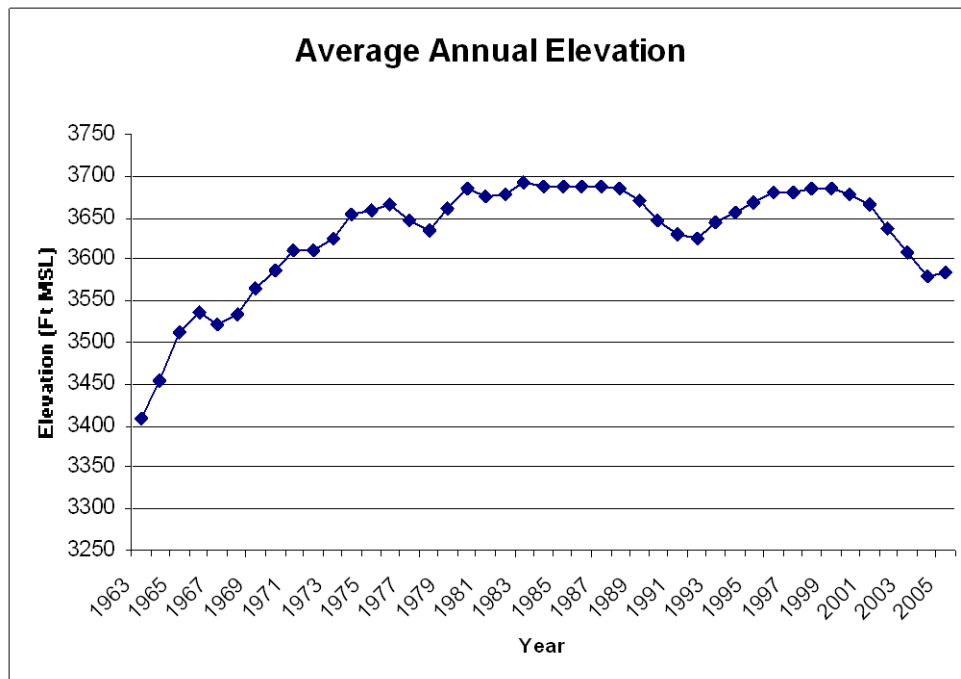
The EPA and the Utah Department of Environmental Quality regulate air quality in Utah through implementation of the Clean Air Act. The Clean Air Act is a federal air quality law that is intended to protect human health and the environment by reducing emissions of specified pollutants at their source. In accordance with this law, permits are required for any stationary facility that qualifies as a “major source.” Further, the Clean Air Act outlines three types of airshed classification areas: class I, II and III. Glen Canyon NRA is located within a class II airshed in which the demonstrated impact of a new stationary source facility may emit no more than 100 tons of a regulated pollutant annually before needing a permit.

The EPA has established primary and secondary National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: carbon monoxide, nitrogen dioxide, particulate matter, ozone, sulfur dioxide and lead. Primary standards are adopted to protect public health, while secondary standards are adopted to protect public welfare. Air quality data for four of the six criteria pollutants that are regulated by the EPA are measured and recorded by the Salt River Project at Glen Canyon Dam next to the Carl Hayden Visitor Center. There are no air quality monitoring sites at or near the uplake developed areas. No data is available for carbon monoxide or lead within Glen Canyon NRA as these pollutants are not monitored due to historically low concentrations in the area—no exceedances have been recorded for the last five years. Ambient air quality data at the downlake monitoring site for Glen Canyon NRA from 1996 through 2001, when compared to the federal standards for those pollutants, indicate that all pollutants monitored are well below established standards.

## WATER RESOURCES

### Introduction

Although Lake Powell reached full capacity at an elevation of approximately 3,700 feet on June 22, 1980, the average lake elevation for 1980 was approximately 3,680 feet amsl (figure 31). At full capacity, Lake Powell extends 186 miles up the Colorado River from the dam and 75 miles up the San Juan River from its confluence with the Colorado. The design surface area at full capacity is 251.2-square miles with 1,960 miles of shoreline (USBR 1988). The lower Colorado River watershed, including the analysis area, has experienced a severe drought six of the last ten years. The lake level dropped to its lowest annual average elevation (since reaching full capacity in 1980) in 2005. The projected water level for Lake Powell at the end of water year 2006 is 3,618 feet. At 3,618 feet lake elevation, the surface area is 140.7-square miles. Predictions of elevation provided by the Bureau of Reclamation are based on factors related to snowpack, melt rate, contributing rain and releases from Glen Canyon Dam. Predictions are updated monthly and will likely change slightly during the preparation of this report.



**FIGURE 28. ANNUAL ELEVATION**

The Bureau of Reclamation manages water levels in Lake Powell within the constraints of supply provided through precipitation and runoff. The National Park Service manages the recreational facilities within and surrounding Lake Powell. The uptake developed areas of Bullfrog, Halls Crossing and Hite have modified available services in response to the decrease in water levels. Boat ramps have been extended or relocated and moorings at wet slips and buoy fields have been moved. These circumstances have been aggravated at Hite by the increased levels of sediment. Hite marina facilities were permanently relocated to Bullfrog and Halls Crossing in 2004.

The Uplake DCP provides an evaluation of potential changes to the uplake developed areas to accommodate future use. Water supply, distribution and treatment are components of the planning for development changes. The EPA, State of Utah and Glen Canyon NRA do not allow discharges from surface facilities into the lake. Impacts from recreational users are managed to maximize water quality.

Bullfrog is located near the inlet of Bullfrog Creek. Halls Crossing is south of Bullfrog on the south shore of the Colorado River, north and upstream of Lake Canyon and west and downstream of Moqui Canyon. Hite is located downstream of Dirty Devil Canyon and slightly north of the confluence of North Wash and the Colorado River.

Lake Powell has a contributing watershed of 107,700-square miles. The major tributaries to Lake Powell are the Colorado, San Juan, Dirty Devil and Escalante rivers. Lake Powell is part of the Colorado River Storage Project, a federal program designed to store seasonal flood waters for beneficial water uses at later periods. The project has a storage capacity of 34 million acre-feet of water (USBR 2006) in Lake Powell, Flaming Gorge Reservoir on the Green River in Utah, Navajo Reservoir on the San Juan River in New Mexico and Blue Mesa Reservoir on the Gunnison River in Colorado. Lake Powell serves as a recreation destination for boaters, nature lovers and fishermen and also produces hydroelectric power.

Lake Powell was filled using upper basin flows over a 21-year period. During this time, outflows to downstream water rights holders averaged 12.07 million acre-feet per year and inflows averaged 15.18 million acre-feet per year. Storage stayed within 94% of the full capacity of 23.35 million acre-feet for the six-year period from 1984 through 1989, before larger fluctuations based on annual inflows began. Inflow matched or exceeded outflow until 2000, when the minimum outflow obligation exceeded the inflow. If the annual amount of water flowing into the lake is less than that lost to dam releases (and evaporation), the reservoir surface elevation drops.

Water obligations to Lower Colorado basin states and Mexico are 8.23 million acre-feet per year and discharges from Glen Canyon Dam have averaged 13.75 million acre-feet in the last 10 years. The Bureau of Reclamation prepares an annual operating plan at the end of every water year for consultation and consensus by Upper Colorado River basin states, Lower Colorado River basin states, American Indian tribes, water delivery contractors, contractors for the purchase of federal power, appropriate federal agencies and others with interests in Colorado River operations. The annual operating plan for 2006 (USBR 2005) couples a 24-month water supply forecast with the operating criteria developed by the secretary of the interior entitled "Criteria for Coordinated Long Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968." In 2004, the *Interim 602(a) Storage Guideline* was adopted, which sets the minimum storage of Lake Powell at 14.85 million acre-feet. This operating protocol will guide releases from Lake Powell during the 2006 water year. In the event that the capacity of Lake Powell exceeds this value, storage equalization criteria between the active storage volumes in Lake Mead and Lake Powell will control releases for the year.

## **Lake Level Analysis**

Six years of drought, coupled with anticipated inlet sedimentation have resulted in new challenges for recreation management at Lake Powell. Between 1999 and 2004, the average annual water level dropped over 100 feet, modifying the perimeter, area and elevation of Lake Powell. The reservoir surface area at 3,600 feet of 149-square miles is 40% less than the area at 3,700 feet (full capacity) of 251-square miles. A drop in the elevation of Lake Powell another 20 feet to 3,580 feet would decrease



the reservoir surface area to 133-square miles. This dramatic decrease in surface area as the lake elevation drops has substantial implications for the lake's recreational carrying capacity.

Normal average annual variation has been approximately 25 feet, with the highest levels occurring in July following snowmelt runoff and the lowest levels occurring in April, after the winter, but prior to high-country runoff. The Bureau of Reclamation predicts that the water level will rise to its highest point for 2006 (3,624 feet) in July.

## Water Quality

Inflow water quality near Hite was measured prior to the construction of Glen Canyon Dam. Assuming no changes in the intervening year, the water at Hite was characterized as hard (average calcium carbonate hardness of 420 mg/l), moderately alkaline (pH ranging from 7.1 to 8.2 and averaging 7.77) and with an average salinity (specific conductance ranging from 399 mg/l to 2060 mg/l) (USGS 2006). The water quality of Lake Powell varies seasonally. The Grand Canyon Monitoring and Research Center performs quarterly water quality assessments at as many as 15 stations on the main channel of the Colorado River. Elevated spring runoff and large upstream storm events bring in elevated sediment concentrations as well as higher levels of dissolved oxygen. Lake Powell also exhibits traditional thermal stratification with some mixing in the fall as the water surface cools and in the spring when large inflows occur. Water quality varies with distance from Glen Canyon Dam and water depth.

Lake Powell is located on the boundary between Arizona and Utah and consequently both states regulate water quality. However, Lake Powell waters within the analysis area are within Utah and are thus regulated by Utah state standards. Utah's antidegradation policy is included in the Utah Administrative Code, Rule R317-2, *Standards of Quality for the State*. The policy establishes a plan to maintain and improve the quality of state waters for public water supplies; the propagation of wildlife, fish and aquatic life; and agricultural, industrial, recreational and other legitimate uses. The policy states that no waste will be discharged into any waters of the state that would compromise the beneficial uses of the receiving waters. Glen Canyon NRA water quality management objectives are focused toward this central premise.

Human waste is a potential threat to recreation area resources because it can be a source of pathogens in water. Lake Powell water quality has been monitored for human waste since 1988. The monitoring periodically shows high concentrations of fecal coliform bacteria, which indicate the presence of untreated sewage. In the early 1990s, several beaches were temporarily closed because of high fecal coliform bacteria levels. There were 12 beach closures for the same reason in 1995. In response to these conditions, the National Park Service has addressed sanitation issues by implementing the Strategic Plan to Protect Water Quality in Lake Powell (NPS 2005f). With implementation of the Strategic Plan to Protect Water Quality in Lake Powell, beach closures due to high concentration of fecal coliform bacteria were reduced to three in 1996 and one in 1999.

Glen Canyon NRA continues to actively perform a beach monitoring program and implement management actions to protect water quality in an effort to exceed levels recommended by the State of Utah. Since 2002, all monitoring of fecal bacteria pollution has used the *Escherichia coli* (E. coli) bacteria Coli-ert system to protect public health. Data was collected in six uplake zones, including Bullfrog and Halls Crossing located in zone 11 and Hite located in zone 13. Zone 11, near Bullfrog and Halls Crossing, had several instances of high levels of fecal bacteria pollution in 1997 and 1998. *E. coli* levels in zone 11 peaked in 1998, but have dropped since that time. A similar pattern is seen for zone 13 (Hite), which had several instances of high levels of fecal bacteria pollution in 1998, but levels

have subsequently dropped. Improvements in water quality may be a result of implementation of the aforementioned Strategic Plan to Protect Water Quality in Lake Powell.

## **Other Water Resources**

Other water resources that occur in or adjacent to the analysis area for Glen Canyon NRA include ephemeral washes, intermittent streams, springs, tinajas and groundwater. Ephemeral washes are fed by the limited precipitation events that occur in or upstream of the NRA. Intermittent streams are fed both by very limited precipitation events and by flow from spring sources within or upstream of the NRA. Tinajas are created when precipitation is captured in depressions on the surface of rock formations within the NRA. These features are intermittent and may contain unique and diverse assemblages of plant and animal life. Groundwater resources of the analysis area may typically be found at varying depths within sandstone formations or in alluvial deposits associated with the Colorado River or its tributaries. The degree to which these hydrologic features may be impacted by proposed development is unknown at this time and would require survey data to adequately define the quantity, quality and location of these resources relative to the analysis areas.

Implementation of standard NPS BMPs for control of sedimentation (as specified in the mitigation measures located in the “Alternatives” section) would mitigate adverse effects to these water resources.

## **Siltation**

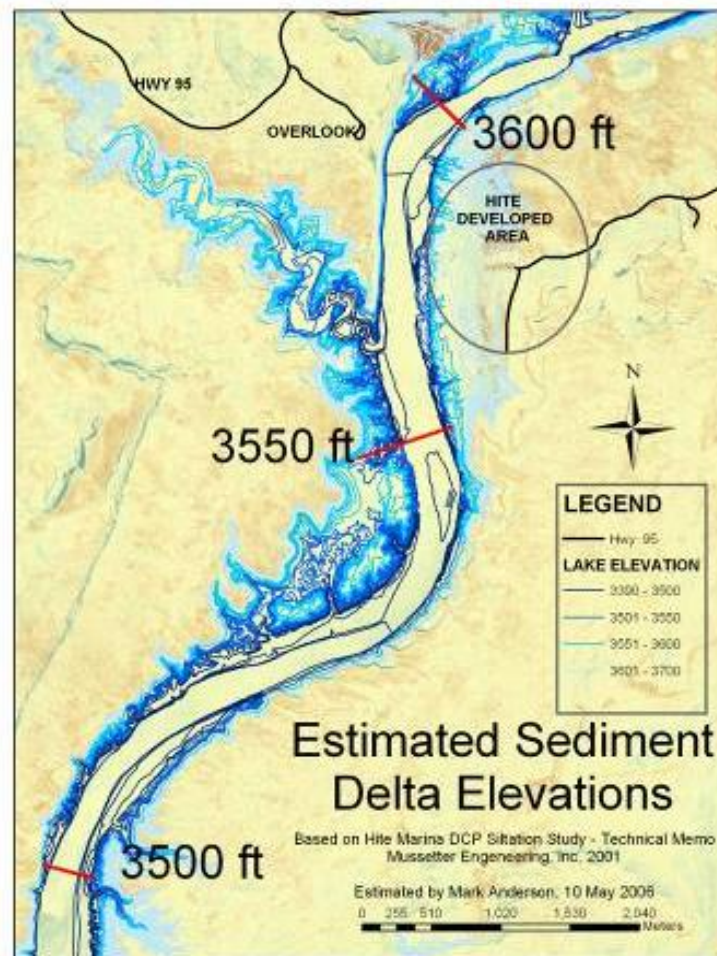
Rivers move weathered sediments during high flows. These form deltas at the inlets of lakes and reservoirs when the velocity of the river decreases. Several estimates of sedimentation have been prepared over the years of operation of Glen Canyon Dam. The most thorough study to date, a 1986 Bureau of Reclamation survey, concluded that 868,231 acre-feet of sediment had been deposited in Lake Powell between March 1963 and September 1986, or 36,946 acre-feet per year, with 54% derived from the Colorado River arm. This would suggest that on average 19,951 acre-feet of sediment per year would enter the reservoir near Hite. A smaller study of the Hite area in June 2001 estimated that 183,400 acre-feet of sediment entered the Colorado River arm between 1986 and 2001, with an average sedimentation rate of 12,200 acre-feet per year (Mussetter 2001). Sediment depth measurements in the Hite vicinity suggest that the lake bottom has risen at an average rate of 4 feet per year over the life of the reservoir (Mussetter 2001).

Sediment deposition will continue to play a role in the use of uplake facilities at Hite. At water levels near full pool, the sediment deposited in the vicinity of Hite could eventually reach a high enough elevation to cause concern for the long-term use of Hite. During lower lake levels, sediment deposition occurs at the lake inlet downstream of Hite and some cutting by the river and flood flows moves previously deposited sediment downstream. Currently, Hite is basically silted in.

## **Effects of Sedimentation**

Sediment carried by the rivers emptying into Lake Powell is deposited on the lake bottom and along the shoreline. The effects of sedimentation relative to these supplemental calculations are most noticeable in zone 13. In figure 32, the red lines indicate approximate locations where the free-flowing river ends and the pooling of water begins at various elevations. The figure also displays estimates of sediment deposits in zone 13. These estimates were prepared based on a sedimentation study of Lake Powell

(Mussetter 2001). It should be noted that sedimentation is an ongoing process and its effects will vary over time; therefore, the effects described for zone 13 are only estimates.



**FIGURE 29. ESTIMATE OF SEDIMENT**

Sediment deposits will reduce the amount of accessible shoreline and surface area of the lake in zone 13, particularly between lake elevations 3,500 and 3,550. Figure 32 provides a visual representation of the estimates. The impacts of sedimentation are not numerically factored into the supplemental calculations presented in this document.

## **FLOODPLAINS**

The 100-year floodplain has been established at the 3,700-foot elevation by the Federal Emergency Management Agency. Additionally, small areas of floodplain occur at the deltas of tributaries to the lake. The elevation of these floodplains is determined by the elevation level of the lake during the flood event. The principle tributaries within or adjacent to the developed areas include the Dirty Devil River, North Wash, Bullfrog Creek, Halls Creek and Stanton Creek. All of these enter the lake and deposit sediments at this interface. NPS policy requires that permanently occupied structures should not be located in a floodplain. Additionally, any facilities (temporarily occupied structures, e.g., water-based stores, or nonoccupied structures, e.g., ramps, roads, parking lots) that are located within floodplain areas should be designed and/or located adequately to protect them during flood events.

## **WATERS OF THE UNITED STATES, INCLUDING WETLANDS**

The USACE has jurisdiction over protecting waters of the United States, including wetlands under section 404 of the Clean Water Act. Waters of the United States are defined as waters that are navigable for interstate commerce and their tributaries. The Colorado River has been identified as a navigable waterway. The jurisdictional limits of waters of the United States have been established by the USACE as occurring at the 3,700-foot elevation along the shoreline of Lake Powell. Due to fluctuating water input, the actual level of the water is oftentimes much lower. Currently Glen Canyon NRA has obtained a Regional General Permit for Lake Powell and its tributaries above Glen Canyon Dam. This permit allows the development of projects within the Corps jurisdiction that would otherwise require the use of multiple Nationwide Permits. These permits were developed for use with projects having little or no environmental impacts. Construction projects having impacts require obtaining an individual permit from the Corps. Additionally, the Corps regulates navigable waters under Section 10 of the Rivers and Harbors Act. Additionally, wetlands are defined as “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3[b]). Wetlands have three diagnostic characteristics: (1) over 50% of the dominant species present must be classified as obligate, facultative wetlands, or facultative; (2) the soils must be classified as hydric; and (3) the area is either permanently or seasonally inundated (USACE 1987).

The National Park Service classifies, delineates and maps wetlands using the USFWS’s Cowardin classification system (USFWS 1979). This system is based on the more inclusive definition, e.g., “lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.” Under this classification, wetlands must have one or more of the following characteristics: (1) the land supports, at least periodically, predominantly hydrophytes (i.e., plants adapted to growing in water or in saturated soils that are oxygen deficient), (2) the substrate is comprised of predominantly undrained hydric (anaerobic) soils and (3) the substrate is saturated with water or covered by shallow water at some time during the growing season of each year (USFWS 1979).

Both wetlands definitions and classification systems (USFWS and USACE) recognize three parameters: hydrophytic vegetation, hydric soil and wetlands hydrology, but differ from each other in how much habitat is considered wetlands. The Cowardin system defines more habitat types as wetlands and also recognizes many unvegetated sites such as mudflats, or areas without soil such as rocky or sandy banks, stream shallows, saline lakeshores, playas and deepwater or sites lacking soil.

A variety of mostly nonnative noxious weeds typically grow in this band of soil between 3,700 feet and the actual waterline. These plants are generally not recognized as wetlands plants and this area does not contain appropriate hydric soils. While there may be some inundation during certain times of the year, this area does not meet the definition of a wetlands by either the USACE or USFWS standards and therefore is only protected as waters of the United States, not as “wetlands.” Small areas of wetlands do occur within the footprint of Bullfrog, Halls Crossing and Farley Canyon. Additionally, wetlands may also occur along the banks of the Colorado River in the Hite area.

## VEGETATION

### Introduction

Glen Canyon NRA and Lake Powell lie within the Colorado Plateau Semidesert province (Bailey 1995). The Colorado Plateau Semidesert province includes tablelands with moderate to considerable topographic relief in the vicinity of Glen Canyon NRA. Elevations range from 3,100 feet in the deeper canyons up to 7,500 feet on canyon rims and mesa tops. Generally, four vegetation zones can be used to describe regional flora and wildlife habitats of the Glen Canyon NRA region. They are (1) arid grassland, (2) xeric shrublands, (3) woodlands and (4) montane communities (Bailey 1995). Of these zones only arid grasslands and xeric shrublands occur in the analysis area. Arid grasslands are composed of sod-forming grasses and bunchgrasses that are typically widely spaced, with open areas often covered by a well-developed cryptobiotic crust between grass patches and shrubs. Xeric shrublands can grow in open stands within arid grassland communities, but may also form extensive, sparse to moderately dense shrublands on appropriate habitats. In addition to these two major community types, riparian vegetation occurs in washes and along the banks of creeks and rivers throughout the NRA and in the analysis area.

In 1988, a report on the vegetation and relict communities of Glen Canyon NRA was completed (Tuhy and MacMahon 1988) (figures 33, 34 and 35). The 1988 report used existing regional information sources along with field observations and limited data collection. The report classified, described and delineated 21 vegetation cover types in Glen Canyon NRA. Major types are illustrated in figure 33. Fourteen of the cover types likely occur in the analysis area of this DCP/EA:

1. *Stipa* [*Achnatherum*, *Hesperostipa*] – *Hilaria* [*Pleuraphis*] Grassland (Indian ricegrass, Needle-and-thread – Galleta) community type
2. Sand-shrub community type
3. *Coleogyne ramosissima* (Blackbrush) cover type
  - *Coleogyne ramosissima* / *Stipa* [*Achnatherum*] *hymenoides* (Blackbrush / Indian ricegrass) community type
  - *Coleogyne ramosissima* / *Hilaria* [*Pleuraphis*] *jamesii* (Blackbrush / James’ Galleta) community type
4. *Atriplex confertifolia* (Shadscale) cover type
  - *Atriplex confertifolia* / *Hilaria* [*Pleuraphis*] *jamesii* – *Stipa* [*Achnatherum*] *hymenoides* (Shadscale / James’ Galleta – Indian ricegrass) community type
  - *Atriplex confertifolia* / *Hilaria* [*Pleuraphis*] *jamesii* (Shadscale / James’ Galleta) community type
5. *Atriplex gardneri* var. *cuneata* (Gardner saltbush) cover type

6. *Atriplex corrugata* (Mat saltbush) cover type
7. *Ceratoides* [*Krascheninnikovia*] *lanata* (Winterfat) cover type
8. Talus slopes with mixed shrubs, below piñon -juniper zone
9. Hanging gardens
10. Perennial riparian
11. Ephemeral washes and higher terraces
12. *Sarcobatus vermiculatus* (Black greasewood) cover type
13. *Atriplex canescens* (Four-wing saltbush) cover type
14. *Artemisia tridentata* ssp. *tridentata* (Basin big sagebrush) cover type

## Analysis Area Vegetation

Plant communities that have become established in the analysis area consist of seral communities of disturbed sites, introduced landscape species and climax native communities of more stable wetlands and upland sites. Disturbed sites include those that are subject to foot traffic and vehicle access and those of the Lake Powell low water zone. Plant species typically present on high-traffic recreation sites include purple threeawn (*Aristida purpurea*), cheatgrass (*Bromus tectorum*), Bermuda grass (*Cynodon dactylon*), witchgrass (*Panicum capillare*), storksbill (*Erodium cicutarium*), knotweed (*Polygonum aviculare*), Russian thistle (*Salsola iberica*), purslane (*Portulaca oleracea*), prostrate vervain (*Verbena bracteata*) and puncture vine (*Tribulus terrestris*). Native and nonnative landscape plantings have been introduced or otherwise became established in campgrounds, around marinas and elsewhere in the developed portion of the recreation area. Landscape shade trees include Fremont cottonwood (*Populus fremontii*), Gooddings willow (*Salix gooddingii*), box-elder (*Acer negundo*), hackberry (*Celtis* sp.), juniper (*Juniperus* sp.), Russian-olive (*Elaeagnus angustifolia*), ash (*Fraxinus* sp.), elm (*Ulmus* sp.), western redbud (*Cercis occidentalis*), pinion pine, Utah juniper and sycamore (*Platanus* sp.).

Much of the analysis area that occurs below the ordinary high water line of Lake Powell has been inundated historically and reexposed as water levels have receded in the past decade. This exposed shoreline habitat often supports both native and nonnative annual and perennial plant species that grow in distinct bands relative to soil moisture and include cocklebur (*Xanthium strumarium*), horseweed (*Conyza canadensis*), curly gumweed (*Grindelia squarrosa*), Fremont and narrowleaf goosefoot (*Chenopodium fremontii* and *C. leptophyllum*), yellow and white sweetclover (*Melilotus officianalis* and *M. alba*), tumble mustard (*Sisymbrium altissimum*), Russian thistle, tumbling orach (*Atriplex rosea*), bassia (*Bassia hyssopifolia*), tarragon (*Artemisia dracunculus*), common sunflower (*Helianthus annuus*), poverty-weed (*Iva axillaris*), dropseeds (*Sporobolus* spp.) and redroot and prostrate pigweed (*Amaranthus retroflexus* and *A. blitoides*). On more mesic shoreline sites, stands of nonnative tamarisk (*Tamarix chinensis*) and native seepwillows (*Baccharis* spp.) become established (Waring 1993).





## Bullfrog Vegetation Analysis Area

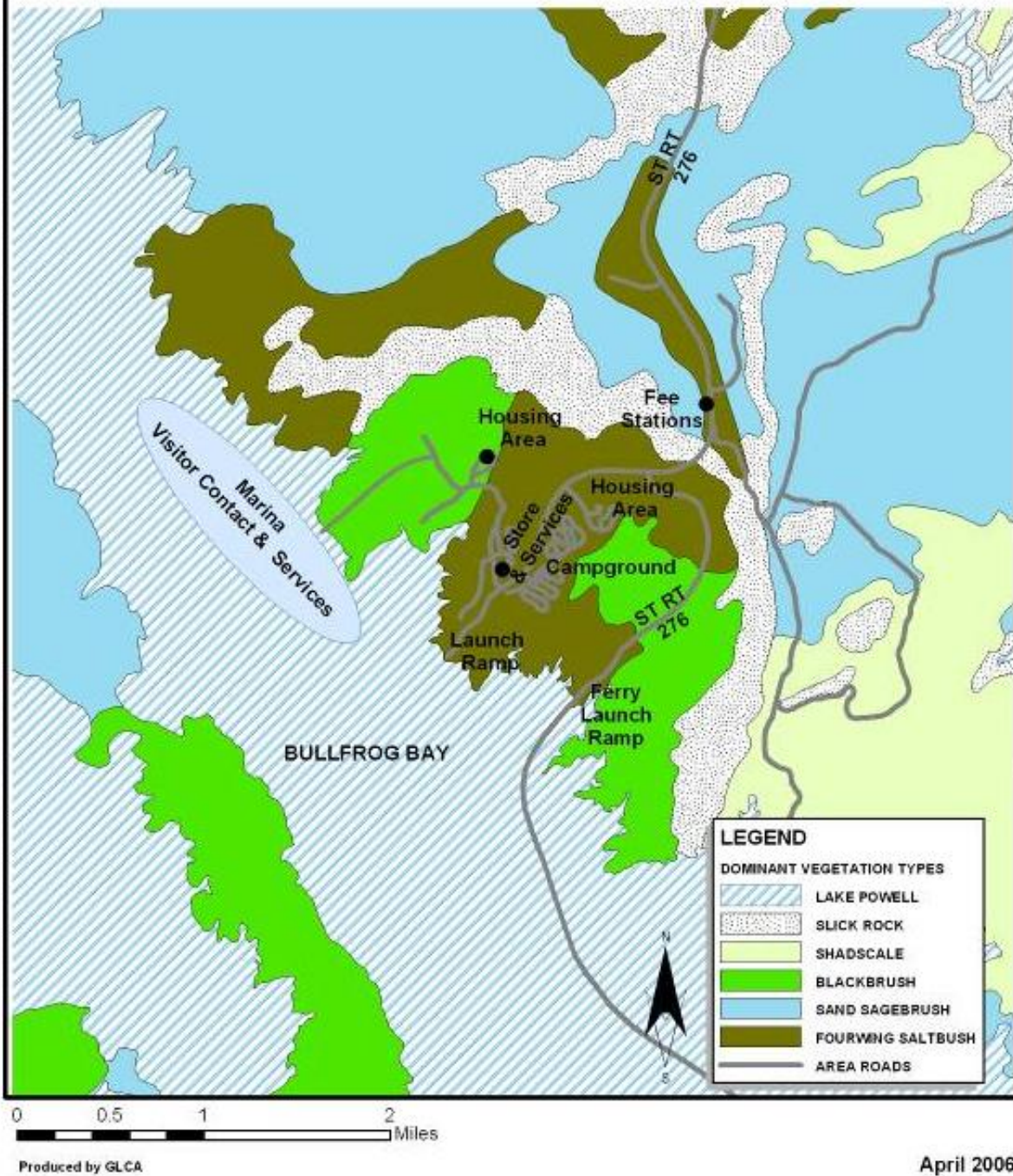
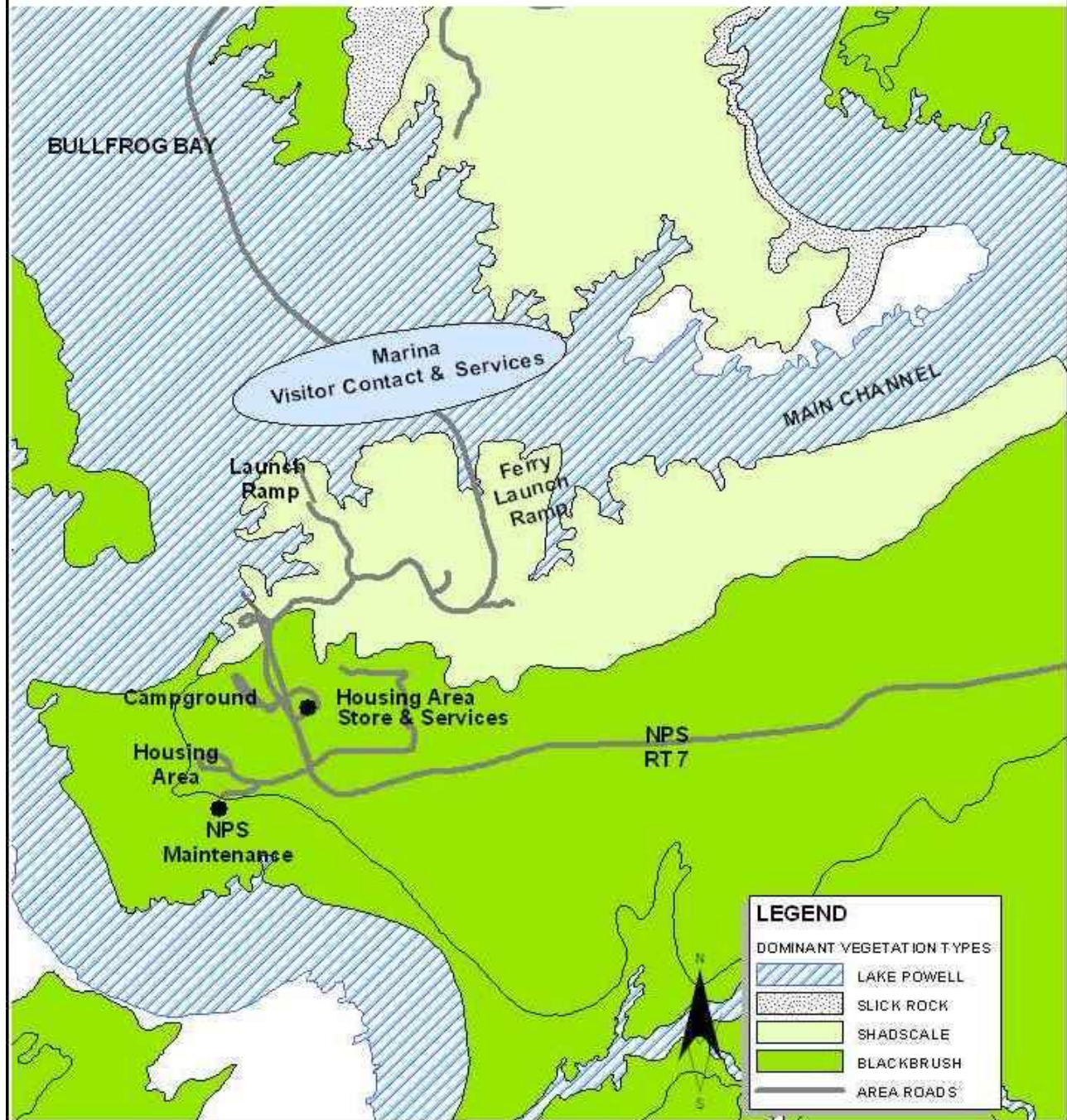


FIGURE 30. VEGETATION OF BULLFROG DEVELOPED AREA





## Halls Crossing Vegetation Analysis Area



0 0.5 1 2 Miles

Produced by GLCA

April 2006

FIGURE 31. VEGETATION OF HALLS CROSSING DEVELOPED AREA





### Hite Vegetation Analysis Area

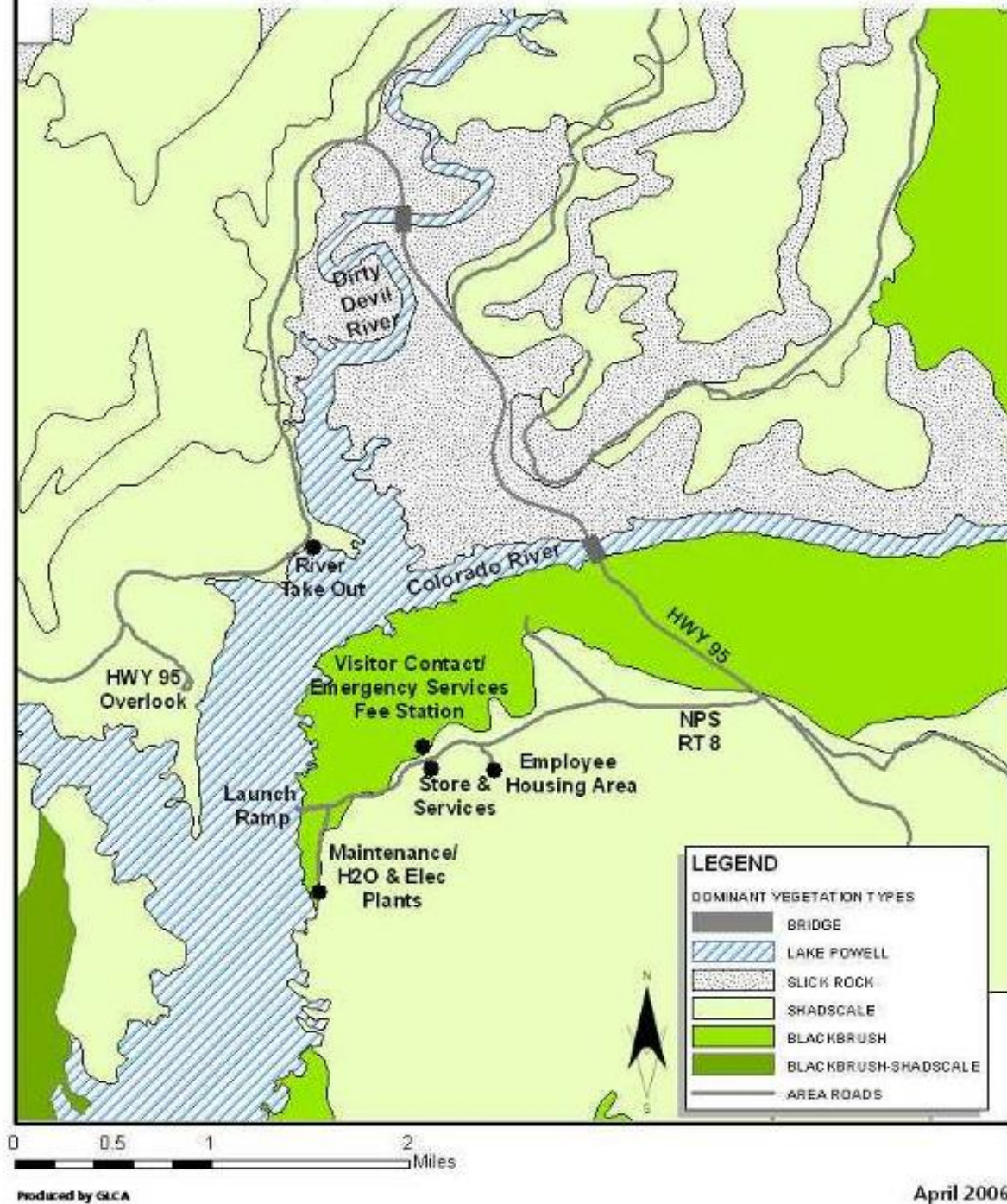


FIGURE 32. VEGETATION OF HITE DEVELOPED AREA

## WILDLIFE

Glen Canyon NRA supports a surprisingly diverse number of wildlife species, which is partly due to the presence of Lake Powell. Within the boundaries of the recreation area, 438 wildlife species have been identified including 311 species of birds, 64 species of mammals, 27 species of fish, 29 species of reptiles and 7 species of amphibians (NPS 2005j). Threatened and endangered species and state species of concern that may be affected by the proposed projects will be discussed in a later section.

### Mammals

The areas that surround the marinas provide limited habitat to the large, mobile mammals of the recreation area. These areas may be briefly used by species that are searching for food and water while they are moving through the area. These species include the desert bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*). Predators are prevalent in all of the vegetation communities where abundant prey is available and include the bobcat (*Felis rufus*), mountain lion (*Felix concolor*), gray fox (*Urocyon cinereoargenteus*), badger (*Spilogale gracilis*), kit fox (*Vulpes velox*) and coyote (*Canis latrans*) (NPS 2003a).

The riparian areas of the analysis area provide sufficient forage and shelter for a diverse population of rodents. A survey of shoreline salt cedar (*Tamarix chinensis*) shrublands noted the following rodents: deer mouse (*Peromyscus maniculatus*), Ord's kangaroo rat (*Dipodomys ordii*), little pocket mouse (*Perognathus longimembris*), long-tailed pocket mouse (*Chaetodipus formosus*), western harvest mouse (*Reithrodontomys megalotis*), canyon mouse (*Peromyscus crinitus*), brush mouse (*Peromyscus boylii*), piñon mouse (*Peromyscus truei*), northern grasshopper mouse (*Onychomys leucogaster*) and desert woodrat (*Neotoma lepida*) (NPS 2003a).

Desert shrublands and herbaceous communities are found inland from the riparian areas and provide a diversity of vegetation for habitat and forage. Mule deer and pronghorn browse on the shrubs, forbs and grasses present in these desert communities. Shrublands and herbaceous communities include a variety of small mammals such as Ord's kangaroo rat, deer mouse, piñon mouse, northern grasshopper mouse, white-tailed antelope squirrel (*Ammospermophilus leucurus*) and desert woodrat (Rosenstock 1996). Rabbits are common and include the desert cottontail (*Sylvilagus audubonii*) and the black-tailed jackrabbit (*Lepus californicus*). Several species of bats use these areas to forage at night including several *Myotis* sp., western pipistrelle (*Pipistrellus hesperus*), big brown bat (*Eptesicus fuscus*), Brazilian free-tailed bat (*Tadarida brasiliensis*) and pallid bat (*Antrozous pallidus*) (NPS 2004b).

### Birds

The majority of wildlife species found within Glen Canyon NRA are birds. Shorebirds, waterfowl and other water-associated bird species frequently use Lake Powell for resting, security and foraging purposes and constitute 101 of the 311 bird species found in Glen Canyon (Spence et al. 2006). Species commonly observed along the shoreline and on the lake include grebes, cormorants, herons, egrets, coots and ducks. These species concentrate at Lake Powell during the winter and during the peak migration months of late fall, winter and early spring, especially at bays such as Bullfrog Bay (Spence 1998, Spence & Bobowski 2003).

Birds also use the dense shrublands of the riparian zones during both migration and breeding for shelter, food and reproduction. During a survey of salt-cedar stands within the recreation area, the following birds were observed: the horned lark (*Eremophila alpestris*), common raven (*Corvus corax*), mourning dove (*Zenaidura macroura*), yellow warbler (*Dendroica petechia*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*) and the house finch (*Carpodacus mexicanus*). Songbird density, abundance and species richness increased toward the northern portion of Lake Powell where Bullfrog, Halls Crossing and Hite marinas are located (Spence et al. 2006).

Desert shrub and grassland communities host a variety of wintering, migrant and resident bird species including the house finch, northern mocking bird (*Mimus polyglottos*), lesser nighthawk (*Chordeiles acutipennis*), Say's phoebe (*Sayornis saya*), the white-crowned sparrow (*Zonotrichia leucophrys*), rock wren (*Salpinctes obsoletus*) and the black-throated sparrow (*Amphispiza bilineata*), which is the characteristic breeding bird of Glen Canyon NRA (LaRue and Spence 2001). Several permanent residents of these areas include the common raven, loggerhead shrike (*Lanius ludovicianus*) and the canyon wren (*Catherpes mexicanus*) (Spence et al. 2006). Most of these species can be seen in the vegetation found in and around the analysis area.

The diversity of small rodents, songbirds, fish and reptiles, combined with the proximity of nesting cliffs, explains the large diverse number of raptors in the analysis area. Species include the osprey (*Pandion haliaetus*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*) and the peregrine falcon (*Falco peregrinus*) (NPS 2003a).

## Reptiles and Amphibians

Systematic surveys of reptile and amphibian species have not been conducted since the creation of Glen Canyon Dam (Plattenberg et al. 2003). However, reptiles and amphibians have been observed and recorded in the ecological systems found within the analysis area. During a survey of salt-cedar (tamarisk) stands, seven species of reptiles and amphibians were documented including the orangehead spiny lizard (*Sceloporus magister cephaloflavus*), side-blotched lizard (*Uta stansburiana stejnegeri*), desert short-horned lizard (*Phrynosoma platyrhinos calidarium*), western whiptail (*Cnemidophorus tigris septentrionalis*), western rattlesnake (*Crotalus viridis*), longnose leopard lizard (*Gambelia wislizenii*) and the Glen Canyon chuckwalla (*Sauromalus obesus multiforaminatus*) (Platenberg et al. 2003). Additionally, Arizona glossy snake (*Arizona elegans*) was observed in the Bullfrog area in 2005. In the analysis area, desert shrublands and grasslands host a diverse population of small rodents and other reptile prey species. Within the analysis area, the following reptiles may be present including the yellowhead collared lizard (*Crotaphytus collaris auriceps*), longnose leopard lizard, side-blotched lizard, California king snake (*Lampropeltis getula californiae*), western whiptail, western rattlesnake and the Great Basin gopher snake (*Pituophis catenifer deserticola*) (NPS 2004b). The Great Basin spadefoot toad (*Spea hammondi intermountana*) has been found in temporary pools within washes that may occur in the analysis area (NPS 2004b). Other species that may be found in temporary pools and scattered springs include the leopard frog (*Rana pipiens*), red-spotted toad (*Bufo punctatus*), Woodhouse's toad (*Bufo woodhousii*) and the canyon treefrog (*Hyla arenicolor*) (NPS 2003a).

## Fish

Glen Canyon NRA hosts fish that are adapted to either lakes or flowing rivers. Before the creation of the dam, the free-flowing Colorado River hosted a number of species that have not been able to adapt to the recent lacustrine environment and the invasion of introduced species. Several native species have been extirpated, but other native species such as the Colorado pikeminnow (*Ptychocheilus lucius*),

flannelmouth sucker (*Catostomus latipinnis*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), bluehead sucker (*Catostomus discobolus*) and roundtail chub (*Gila robusta*) still occur in extremely reduced populations within the Colorado River, its tributaries and its interface with Lake Powell (NPS 2003a). Threatened and endangered species that may be affected by the proposed projects will be discussed in the threatened and endangered species section.

Since the creation of Lake Powell, a large sport fishing industry has taken advantage of the excellent quality of the lake's fishery. Introduced species that are adapted to the lacustrine environment are the backbone of this industry. Striped bass (*Morone saxatilis*) and smallmouth bass (*Micropterus dolomieu*) comprise the majority of the annual game fish harvest, but largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), crappie (*Promoxis nigromaculatus*) and bluegill (*Lepomis macrochirus*) are also present. Important nongame fish species include the common carp (*Cyprinus carpio*), red shiner (*Cyprinella lutrensis*) and threadfin shad (*Dorosoma petenense*) (NPS 2003a).

## **Invertebrates**

Along the shoreline of Lake Powell, aquatic invertebrate density and richness is low due to the fluctuating water levels of the reservoir. These fluctuations reduce or eliminate food and/or shelter available to aquatic invertebrates. Invertebrate species that do exist along the shoreline habitat include Asiatic clam (*Corbicula fluminea*) and crayfish, (*Orconectes virilis*), both of which are introduced (NPS 2003a).

Riparian communities and desert shrub communities provide ample food and shelter for a variety of invertebrates that range from microscopic protozoans and nematodes to mites, mollusks and insects. Insects include various grasshoppers, cicadas and seed-eating harvester ants.

## **THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN / DESIGNATED CRITICAL HABITAT**

### **Federally Listed Species Known to Occur in Analysis Area**

In accordance with threatened or endangered species consultation and coordination activities, the USFWS identified 19 listed and 1 candidate species for portions of Garfield, Kane and San Juan counties, Utah (USFWS 2002). Within the analysis area, suitable habitat for one federally listed endangered species (southwestern willow flycatcher) and one federally listed threatened species (bald eagle) occurs (table 15). Species or potentially suitable habitat likely to be present within this analysis area are identified and discussed further. Species listed by the USFWS for which suitable habitat is not present within the analysis area are eliminated from further discussion.

### **Presence of Designated Critical Habitat for Federally Listed Species**

Provisions of the Endangered Species Act require consideration of both species populations and designated critical habitat for species listed or proposed for listing. Critical habitat is defined as a specific geographic area that is essential for conservation of an endangered or threatened species and is designated as such in the recovery plan for that species, or in subsequent legislation.

Glen Canyon NRA supports designated critical habitat for four endangered fish species (NPS 2003a). These are the razorback sucker (*Xyrauchen texanus*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*) and the bonytail chub (*Gila elegans*). Designated critical habitat for these fish occurs in portions of the Colorado, Dirty Devil and San Juan rivers, including their 100-year floodplains up to the full pool elevation of Lake Powell (50 CFR Part 17, 1994) (table 16) and North Wash. Some of this habitat occurs in the Hite area. The bonytail is no longer present in the upper basin of the Colorado River and is believed to be the most endangered of these four native fish species. Prior to 1996, fewer than 10 bonytails were captured in Lake Powell. At the lowest projected lake level, critical habitat in areas that were previously submerged may increase in the Hite area as the water level lowers and the silt level rises. Within the analysis area, designated critical habitat exists for only two of these fish: the Colorado pikeminnow and the razorback sucker.

**TABLE 15. FEDERAL THREATENED, ENDANGERED, OR CANDIDATE SPECIES OF GARFIELD, KANE AND SAN JUAN COUNTIES, UTAH**

Species	County	Status	Habitat	Comments	Species Considered?	Reason for Exclusion / Inclusion
Aquarius paintbrush <i>Castilleja aquariensis</i>	Garfield	Candidate	Subalpine sagebrush-grass meadows and openings in spruce communities. Rocky/gravelly soils. 9,100–11,960 ft elevation.	Known only from Fremont, Escalante and East Fork Sevier drainages.	No	No known populations or habitat in analysis area.
Autumn buttercup <i>Ranunculus aestivalis</i>	Garfield	Endangered	Hummocks or raised dry areas associated with marshes/bogs along Sevier River.	Known only from west slope of Sevier River valley.	No	No known populations or habitat in analysis area.
Jones cycladenia <i>Cycladenia humilis</i> var. <i>jonesii</i>	Garfield, Kane	Threatened	Salt clay and gypsum soils at 4,400 to 6,000 feet elevation. Communities include mixed desert scrub, juniper, or wild buckwheat-Mormon tea.	This species occurs within the NRA west of the Waterpocket Fold.	No	No known populations or habitat in analysis area.
Maguire daisy <i>Erigeron maguirei</i>	Garfield	Threatened	Exposed mesas; steep, narrow canyons cut into Navajo sandstone; cool, shaded, mesic sites in crevices that collect soil and organic matter; less frequently along canyon bottom washes. 5,250–7,120 ft elevation.	Known from San Rafael, Muddy and Fremont drainages.	No	No known populations or habitat in analysis area.
Ute ladies'-tresses <i>Spiranthes diluvialis</i>	Garfield	Threatened	Moist to very wet meadows along streams or in abandoned stream meanders that still retain ample groundwater; also near 4,265–5,250 ft elevation.	In southeastern Utah, known only from upper reaches of the Escalante watershed.	No	No known populations or habitat in analysis area.
Navajo sedge <i>Carex specuicola</i>	Kane, San Juan	Threatened	Moist, sandy to silty soils of shady seep-spring pockets or alcoves with somewhat limited soil development. 5,700–6,000 ft elevation.	Endemic to the Navajo Nation, Coconino County, Arizona and San Juan County, Utah; Chinle and Lower San Juan watersheds.	No	No known populations or habitat in analysis area.
Siler pincushion cactus <i>Pediocactus sileri</i>	Kane	Threatened	Limited to southwestern Utah and northwestern Arizona, where it is ecologically restricted to a specific gypsum and salt-rich soil.	Known from the St. George area of Utah.	No	No known populations or habitat in analysis area.
Welsh's milkweed <sup>4</sup> <i>Asclepias welshii</i>	Kane	Threatened	Crest and lee slopes of Coral Pink Sand Dunes in sagebrush, juniper and ponderosa pine communities at 5,580–6,230 ft.	Known from area south and west of the analysis area (Paria and Chinle watersheds).	No	No known populations or habitat in analysis area.

**TABLE 15. FEDERAL THREATENED, ENDANGERED, OR CANDIDATE SPECIES OF GARFIELD, KANE AND SAN JUAN COUNTIES, UTAH**

Species	County	Status	Habitat	Comments	Species Considered?	Reason for Exclusion / Inclusion
Kodachrome bladderpod <i>Lesquerella tumulosa</i>	Kane	Endangered	Extremely dry, sparsely vegetated, white shale knolls with thin soils derived from the Windsor Member of the Carmel formation. Associated with scattered Utah juniper within a <i>Bouteloua</i> grassland.	Known from a single population scattered over an area about 2.5 miles wide in western Kane County, Utah (in the Paria watershed).	No	No known populations or habitat in analysis area.
Kanab ambersnail <sup>5</sup> <i>Oxyloma haydeni kanabensis</i>	Kane	Endangered	Springs and seeps at base of sandstone or limestone cliffs. Associated with perennially wet surface soil or shallow standing water.	Known only from Kanab drainage in western Kane County and from Grand Canyon National Park in Arizona.	No	No known populations or habitat in analysis area.
Coral pink sand dunes tiger beetle <i>Cincindela limbata albissima</i>	Kane	Candidate	Interdunal swales and dune slopes in Coral Pink Sand Dunes near Kanab.	Known only from a small area in Coral Pink Sand Dunes State Park and a BLM parcel approximately 3 miles northeast of that park.	No	No known populations or habitat in analysis area.
Bonytail chub <sup>4, 10</sup> <i>Gila elegans</i>	Garfield, San Juan	Endangered	In or near deep, swift water in main stream of mid-sized to large rivers; in flowing pools and backwaters, over mud or rocks; also in reservoirs.	Restricted to the Colorado River system, where only a few scattered remnant populations remain; critical habitat designated in Glen Canyon in upstream portions of tributaries to Lake Powell.	No	Species is extirpated from Lake Powell. Critical habitat designated in park is located a considerable distance upstream of the analysis area. No suitable habitat within analysis area.
Colorado pikeminnow <sup>4, 10</sup> <i>Ptychocheilus lucius</i>	Garfield, Kane, San Juan	Endangered	Medium to large rivers; young prefer small, quiet backwaters; adults use deep, turbid, strongly flowing water, eddies, runs, flooded bottoms, or backwaters; lowlands inundated during spring high flow appear to be important.	Critical habitat designated in Glen Canyon.	No	Species is extirpated from Lake Powell. Critical habitat in analysis area adjacent to Hite developed area only. There is no suitable habitat at or adjacent to proposed development sites.
Humpback chub <sup>4, 10</sup> <i>Gila cypha</i>	Garfield, San Juan	Endangered	Adults use variety of habitats in large rivers; young usually in eddies and runs.	Critical habitat designated in Glen Canyon below the confluence of the Colorado River with the Paria River, below Glen Canyon Dam.	No	Critical habitat designated in the NRA is located on the Colorado River below Glen Canyon Dam, almost 180 miles south of analysis area. There is no suitable habitat in the analysis area.

**TABLE 15. FEDERAL THREATENED, ENDANGERED, OR CANDIDATE SPECIES OF GARFIELD, KANE AND SAN JUAN COUNTIES, UTAH**

Species	County	Status	Habitat	Comments	Species Considered?	Reason for Exclusion / Inclusion
Razorback sucker <sup>4, 10</sup> <i>Xyrauchen texanus</i>	Garfield, Kane, San Juan	Endangered	Slow areas, backwaters and eddies of medium to large rivers.	Critical habitat designated in Glen Canyon in upstream portions of the tributaries to Lake Powell.	No	Species is extirpated from Lake Powell. Critical habitat in analysis area adjacent to Hite developed area only. There is no suitable habitat at or adjacent to proposed development sites.
Bald eagle <sup>3</sup> <i>Haliaeetus leucocephalus</i>	Garfield, Kane, San Juan	Threatened	Cliffs, forests and woodlands with snags and close to open water.	Winter resident only. Common on Lake Powell from November to March. Avoids areas with nearby human activity.	Yes	Migratory winter habitat occurs in or proximal to analysis area. Both adult and immature bald eagles have been seen foraging in Bullfrog Bay and have also been seen roosting on sandstone hilltops north and south of the Bullfrog developed area and north and south of the Hite developed area.
California condor <sup>7</sup> <i>Gymnogyps californianus</i>	Garfield, Kane, San Juan	Endangered	Mountainous country, low to moderate elevations, especially rocky and brushy areas with cliffs available for nest sites, foraging also in grasslands, oak savanna, mountain plateaus, ridges and canyons.	Extirpated from the wild by late 1980s; reintroductions began in 1996 and wild condors hatched in northern Arizona in 2003 and 2004. The population in Arizona is nonessential experimental.	No	Sightings in NRA since reintroduction in Arizona have been limited to the area south of U.S. 89 approx. 180 miles south of the analysis area.
Mexican spotted owl <sup>1, 4</sup> <i>Strix occidentalis lucida</i>	Garfield, Kane, San Juan	Threatened	In southern Utah - mesa tops, benches and warm slopes above canyons in fall and winter; relatively cool canyons in summer.	In Utah and Colorado, most nests are in caves or on cliff ledges in steep-walled canyons.	No	While designated critical habitat crosses the analysis area, the nearest suitable habitat is located approx. 25 miles across Lake Powell from Bullfrog and Halls Crossing and more than 70 miles from Hite.



**TABLE 15. FEDERAL THREATENED, ENDANGERED, OR CANDIDATE SPECIES OF GARFIELD, KANE AND SAN JUAN COUNTIES, UTAH**

Species	County	Status	Habitat	Comments	Species Considered?	Reason for Exclusion / Inclusion
Southwestern willow flycatcher <i>Empidonax traillii extimus</i>	Garfield, Kane, San Juan	Endangered	Thickets, scrubby and brushy areas, open second growth, swamps and open woodland.	No confirmed nesting or breeding in Glen Canyon. The proposed critical habitat for this species has been vacated due to court action; therefore, there is currently no proposed or assigned critical habitat for this species. The one sighting for this species occurred below the dam—not anywhere near the analysis area. However, due to extreme low water at Hite, there is now increasing suitable habitat for this species along the riverbanks at Hite.	Yes	While this species has not been seen in the analysis area, changes in the water level have favored the growth of suitable habitat in and adjacent to Hite.
Yellow-billed cuckoo <sup>11</sup> <i>Coccyzus americanus</i>	Garfield, Kane, San Juan	Candidate	Riparian forests with multiple vegetation layers.	Has been observed near Lees Ferry below Glen Canyon Dam and at Clay Hills Crossing on the upper San Juan River. This species has only been seen below the dam—far outside the project or analysis area. There is no suitable habitat for this species within or near the analysis area.	No	No suitable habitat within the analysis area.
Gunnison sage grouse <i>Centrocercus minimus</i>	San Juan	Candidate	Upland to mesic habitats, all with sagebrush, esp. <i>L. tridentata</i> (big sage brush).	Known only from extreme eastern Utah.	No	No known populations or habitat in analysis area.
Black-footed Ferret <sup>6</sup> <i>Mustela nigripes</i>	San Juan	Endangered	Open habitat of grasslands, steppe and shrub steppe; prairie dog towns.	Extirpated from the wild by 1987; reintroduced in an experimental area of northwestern Colorado and eastern Utah in 1999.	No	No known populations or habit in analysis area.
Utah prairie dog <i>Cynomys parvidens</i>	Garfield, Kane	Threatened	Grasslands, in level mountain valleys, in areas with deep well-drained soil and vegetation that prairie dogs can see over or through.	Occurs in western parts of Garfield and Kane counties.	No	No known populations or habitat in analysis area.

<sup>1</sup> Nests in this county of Utah.

<sup>3</sup> Wintering populations (only four known nesting pairs in Utah).

<sup>4</sup> Critical habitat designated in this county.

<sup>5</sup> Critical habitat proposed in this county.

<sup>6</sup> Historical range.

<sup>7</sup> Experimental nonessential population.

<sup>10</sup> Water depletions from any portion of the occupied drainage basin are considered to adversely affect or adversely modify the critical habitat of the endangered fish species and must be evaluated with regard to the criteria described in the pertinent fish recovery programs.

<sup>11</sup> "Western" yellow-billed cuckoo = distinct population segment in Utah.

**TABLE 16. LOCATION OF ENDANGERED FISH SPECIES CRITICAL HABITAT**

Species	Critical Habitat Location
Colorado pikeminnow	<p>Glen Canyon NRA Colorado pikeminnow habitat includes the 100-year floodplain of the Colorado River extending to Lake Powell's full pool elevation, Lake Powell's arm of the Dirty Devil River extending upstream of North Wash and the San Juan River's 100-year floodplain extending to Lake Powell's full pool elevation near Neskahi Canyon. Specific locations are as follows:</p> <p>Grand, San Juan, Wayne and Garfield counties, the Colorado River and its 100-year floodplain from the Colorado River bridge at exit 90, north off Interstate 70 in T6S, R93W, sec. 16 (6th Principal Meridian) to North Wash including the Dirty Devil arm of Lake Powell up to the full pool elevation in T33S, R14E, sec. 29 (Salt Lake Meridian). San Juan County, the San Juan River and its 100-year floodplain from SH 371 bridge in T29N, R13W, sec. 17 (New Mexico Meridian) to Neskahi Canyon in the San Juan arm of Lake Powell in T41S, R11E, sec. 26 (Salt Lake Meridian) up to the full pool elevation.</p>
Razorback sucker	<p>Glen Canyon NRA razorback sucker habitat includes the 100-year floodplain of the Colorado River extending to Lake Powell's full pool elevation, Lake Powell's arm of the Dirty Devil River extending upstream of North Wash and the San Juan River's 100-year floodplain extending to Lake Powell's full pool elevation near Neskahi Canyon. Specific locations are as follows:</p> <p>Grand, San Juan, Wayne and Garfield counties, the Colorado River and its 100-year floodplain from Westwater Canyon in T20S, R25E, sec. 12 (Salt Lake Meridian) to full pool elevation, upstream of North Wash and including the Dirty Devil arm of Lake Powell in T33S, R14E, sec. 29 (Salt Lake Meridian). San Juan County, the San Juan River and its 100-year floodplain from the Hogback diversion in T29N, R16W, sec. 9 (New Mexico Meridian) to the full pool elevation at the mouth of Neskahi Canyon on the San Juan arm of Lake Powell in T41S, R11E, sec. 26 (Salt Lake Meridian).</p>
Humpback chub	<p>Glen Canyon NRA humpback chub habitat includes the 100-year floodplain of the Colorado River along the rapids in Cataract Canyon upstream of Gypsum Canyon. Specific locations are as follows:</p> <p>Garfield and San Juan counties, the Colorado River from Brown Betty Rapid in T30S, R18E, sec. 34 (Salt Lake Meridian) to Imperial Canyon in T31S, R17E, sec. 28 (Salt Lake Meridian).</p>
Bonytail	<p>Glen Canyon NRA bonytail habitat includes the 100-year floodplain of the Colorado River along the rapids in Cataract Canyon upstream of Gypsum Canyon. Specific locations are as follows:</p> <p>Garfield and San Juan counties, the Colorado River from Brown Betty Rapid in T30S, R18E, sec. 34 (Salt Lake Meridian) to Imperial Canyon in T31S, R17E, sec. 28 (Salt Lake Meridian).</p>

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Source: *Federal Register* 50 CFR Part 17, Monday, March 21, 1994

## Species-Specific Information

Information relevant to the assessment of any potential effect on species considered in detail in this analysis is as follows:

**Southwestern Willow Flycatcher** (*Empidonax traillii extimus*) is associated with low elevation dense willow, cottonwood and salt-cedar communities along streams and rivers. This species was observed and recorded about 30 miles from Lake Powell, up the Escalante River and along the San Juan River near Clay Hills Crossing, but there is no confirmed nesting or breeding habitat present in the recreation area (NPS 2003a). In Arizona, more than 110 pairs of southwestern willow flycatchers occupy 160 territories, including breeding territory along the Colorado River. Smaller populations are known to exist in Utah. Adjacent to the recreation area, breeding habitat typically is present along the larger rivers and lake shorelines at low elevations in areas of dense willow, cottonwood and salt-cedar (tamarisk), or other woodlands along streams and rivers. Loss of native riparian habitat, combined with predation and brown-headed cowbird nest parasitism, has reduced the species' populations. Due to lowering water levels, the mouth of the Colorado River has moved downstream past the Hite area. This has resulted in increased siltation that has narrowed and moved the active water channel to the western bank and resulted in rapid growth of riparian vegetation (primarily salt-cedar and willow) that may be suitable habitat for this species. Surveys have not been completed for this species in the Hite area and there is no suitable habitat for this species in or near Halls Crossing or Bullfrog.

**Bald Eagle** (*Haliaeetus leucocephalus*) habitat is present along the larger rivers in southern Utah. In the recreation area, this includes the San Juan River and the main lake channel upstream from Bullfrog. No nest sites have been observed or recorded along the Lake Powell shorelines.

Bald eagles are present between the months of September to March, in small numbers throughout the Lake Powell area. Observations recorded principally during the November-to-February time periods for the years 1991 through 2002 are summarized in appendix C. Areas of Lake Powell and Glen Canyon NRA that consistently provide suitable wintering habitat include Antelope Island, Bullfrog, Cataract Canyon, Good Hope Bay, Halls Creek, Hite, Wahweap and Warm Creek; however, there are no known consistently used winter roosts within the recreation area. Bald eagles have been observed feeding at Antelope Island and other portions of Lake Powell (Spence et al. 2002, NPS 2002).

Prior to 1995, 131 bald eagle sightings had been recorded, but recordkeeping was inconsistent (Spence 2002). Annual surveys conducted by the National Park Service report that 18 to 20 bald eagles typically winter in the recreation area and as many as 70 seasonal observations of over-wintering bald eagles have been recorded in recent years. The results recorded during 10 seasons of observations within the recreation area are presented in appendix C (Spence 2002). Potentially favorable bald eagle roosting sites along the rivers and shorelines of reservoirs like Lake Powell are monitored (Spence et al. 2002, NPS 2003a).

## Utah State Wildlife Species of Concern

The following species are included on the State of Utah, Department of Natural Resources Division of Wildlife Resources; Utah Sensitive Species List dated May 12, 2006. This list has been prepared pursuant to Utah Division of Wildlife Resources Administrative Rule R657-48. By rule, wildlife species that are federally listed, candidates for federal listing, or for which a conservation agreement is in place automatically qualify for the Utah Sensitive Species List. The additional species on the Utah Sensitive Species List, “wildlife species of concern,” are those species for which there is credible scientific evidence to substantiate a threat to continued population viability. It is anticipated that wildlife species of concern designations will identify species for which conservation actions are needed and that timely and appropriate conservation actions implemented on their behalf will preclude the need to list these species under the provisions of the federal Endangered Species Act (Utah Division of Wildlife Resources 2006a).

**Burrowing Owl** (*Athene cunicularia*) breeds in southwestern Canada, the western United States and Florida, northern Mexico and parts of the West Indies. It winters from the southwestern United States to Honduras, northern populations being migratory. In Utah, it is uncommon during summer in native habitat throughout the state. Burrowing owl habitats comprise open grassland and prairies, but it also uses other open areas such as golf courses, cemeteries and airports. Its diet consists of terrestrial invertebrates and also integrates a variety of small vertebrates including small mammals, birds, frogs, toads, lizards and snakes (Utah Division of Wildlife Resources 2006b).

Burrowing owl nests are found in mammal burrows, usually that of a prairie dog, ground squirrel, badger, or armadillo. If a mammal burrow is not available, the owls will sometimes excavate their own nest burrow. Three to 11 (usually 5 to 9) eggs are incubated by the female, who is fed by the male for 27 to 30 days. The young are tended by both parents and fledge after about 40 to 45 days (Utah Division of Wildlife Resources 2006b).

Burrowing owls are known to nest adjacent to the airstrip that serves Bullfrog. The airstrip is not included in the analysis area for this DCP/EA.

**Common Chuckwalla** (*Sauromalus ater*) is a fairly large lizard, sometimes reaching over 8 inches in length, not including the tail. Chuckwallas are predominantly found near cliffs, boulders, or rocky slopes where they use rocks as basking sites and rock crevices for shelter. Chuckwallas are primarily herbivorous, although insects are also consumed. Female chuckwallas lay one clutch of 5 to 15 eggs during the summer months. In Utah, the species occurs only in the southern portion of the state. It is included on the Utah Sensitive Species List because of habitat modification and other threats (Utah Division of Wildlife Resources 2006b).

**Glossy Snake** (*Arizona elegans*) can be found in a variety of habitats throughout its range, but it seems to prefer areas of barren open ground in deserts, sagebrush and brushy grasslands, usually on sand, loam, or rocks. This snake is especially wary, burrowing in the ground during the day and becoming active at night. Females lay a clutch of 3 to 23 eggs during the summer. The glossy snake typically eats lizards, other snakes and small mammals. The glossy snake is often referred to as the “faded snake,” due to the faded appearance of its coloration, which can be light brown to light gray with dull blotches of tan or gray (Utah Division of Wildlife Resources 2006b).

Two subspecies of the glossy snake can be found in Utah. The desert glossy snake (*Arizona elegans eburnata*) occurs in extreme southwestern Utah, while the Painted Desert glossy snake (*Arizona elegans philipi*) occurs in southeastern Utah (Utah Division of Wildlife Resources 2006b).

**Big Free-tailed Bat** (*Nyctinomops macrotis*) occurs in the western United States and in much of Latin America. The species is rare in Utah, occurring primarily in the southern half of the state and occasionally in northern Utah (Utah Division of Wildlife Resources 2006a).

The big free-tailed bat prefers rocky and woodland habitats where roosting occurs in caves, mines, old buildings and rock crevices. The species is typically active year-round, spending summers in temperate North America and migrating to warmer areas in North America and South America for the winter. Big free-tailed bats eat insects, primarily moths. Females may give birth to a single offspring each year during late spring or early summer (Utah Division of Wildlife Resources 2006b).

**Fringed Myotis** (*Myotis thysanodes*) is a small bat that occurs in most of the western United States, as well as in much of Mexico and parts of southwestern Canada. The species is widely distributed throughout Utah, but is not common in the state. The fringed myotis inhabits caves, mines and buildings, most often in desert and woodland areas. The species commonly occurs in colonies of several hundred individuals (Utah Division of Wildlife Resources 2006b).

Females generally give birth to a single offspring during the summer. Beetles, which are plucked from vegetation or the ground, are the major prey item of the fringed myotis. Because the fringed myotis flies so close to rocks and thick vegetation, its wings are particularly strong and puncture resistant. The species is nocturnal and individuals hibernate during the cold winter months. The fringed myotis is brown in color, with a characteristic fringe of stiff hairs along the edge of the tail membrane (Utah Division of Wildlife Resources 2006).

**Townsend's Big-eared Bat** (*Corynorhinus townsendii*) occurs in western North America, from southwestern Canada to Mexico. Isolated populations of the species also occur in areas of the central and eastern United States. The species occurs statewide in Utah at elevations below 9,000 feet; however, Townsend's big-eared bat populations in Utah are thought to be declining (Utah Division of Wildlife Resources 2006).

Townsend's big-eared bat can occur in many habitat types, but is often found near forested areas. Caves, mines and buildings are used for day roosting and winter hibernation. Consequently, human disturbances of caves and the closures of abandoned mines may constitute threats to the species (Utah Division of Wildlife Resources 2006).

Females congregate in nursery colonies and typically give birth to one offspring each year. Townsend's big-eared bats eat flying insects, particularly moths and individuals are often seen foraging near trees. The species is nocturnal and typically does not leave the roost until well after sunset (Utah Division of Wildlife Resources 2006).

## VISUAL RESOURCES

Visual resources include the natural and human-made physical features that give a particular landscape its character and quality. Landscapes are not static, but are always undergoing change as a result of natural environmental processes or external modification. Underlying the character and condition of a landscape are the geological conditions and processes under which the landscape has evolved. These factors, in combination with climate, influence the type and condition of soils and vegetative cover, the type and abundance of wildlife and the way in which people make use of the land. The resulting landscape character, together with our individual experience and expectations, determine the meaning we attach to the landscape.

The Bullfrog, Halls Crossing and Hite developed areas are all located along the lakeshore and are characterized by stunning natural landscapes interspersed with human-made structures. The developed areas are comprised of marinas, campgrounds, housing areas, floating marina facilities and launch ramps, which contrast with the natural environment. Farley Canyon is located on an area of the lakeshore area that is currently used for primitive camping that is accessible from a graded road.

At Bullfrog, the lodge is the largest human-made feature. It was constructed in the southwestern architectural style, which harmonizes well with the desert landscape. This architectural theme is carried out in other land-based facilities including the ranger station / emergency facilities / visitor contact station. Recently constructed facilities (restrooms and showers) in the day-use area are architecturally similar. The government employee housing area's numerous structures also reflect southwestern design. The older structures are of a more traditional design and appearance. Water-based development, floating stores, wet slips, buoy fields, gas docks and boat rental facilities, however, have a contemporary nautical appearance.

Land-based facilities at Halls Crossing, primarily government facilities including maintenance facilities and NPS and concessioner employee housing, are not as visible, with the possible exception of the dry boat storage area. Much of Halls Crossing construction is older and of a more traditional style—not designed to blend with the natural landscape. As with Bullfrog, the water-based facilities (floating marina store, wet slips, buoy field and ranger offices) have a contemporary nautical appearance.

Both Halls Crossing and Bullfrog exhibit the results of the recent construction of roads, launch ramps (or extensions) and parking areas. Such construction has disturbed vegetation; however, much of the disturbance would be below the high water line if the lake was at full capacity.

Land-based facilities at Hite are on the south side of the access road in a concentrated area and are generally older than at Bullfrog or Halls Crossing. The newer ranger station / visitor contact station is designed to harmonize with the surrounding landscape. No marina facilities are currently located at Hite.

Although Bullfrog, Halls Crossing and Hite developed areas contain contrasting elements with the lake and desert landscape, the visual intrusions are mitigated by the fact that Glen Canyon is a national recreation area and visitors expect development and service facilities that will support their recreational activities. Therefore, facilities that contrast with the natural scenic landscape and create a visual intrusion are expected and accepted in this environment.

## **SOUNDSCAPES**

Preservation of natural soundscapes is an important mission of the National Park Service. Natural soundscapes are defined in NPS *Management Policies 2001* as a combination of all the natural sounds that occur in a park, together with the physical capacity for transmitting natural sounds. Director's Order – 47: *Soundscape Preservation and Noise Management* (NPS 2000a) states that the natural ambient sound level of a park is the basis for determining the affected environment in Environmental Impact Statements and other documents prepared for NEPA compliance.

Natural sounds occur within and beyond the range of sound that humans can perceive and can be transmitted through air, water, or solid materials. Natural soundscapes would include all naturally occurring sounds such as waves on the shoreline, birds calling, wind blowing, or the sound of thunder. It would also include “natural quiet” that occurs in the absence of natural or human-generated sound. The

opportunity to experience natural sounds is an enjoyable part of the experience for some visitors to Glen Canyon NRA.

Human-caused sounds at Glen Canyon NRA include all types of watercraft, automobiles, aircraft and electronic devices such as radios and horns. Engines are the primary source of human-caused sound at Glen Canyon NRA. Human sounds are not unexpected or necessarily inappropriate at the developed areas, but are part of the overall soundscape in an area where water activities, picnicking, camping, sightseeing and other recreational uses are part of the activity of the recreation area. Evaluation of the appropriateness of human sounds is evaluated by considering visitor expectation, management guidelines, resource sensitivity and recreation area purpose.

Noise is generally defined as an unwanted or intrusive sound. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. Sound is measured in a logarithmic unit called a decibel (dB). Because the human ear is more sensitive to middle and high-frequency sounds than to low-frequency sounds, sound levels are weighted to reflect human perceptions more closely. These “A-weighted” sounds are identified by the symbol “dBA.”

For the average human, a 10-dBA increase in the measured sound level is subjectively perceived as being twice as loud and a 10-dBA decrease is perceived as half as loud. The decibel change at which the average human would indicate that the sound is just perceptibly louder or perceptibly quieter is 3-dBA. There is generally a 6-dBA reduction in sound level for each doubling of distance from a sound source due to spherical spreading loss (e.g., if the sound level at 25 feet from a boat was 86 dBA, the sound level at 50 feet would be expected to be 80 dBA, at 100 feet 74 dBA, etc.). Noise levels from typical construction efforts may reach as high as 89 dBA 50 feet from the source, which would drop off 6 dBA per doubling of distance. So at 100 feet from the sound source the noise level would be 83 dBA and at 200 feet it would be 77 dBA; this would continue until the sound became indistinguishable from the natural, or ambient noise, whichever is greater (NPS 2003b).

The GMP (NPS 1979) divided Glen Canyon NRA into four management zones. The Bullfrog, Halls Crossing and Hite developed areas are located in the development zone. Noise from vessels is consistent with the purpose and management direction of the development zone where these areas are located.

Watercraft-generated noise levels vary from vessel to vessel. Noise limits established by the National Park Service require vessels to operate at less than 82 dBA at 82 feet (25 meters) from the vessel (36 CFR 3.7).

## **ARCHEOLOGICAL RESOURCES**

Humans have occupied the Glen Canyon region for at least 11,000 years, spanning four cultural periods, or stages. These include the Paleo-Indian period (11,000 before present [BP] – 9,500 BP), which was dominated by a dispersed mobile hunter-gatherer population that left little evidence in the Glen Canyon area and the Archaic period (9,500 BP – 1,800 BP), when hunting was supplemented by the collection of a broad spectrum of wild plant and animal foods. As populations adopted the cultivation of squash and maize and settled into somewhat sedentary village life, the Formative period (1,800 BP – 700 BP) began. Regionally, early Formative period residents, also known as Ancestral Puebloans, exploited wild animal and plant food in addition to practicing agriculture. Approximately 700 years ago, the Ancestral Puebloans and their neighbors to the north, the Fremont, abandoned southern Utah and, it is presumed, joined the general Puebloan population living in larger villages in New Mexico and Arizona. This exodus



marks the beginning of the Protohistoric period (700 BP – 250 BP) in which the Paiute, Ute and Navajo peoples occupied the area.

The majority of the prehistoric sites recorded within Glen Canyon date to the Formative period, although evidence for Paleo-Indian and Archaic period occupations have been observed in limited sections of the recreation area. A small number of protohistoric remains are also present, characterized mostly by ephemeral open sherd and lithic scatters, brush shelters and diagnostic rock art panels. Historic cultural resources are also present in relatively small numbers. Site densities of all site types tend to be relatively low.

Approximately 2% of Glen Canyon NRA has been intensively surveyed or tested for cultural resources. As one would expect, the developed areas have received the most attention. Studies have been completed at Hite (Kay 1974, Goetze 1995, Zeir et al. 2002), Halls Crossing (Fowler et al. 1959b, Kay 1974, Tipps 1979, Schroedl 1981, Hurst 1984, Goetze 1995, Neal and Wenker 1997, Tipps and Warburton 2000) and Bullfrog (Fowler et al. 1959a; Kay 1974; Geib 1989; Lefree 1993; Goetze 1995; Neal and Wenker 1997; Huber and Bradley 1998, 1999).

The aggregate of the acreages intensively surveyed indicates that each of the developed areas of concern as well as Farley Canyon have had extensive intensive surveys completed, some relatively recently. Two surveys are of particular use in the current planning process: the 1997 surveys of the Halls Crossing and Bullfrog areas (Neal and Wenker 1997) and the 2001 survey of Hite (Zeir et al. 2002). These surveys included the entire area within the boundaries of the current development planning process.

The Glen Canyon project archeologists (noted in textual references as Fowler et al. 1959a and 1959b) surveyed up to the 3,700-foot flood level, where accessible. They did not provide specifics as to which areas were not surveyed and which were. Almost all the subsequent surveys were conducted to the water level, which varied from year to year.

As previously discussed, the Bullfrog, Halls Crossing and Hite areas have undergone numerous archeological surveys over the years. The most extensive and recent survey at Hite was conducted in support of the development planning process between March 28 and April 1, 2001. The survey encompassed 1,480 acres and was bound on the north and west sides by Lake Powell, on the south by the foot of Brown's Rim and on the east and northeast by SH 95. Eleven prehistoric sites and 24 isolated finds were recorded (including three previously recorded by Kay in 1974). No historic sites were noted. Sites consisted of lithic scatters (4), lithic scatter/procurement (5), sandstone slab feature / possible pit (1) and a rock shelter with lithic scatter (1). All sites occurred north of the Hite Marina access road. Seven of the sites are considered eligible for the NRHP (42SA3954–3956, 42SA24694–24697). Isolated finds included individual or small clusters of lithic artifacts in a variety of physiographic settings (Zeir et al. 2002).

A recent survey (1997), initiated because of anticipated development projects at Bullfrog and Halls Crossing and Farley Canyon, identified 25 sites at Halls Crossing and 4 at Farley Canyon. Seven had been previously recorded (three of these were completely rerecorded and three were updated). Of the sites recorded at Halls Crossing, nine (all lithic scatters) were considered NRHP-eligible (42SA3708, 42SA3941, 42SA3952–3953 and 42SA23087–23090). Seventy-two isolated finds were also noted (Neal and Wenker 1997). The same survey located 14 sites at Bullfrog. Four had been previously recorded. Of the sites recorded at Bullfrog, eight (all lithic scatters) are considered NRHP-eligible (42KA2382, 42KA4294, 42KA3467, 42KA4316–4317, 42KA4319, 42KA4321 and 42KA4323). Seventeen isolated finds were also located (Neal and Wenker 1997).

It is expected that because of the level of previous survey and the flexibility of site development that avoidance of known sites would be possible. Surveys would be completed only if undisturbed (and unsurveyed) areas are expected to be affected by development.

## ETHNOGRAPHIC RESOURCES

Many Glen Canyon NRA resources are considered sacred by American Indians. These include, but are not limited to, the Colorado and San Juan rivers, their side canyons and the landscapes in which they occur. Five contemporary American Indian tribes are associated with Glen Canyon: the Hopi, Kaibab Paiute, Navajo, San Juan Southern Paiute and Ute Mountain Ute. Other groups that have an ethnographic interest in the NRA include the Kanosh and Koosharem bands of the Paiute Indian Tribe of Utah, the Havasupai Tribe and Hualapai Tribe.

Surveys for and evaluations of, archeological (prehistoric and/or historic) resources and traditional cultural properties were conducted in August and October 1995 (Goetze 1995). The project was initiated by the anticipated construction of fee stations and associated housing at 13 different locations throughout Glen Canyon. The entire Halls Crossing developed area was declared a traditional cultural property based on consultation and ethnographic evidence (Goetze 1995).

## VISITOR USE AND EXPERIENCE

Glen Canyon NRA is one of the premier water-based recreation areas in the country. Lake Powell, its 96 major side canyons and related natural, cultural and geologic resources are the primary recreation features of Glen Canyon NRA.

A variety of recreational opportunities exist on and around Lake Powell. Power boating, use of houseboats and personal watercraft, waterskiing, fishing, boat tours and kayaking are among the many water sports visitors enjoy. Opportunities also exist for hiking in the surrounding canyon areas, many of which are accessible only by water for most visitors. Visitors can also see archeologically and culturally important sites throughout the NRA. Visitors to Lake Powell are primarily interested in water-based activities. The 2005 visitor survey found that 94% of survey respondents participated in motor boating, 57% in fishing and 51% participated in water sports. Popular land-based activities include hiking (65%) and camping (42%) (NPS 2005g).

Glen Canyon NRA experiences visitation year-round. The peak visitor season is from May 15 to Labor Day. During the “shoulder” seasons, from March 1 to May 15 and from Labor Day through Thanksgiving, the recreation area sees substantial visitation, but not at the levels experienced during the peak season. Total visitation at Glen Canyon NRA in 2005 was 1,928,274. Visitation for the uplake areas within Glen Canyon NRA for the 10-year period from 1995 to 2005 is presented in table 18.

**TABLE 17. UPLAKE VISITATION 1995–2005**

Year	Bullfrog	Halls Crossing	Hite	Total	% Change from Previous Year
1995	263,966	65,370	133,117	462,453	

<b>1996</b>	239,275	59,648	133,302	432,225	-6.54%
<b>1997</b>	248,041	64,708	127,540	440,289	1.87%
<b>1998</b>	274,120	56,696	132,084	462,900	5.14%
<b>1999</b>	256,875	86,503	154,107	497,485	7.47%
<b>2000</b>	275,919	86,741	147,694	510,354	2.59%
<b>2001</b>	272,195	75,198	143,108	490,501	-3.89%
<b>2002</b>	257,708	62,163	110,065	429,936	-12.35%
<b>2003</b>	214,406	72,579	62,442	349,427	-18.73%
<b>2004</b>	197,928	49,447	50,772	298,147	-14.68%
<b>2005</b>	216,663	58,845	59,405	334,913	12.33%

Source: National Park Service Public Use Statistics Office: <http://www2.nature.nps.gov/mpur/Reports/viewreport.cfm>

After 1996 and prior to the onset of drought in 2001, uplake visitation showed a trend of steady increases.

Visitors can enjoy camping opportunities ranging from remote and undeveloped campsites to fully developed campgrounds (hardened campsites with picnic tables, fire grates and available restroom facilities) managed by Glen Canyon NRA.

## **SOCIOECONOMIC ENVIRONMENT**

The existing and proposed development associated with the alternatives is located in Kane and Garfield counties, Utah (location of Bullfrog) and San Juan County, Utah (location of Halls Crossing and Hite). However, the affected environment for socioeconomic includes a larger analysis area that may experience direct and indirect socioeconomic change from the proposed alternatives. Socioeconomic effects include those related to visitors traveling to and from the region, those recreating in the area and the activities of the National Park Service, its concessioner and NPS and concessioner employees.

In addition to portions of Kane, Garfield and San Juan counties, the socioeconomic analysis area boundary comprises parts of Wayne County in Utah because of effects to employment, income and local government revenues, as well as potential indirect effects if prevailing trends in visitation change.

The Kane and San Juan counties school districts are in the analysis area for potential changes to tax revenue and enrollment at the Lake Powell School, which is in Kane County, but operates under an agreement to serve students from both Bullfrog in Kane County and Halls Crossing in San Juan County. Utah state government and the National Park Service at the federal government level are areas for analysis of potential tax and commercial services revenue effects.

## Affected Counties

The potentially affected counties each cover thousands of square miles and possess extensive open space; they are some of the most sparsely populated parts of Utah and the United States. Average population density ranges from less than two persons per square mile in San Juan and Kane counties, to one person per square mile or less in Wayne and Garfield counties. Utah's average population density is nine persons per square mile (U.S. Census Bureau 2004a).

Population rose by 5.3% overall in Utah from 2000 to 2003, but fell in the potentially affected counties over the same period. Estimated population in 2003 was 6,039 for Kane County, down 0.1% from 2000 and 13,901 for San Juan County, down 3.6%. Garfield and Wayne counties experienced population declines of 4.1% and 2.2% (table 19).

**TABLE 18. DEMOGRAPHIC PROFILE OF THE STATE OF UTAH AND POTENTIALLY AFFECTED COUNTIES**

Counties					
	Utah	Garfield	Kane	San Juan	Wayne
<b>Population 2003 (July 1)</b>	2,351,467	4,542	6,039	13,901	2,454
<b>Population 2000 (April 1)</b>	2,233,169	4,735	6,046	14,413	2,509
<b>Population 1990 (April 1)</b>	1,722,850	3,980	5,169	12,621	2,177
<b>Percent change 2000 to 2003</b>	5.3%	-4.1%	-0.1%	-3.6%	-2.2%
<b>Percent change 1990 to 2000</b>	29.6%	19.0%	17.0%	14.2%	15.3%
<b>Race and Ethnicity 2000</b>					
<b>White</b>	89.2%	95.0%	96.0%	40.8%	97.3%
<b>American Indian</b>	1.3%	1.8%	1.6%	55.7%	0.4%
<b>Other races</b>	9.5%	3.2%	2.4%	3.5%	2.3%
<b>Hispanic/Latino (any race)</b>	9.0%	2.9%	2.3%	3.7%	2.0%

Source: U.S. Census Bureau 2004a

Roughly 56% of the population of San Juan County is American Indian (table 18). This group is mostly Navajo and a smaller number of Ute. This reflects the fact that about 23% of the land area of San Juan County is in either the Navajo Nation or Ute Indian reservations.

American Indians are less than 2% of the population in Garfield, Kane and Wayne counties and are 1.3% of the state population. Other minority races make up 3.5% or less of the population in the four counties, compared to a 9.5% share in the state. People of Hispanic or Latino heritage are 3.7% or less of the county populations, compared to 9% of the state.

Considerable open space in the analysis area is devoted to agriculture. Farm jobs were almost 15% of the estimated 2002 total employment of 1,640 in Wayne County, 11.5% of 3,008 total jobs in Garfield County, 5.3% of 5,520 jobs in San Juan County and 4.3% of 3,826 jobs in Kane County (table 20). Farm jobs averaged only 1.4% of total employment in Utah in 2002.

**TABLE 19. ECONOMIC PROFILE OF THE STATE OF UTAH AND POTENTIALLY AFFECTED COUNTIES**

	Counties				
	Utah	Garfield	Kane	San Juan	Wayne
Total jobs in region 2002(1)	1,395,229	3,008	3,826	5,520	1,640
Agricultural	1.4%	11.5%	4.3%	5.3%	14.8%
Trade, transportation and utilities (estimated)	18.4%	10.0%	13.2%	12.3%	12.0%
Leisure and hospitality (estimated)	8.5%	26.3%	22.5%	10.6%	11.0%
State and federal government	7.1%	8.2%	4.5%	9.8%	7.7%
Per capita income 2002(2)	\$24,649	\$19,688	\$23,513	\$14,297	\$19,788
Median household income 1999(3)	\$45,726	\$35,180	\$34,247	\$28,137	\$32,000
Persons below poverty line 1999(4)	9.4%	8.1%	7.9%	31.4%	15.4%
Civilian labor force 2003(5)	1,184,400	2,806	2,857	4,644	1,504
As percent of population	50.4%	45.4%	47.3%	33.4%	61.3%
Unemployment rate 2003(6)	5.6%	10.8%	4.6%	10.2%	7.2%
Gross taxable sales per capita 2003(7)	\$13,846	\$14,478	\$15,926	\$6,132	\$10,844
Value of all building permits 2003 (000s)(8)	\$4,560,852.6	\$10,302.8	\$13,088.3	\$8,180.3	\$4,440.8

Note: Some employment sectors are estimated from state data because federal data are undisclosed for certain sectors in small counties.

Sources: U.S. Bureau of Economic Analysis 2004 (1,2); U.S. Census Bureau 2004a (3,4); Utah Department of Workforce Services 2004 (1,5,6,7,8)

However, even in Wayne County, the most agricultural of the four counties, the economic base of the analysis area has shifted away from dependence on agriculture and mining to heavy reliance on tourism and recreation. This distinguishes the area from Utah as a whole, which is still one of the most industrially diversified states in the country. The importance of tourism and recreation in the analysis area is reflected in the importance of jobs in the leisure and hospitality sectors, which comprises from 11% to 26% of county employment in the analysis area, compared to less than 9% in Utah as a whole (table 19).

After years of economic stagnation, tourism and social services jobs have stimulated recent growth in population, home construction and wages in Wayne County. Garfield County depends more on tourism and recreation for employment than any other county in Utah. Bryce Canyon National Park and Lake Powell are the chief attractions. Kane County also relies heavily on tourism. Lake Powell and Grand Staircase-Escalante National Monument are major attractions.

Kane County has the highest job growth rate in the state since 1997, in part because of growth in tourism and recreation. Similarly, in Garfield County, tourism has resulted in new economic development, but the county also experiences high unemployment rates because of tourism seasonality. San Juan County's economic base derives its impetus from government, trade and occasional mining projects in addition to tourism and recreation (Utah Department of Workforce Services 2004).

In 2002, estimated per capita income in San Juan County was \$14,297, or 42% lower than the Utah average of \$24,649. Other indicators of recent economic difficulty in San Juan County are a 2003 unemployment rate of 10.2% in 2003, compared to the state average of 5.6%; labor force participation of 33.4%, compared to 50.4% statewide; and 31.4% of the population below the poverty line in 1999, compared to the state average of 9.4%.

Table 20 shows lower-than-average median household income in 1999 in all four counties, ranging from about 77% of the state average in Garfield County to about 62% in San Juan County. Among the four counties, Garfield and Kane counties have higher than average taxable sales per capita, which may reflect sales to nonresidents, including tourist and recreation visitors.

Lower income levels in the region are partly the effect of the large American Indian populations in San Juan County and elsewhere. This occurs because of the disproportionately high unemployment and low labor force participation that affects some tribes. At the same time, reservations such as the Navajo Nation, which covers much of the southern part of San Juan County, are a source of federally funded government employment (Utah Department of Workforce Services 2004).

## **Gateway Communities**

The town of Hanksville (Wayne County), the city of Blanding (San Juan County) and Ticaboo Resort (unincorporated Garfield County) are gateways to Bullfrog, Halls Crossing and Hite.

The economy of Hanksville depends heavily on mining, ranching and visitation to Lake Powell. The town, with an estimated population of 206 in 2002 (U.S. Census Bureau 2003), has some lodging, restaurants and a small store. Hanksville is 45 road miles north of Hite, 68 miles north of Bullfrog and 70 miles north of Halls Crossing.

Blanding, with an estimated population of 3,004 in 2002 (U.S. Census Bureau 2003), depends economically on tourism and on government institutions, including the state-operated College of Eastern Utah. Because it is located near Lake Powell and many other attractions (e.g., Natural Bridges and Hovenweep national monuments, Goosenecks and Edge of the Cedars state parks and Monument Valley Navajo Tribal Park), Blanding has a range of lodging, restaurants and other visitor-oriented business establishments. Blanding's location 80 to 85 miles east of Halls Crossing and Hite enables it to provide medical services for the two developed areas.

Ticaboo Resort, 13 miles north of Bullfrog on SH 276, has a motel, campground, restaurants and incidental boating services. The population in and around Ticaboo was 73 in 2000 (U.S. Census Bureau 2004b).

## **Business Activity**

Business activity at Lake Powell is driven by tourist and recreation visitation to Glen Canyon NRA. The Lake Powell developed areas are the most heavily visited areas of Glen Canyon NRA. Use is concentrated in the spring, summer and fall months and when water levels are highest. Fluctuations in seasonal use affect business activity at the developed areas and NPS and concessioner employment.

One of the primary concessioners at Glen Canyon NRA is ARAMARK Sports and Entertainment Services, Inc. (ARAMARK). Commercial services offered by ARAMARK in the uplake areas include lodging, slip, buoy and secured storage space rental; a restaurant; snack bars; a liquor store; marina stores

and gift shops; water-based fuel stations; land-based fuel stations; boat maintenance and repairs; and boat tours.

ARAMARK operates rental fleets based at each of the three uplake marinas. At low water levels, all rental operations move to Bullfrog. Incidental commercial services (e.g., boat caretaking, repairs, launch and retrieval, fishing guides and hiking services) are provided by about 130 holders of independent business permits.

ARAMARK operates Bullfrog as a full-service resort, provides a less comprehensive level of service at Halls Crossing and offers limited visitor services at Hite.

Trends for major commercial services provided by the concessioner were analyzed by looking at activity levels for fleet rentals, lodging and campsite rentals at the uplake developed areas. Concessioner facility use and visitor trends from 1997 to 2005 show a diverging pattern based on examination of the annual account reports. Both increases and decreases in visitor use and types of use have affected concessioner receipts and profits. Social, economic and environmental factors such as a declining economic outlook, decreasing domestic and international travel, the effects of a regional drought and increasing gasoline prices have decreased the concessioners' ability to make a profit. Specifically, after modest revenue increases occurred from 1997 through 2000, concessioner profits turned downward by almost 2% from 2000 to 2001. Profits continued to drop between 2001 to 2004. However, in 2005 a revenue upswing of about 2% is evident. This modest increase is encouraging, but insufficient to base a long-term projection on the profitability needed to expand facilities and services in the future.

River trips on the Colorado River end at the river takeout at Hite. Commercial outfitters provide a large share of these river trips. National Park Service data indicates a decline in active companies, trips and visitors. Between the 2000 and 2003 seasons, the number of active companies providing river trips declined by 22% and the number of visitors declined by 27%.

Peak season activity may be an indicator of the adequacy of facilities to meet current and projected future visitor needs.

Table 21 demonstrates that demand for lodge rooms peaked in 1999, prior to several years of severe drought that resulted in record low lake levels. Demand for lodge rooms in 2005 showed a slight increase, possibly resulting from increased lake levels over those of the previous four years. Prior to the onset of drought and decreasing lake levels, almost all lodge rooms were occupied during the peak month. Even during drought conditions, 90% of lodge rooms were filled during the peak month.

**TABLE 20. LODGE ROOM AND PEAK OCCUPANCY**

Year	Peak Season <sup>1</sup> Average Occupancy	Peak Month <sup>2</sup>	Peak Month Occupancy Percentage
2005	77%	July	89%
2003	75%	July	90%
1999	89%	August	96%
1997	86%	August	96%

<sup>1</sup>Peak season for these calculations is defined as May through September.

<sup>2</sup>Peak month is the month with the greatest percentage of occupancy.

The occupancy rates in table 21 may indicate that occupancy rates during the peak season dropped in response to the severe drought that resulted in record low lake levels. At Bullfrog, the occupancy rate for family rental units in the peak month was still nearly 90% during the year with the lowest occupancy rate for the peak season. It would appear demand for family rental units at Bullfrog continued to be high despite drought and low lake level conditions.

**TABLE 21. HOUSEKEEPING (FAMILY RENTAL) UNIT PEAK OCCUPANCY**

Year	No. Unit Nights Available Peak Season	Peak Season <sup>1</sup> Average Occupancy	Peak Month <sup>2</sup>	Peak Month Occupancy (%)
<b>Bullfrog</b>				
2005	1,232	73%	July	89%
2003 – Low <sup>3</sup>	1,288	69%	August	87%
2000 – High <sup>4</sup>	1,250	80%	July	100%
<b>Halls Crossing</b>				
2005	3,080	41%	July	52%
2004 - Low	3,080	36%	July	48%
2000 - High	3,080	71%	August	89%
<b>Hite</b>				
2005 - Low	770	2%	July	5%
2000 - High	770	75%	July	88%

1. Peak season for these calculations is defined as May through September.
2. Peak month is the month with the greatest percentage of occupancy.
3. Low: The year with the lowest percentage of occupancy for the peak season.
4. High: The year with the highest percentage of occupancy for the peak season.

Campground occupancy has decreased over time. At Bullfrog, occupancy peaked at 65% in mid-summer in the early 1990s, declined through the late 1990s, then dropped sharply during recent drought years. At Halls Crossing, the occupancy percentage during the peak season was in the mid-30% range consistently in the late 1990s leading up to the drought years and then dropped precipitously. Occupancy at Halls Crossing peaked around 40% in the early 1990s. However, the campgrounds in the uplake area are antiquated because the electrical amperage provided is below the demands of modern RVs and sites in both the existing campgrounds and RV parks will not accommodate larger RVs. No commercial RV parks are available close to the NRA perimeter because of the remote location of the uplake area.

Peak season (May through September) activity may be an indicator of the adequacy of facilities to meet current and projected future visitor needs. Occupancy of lodge rooms peaked in 1999, with an average peak season occupancy rate of 89% and then declined to a low of 75% in 2003. Despite persistent drought and record low lake levels from 2000 to 2004, lodge room occupancy was nearly 100% in some summer months.

Family rental unit occupancy shows trends similar to that of lodge rooms. Occupancy of family rental units during the peak season reached all-time highs in 2000 and declined through the subsequent drought years. Yet, occupancy of family rental units continued to reach nearly 90% during some summer months,



particularly at Bullfrog. Occupancy at Halls Crossing showed the greatest decline with peak occupancy of only 48% in August of 2004.

Slips and buoys available for long-term rental are fully rented. There are waiting lists for both slips and buoys; with names of customers interested in long-term rentals should any vacancies occur.

Occupancy of houseboat rentals peaked in 2000. In the month of August, occupancy peaked at 97.5%. Overall occupancy for 2000 was 39.3%. Rental houseboat occupancy declined to an overall low of 23.3% in 2004, with just 64.9% in August. In 2005, occupancy rates for rental houseboats increased to an overall rate of 29.2%, with 81.6% of rental houseboats occupied in July.

## **Lake Powell School**

Children of families living in housing at Bullfrog and Halls Crossing attend the Lake Powell School at Bullfrog, which is operated by the Kane County School District.

## **Tax Revenue**

Facilities and activities at the uplake developed areas generate tax revenues for the State of Utah and for local governments. All sales, watercraft and lodging rentals at Bullfrog, Halls Crossing and Hite are taxed. Revenues go to the State of Utah and to Kane and San Juan counties. The county sales tax includes a special levy for county hospital services.

Local governments also levy a property tax or a privilege tax on facilities, fleet and equipment at each developed area. Taxable property located at the developed areas includes federal property used for business by the concessioner and private boats moored or stored at the lake, but it excludes federal property used by NPS personnel. Property and privilege tax revenues go to Kane County and San Juan County governments and school districts. Other revenue generated by business activity at the uplake developed areas comes from state taxes on fuels and special Kane County excise taxes for tourism promotion levied on lodging rentals and food service sales.

Visitors going to and from Lake Powell also generate tax revenue for state and local government. Purchases of fuel, food, lodging and other goods and services by visitors passing through in the gateway communities of Hanksville, Blanding and Tropic yield sales and excise taxes for the State of Utah; Wayne, San Juan and Garfield counties; the town of Hanksville; and the city of Blanding. The State of Utah also earns revenues from sales tax on purchases of commercial river trips and from a special tax on rental cars.

## **Fee Revenue**

The National Park Service charges entrance and any applicable enhanced amenity fees (e.g., camping, boating) including concessioner franchise fees at Lake Powell. The NPS Recreation Fee Program allows Glen Canyon NRA to retain 80% of the total revenue collected. These revenues from cost-of-collection and franchise fees are used for projects that enhance visitor enjoyment of Lake Powell.

## **PARK OPERATIONS**

Glen Canyon NRA staff provides the full scope of functions and activities to accomplish management objectives and meet requirements of law enforcement, emergency services, public health and safety, science, resource protection and management, visitor services, interpretation and education, community services, utilities, housing and fee collection. Management of the recreation area requires the participation of seven recreation area divisions. They include the superintendent's office, administration, visitor protection, interpretation, maintenance, concessions and resource management.

The superintendent is responsible for the full scope of managing the area; its staff and residents; all of its programs; and its regulations with persons, agencies and organizations interested in Glen Canyon NRA. The division of administration provides management, services and technical expertise in all areas of administrative support. The superintendent's office and the administration division do not expend resources directly to manage park unit operations and resources. Instead, they provide support for the other divisions in their management of the recreation area.

The visitor protection division normally employs permanent rangers who patrol; enforce boating laws, including personal watercraft regulations; provide emergency medical services; and conduct search and rescue operations. In addition, during high visitor use periods, the NRA typically hires seasonal employees to support existing enforcement staff.

Development and dissemination of materials related to Glen Canyon NRA resources, visitor activities and visitor safety and conflict is provided by the interpretive division. Information pertaining to Glen Canyon NRA resources and visitor activities also is available through non-personal media such as Glen Canyon NRA newspapers and brochures. These are available to visitors at all entry points and at developed sites throughout Glen Canyon NRA.

Maintenance employees perform a variety of services related to recreational use including, but not limited to, facilities and infrastructure upkeep and repair, sign construction and repair, dock repair, maintenance and placement of navigational devices such as buoys according to changes in lake levels and sanitation services. NRA maintenance operations are responsible for water supply and wastewater treatment systems operations and maintenance.

The business division manages the concessions program, including concessions contracts, special-use permits, right-of-way permits and commercial-use authorizations and fee remittances at Glen Canyon NRA.

The resource management division protects and manages natural and cultural resources. Its staff includes terrestrial and aquatic biologists, archeologists and geographic information system specialists. Among other responsibilities, this staff provides monitoring, evaluation and planning to ensure the protection of NRA resources for future generations.

A primary concessioner, ARAMARK, employs staff providing visitor service and operational support for services such as boat rentals, overnight accommodations, food service, fueling stations and boat maintenance and repair.

Glen Canyon NRA staff manages housing in conjunction with the concessioner. Per the NPS Housing Management Plan (a management action common to all alternatives), the current direction is to provide only the minimum number of housing units necessary to support the mission of the National Park Service. To comply with this policy, the National Park Service is currently evaluating existing housing and providing recommendations for the appropriate amount and types of housing.

The concessioner is responsible for power generation and maintenance of the power facilities at the uplake developed areas. The NPS maintenance staff is responsible for water supply, treatment and distribution systems and maintenance of wastewater treatment systems. The National Park Service, in conjunction with the concessioner, is responsible for the wastewater collection system.

Glen Canyon NRA operations have been particularly stressed during the last several years of low water levels. The decrease in water elevation has resulted in changes to many water-based services and facilities. NPS maintenance staff has been responsible for ensuring that the public launch ramps are extended and that ferry launch ramps are maintained. The ferry service is operated by UDOT. The National Park Service has worked closely with the concessioner to relocate water-based facilities such as the wet slips and buoy fields, to ensure that these remain in operation. Construction of new parking areas and access roads has been the result of a collaborative effort between NPS maintenance staff and the concessioner.

## PUBLIC HEALTH AND SAFETY

Public health and safety facilities in the area are located at Bullfrog, Halls Crossing and Hite. The uplake district ranger's office at Bullfrog coordinates law enforcement and emergency response, fire protection and visitor information for all three developed areas. Ranger staff is assigned to Bullfrog, Halls Crossing and Hite subdistricts. Jurisdiction for handling public safety issues (i.e., law enforcement) is generally assigned to NPS rangers, although other law enforcement entities may also respond. The medical clinic at Bullfrog provides emergency medical care through a staff of physician's assistants and ranger staff with varying levels of medical certification ranging from first responders to emergency medical technicians and paramedics.

Boating safety requirements are enforced by several agencies including the National Park Service, U.S. Coast Guard, Utah State Parks and Recreation and the Utah Department of Natural Resources. Glen Canyon NRA normally employs between 25 and 30 permanent rangers who patrol and enforce boating laws. The distribution of enforcement staff is based on levels of visitor use and the frequency of problems. About 50% of the law enforcement staff is assigned to the uplake district, which accounts for slightly less than 25% of watercraft use at Lake Powell (NPS 2003b).

Typically during the summer months, approximately nine NPS law enforcement officers are assigned to the Bullfrog area, four to Halls Crossing and two to Hite. NPS rangers are responsible for ensuring the safety of visitors and for protecting NRA resources on both land and water. This presents a challenge because most visitor activity is water-based, while about 85% of the recreation area is dry land. Land-based areas of concentrated visitor activity such as the boat launches and campgrounds require disproportionate commitments of NPS law enforcement staff (NPS 2003a).

**TABLE 22. RESOURCE AND VISITOR PROTECTION ACTIVITY IN GLCA NRA 2005**

Activity	Level
Law Enforcement	
Part I Offenses Investigated	54
Part II Offenses Reported	2711

**TABLE 22. RESOURCE AND VISITOR PROTECTION ACTIVITY IN GLCA NRA 2005**

<b>Activity</b>	<b>Level</b>
Emergency Medical Services	
Total Medical Incidents	371
Deaths (accidental)	9
Search and Rescue Incidents	77

Source: NPS 2005k

Appropriate state and federal regulatory permits would be obtained prior to the start of any new construction projects.

## **TRANSPORTATION**

### **Automobile**

The main entrance to Bullfrog is via SH 276, entering the recreation area from SH 95, approximately 70 miles south of Hanksville, Utah. The Bullfrog area has a well-developed road system. Once inside the recreation area entrance, most secondary roads at Bullfrog are paved roads. Some of the newer roads created to maintain access to the lake under current low water conditions are packed dirt or gravel. In addition, access roads to shoreline camping areas at North and South Bullfrog and Stanton Creek are dirt roads.

Bullfrog can also be accessed by The Notom – Bullfrog Road, which is paved for approximately 25 miles north of Bullfrog and is dirt northward from the intersection with SH 24. The Burr Trail Road from Boulder, Utah, intersects the Notom – Bullfrog Road as well.

The main entrance to Halls Crossing is via SH 276, entering the recreation area from SH 95, west of Natural Bridges National Monument and approximately 45 miles west of Blanding, Utah. Most of the secondary access roads at Halls Crossing are paved roads. Some of the newer roads created to maintain access to the lake under current low water conditions are packed dirt or gravel.

Hite is accessed from SH 95. The main access to Hite is a paved road that runs from SH 95 to the main launch ramp. Most of the secondary roads are paved roads. Some shoreline camping accesses are packed dirt.

### **Ferry Service**

A Utah state-owned toll ferry provides access between Bullfrog and Halls Crossing and alternate entrances to both marinas. The ferry can accommodate most vehicles and runs every other hour from each location (i.e., even hours from Halls Crossing and odd hours from Bullfrog). Hours of operation vary from winter to summer with winter hours being more restricted. The ferry is also used to transport school children to the Lake Powell School at Bullfrog. A school bus picks up the children on the Bullfrog side and transports them to the school building.

## **Navigation and Navigable Waterways**

For the purposes of the Clean Water Act and Rivers and Harbor Act, the Colorado River has been identified as a navigable waterway by the U.S. Army Corps of Engineers and the U.S. Coast Guard. As such Glen Canyon NRA under an agreement with the U.S. Coast Guard deploys and maintains navigation buoys to identify the navigation channel within Lake Powell.

The U.S. Army Corps of Engineers manages impediments to navigation thorough their Section 10 permitting process. Impediments to navigation on Lake Powell generally include any kind of floating facilities, including docks, pedestrian walkways, new bulkheads, breakwaters and courtesy docks.

## Environmental Consequences

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## ENVIRONMENTAL CONSEQUENCES

### INTRODUCTION

This section describes the environmental consequences of the three alternatives. First, methods for assessing environmental consequences are discussed. NEPA requires consideration of context, intensity and duration of impacts, cumulative impacts and measures to mitigate impacts. Next, an explanation of resource impairment is assessed by alternative, in accordance with NPS policy. Table 1 provides a summary of alternatives by impact topic.

### METHODOLOGY

Overall, the National Park Service based these impact analyses and conclusions on a review of existing literature and Glen Canyon NRA studies, information provided by experts within Glen Canyon NRA and other agencies, professional judgments and NRA staff insights, interested local American Indian tribes and public input.

The following definitions were used to evaluate the context, intensity, type, duration and cumulative nature of impacts associated with project alternatives:

- **Context.** Context is the setting within which an impact is analyzed such as local, parkwide, or regional. The Council on Environmental Quality requires that impact analysis include discussions of context.
- **Impact Intensity.** Impact intensity is the degree to which a resource would be beneficially or adversely affected. The criteria that were used to rate the intensity of the impacts for each resource topic is presented under each impact topic discussion.
- **Type of Impact.** Impacts can be beneficial or adverse. Beneficial impacts would improve resource conditions while adverse impacts would deplete or negatively alter resources.
- **Duration.** The duration of the impacts in the analysis is defined as short-term or long-term. A definition of the time frame that constitutes short-term and long-term is included under each impact topic discussion.
- **Direct versus indirect impacts.** A direct impact is an effect that is caused by an action and occurs at the same time and place. An indirect impact is an effect that is caused by an action, but is later in time or farther removed in distance, but still reasonably foreseeable.

For each impact topic, the analysis includes a description of the affected environment and an analysis of the environmental consequences using the methods and terms presented in this section. The impact analysis involved the following steps:

- Identify the area that could be affected.

- Compare the area of potential effect with the resources that are present as compared to the baseline (Alternative A).
- Identify the intensity, context, duration (short or long-term) and type (direct or indirect) of effect, both as a result of this action and from a cumulative effects perspective.

## **CUMULATIVE EFFECTS ANALYSIS METHOD**

Council on Environmental Quality regulations, which implement NEPA, requires assessment of cumulative impacts in the decision making process for federal projects. Cumulative impacts are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions” (40 CFR 1508.7).

Cumulative effects were determined by combining the effects of the alternative with other past, present and reasonably foreseeable future actions. Therefore, it was necessary to identify these actions at Bullfrog, Halls Crossing and Hite; within Glen Canyon NRA; and in the surrounding region. Other actions that have the potential to have a cumulative effect in conjunction with the proposed action include the following:

### **Actions That Make Up the Cumulative Impacts Scenario**

#### **Road and Highway Improvements**

- The Burr Trail is a historic road that begins at Boulder, Utah, terminating at SH 276, north of the Bullfrog developed area within Glen Canyon NRA. The Burr Trail connects to Utah SH 24 to the north via Notom Road. The Burr Trail has been upgraded on BLM lands and where the counties have jurisdiction, improvements have been made to the Burr Trail and Notom Road in areas outside of Capitol Reef National Park. The National Park Service has released a draft environmental impact statement proposing a range of modifications to the Burr Trail within Capitol Reef National Park (NPS 2005a). Collectively, the past and proposed improvements and modifications to the Burr Trail could make an attractive alternative route for visitors traveling from points in northern Utah via SH 24 and from Boulder, Utah.
- UDOT has no major reconstruction projects planned for highways in the area of the uplake district of Glen Canyon NRA. Future projects include chip sealing and overlay, with each project estimated to be three to five days in duration. These projects would result in some minor traffic delays due to one-lane traffic during construction (Lee 2005).

#### **Canyonlands National Park River Management Plan.**

Visitors enjoying private and commercial raft trips remove their rafts from the river at Hite. Canyonlands National Park (Canyonlands NP) manages the use of the Colorado River from their park into Glen Canyon NRA under a river management plan that was implemented in the early 1980s. Canyonlands NP has initiated a process to update the river management plan and anticipates issuance of a draft plan for review in the spring or summer of 2006 (Cowan 2005). Changes made to future river management under the new plan may contribute to cumulative impacts; however, because plan development is in the preliminary stages the plan cannot be analyzed with regard to cumulative impacts.