National Park Service
U.S. Department of the Interior

Mojave National Preserve
California

Mojave National Preserve

Management Plan For Developed Water Sources and Environmental Assessment

March 2018

Management Plan for Developed Water Sources
Mojave National Preserve

Environmental Assessment

March 2018

SUMMARY

Introduction

This Environmental Assessment (EA) and plan evaluates a range of alternatives for water resources management in California's Mojave National Preserve (Preserve). The plan presents and analyzes the potential effects of three action alternatives and a no action alternative, which represents the continuation of current management practices. Based on the analysis of effects, the National Park Service (NPS) will select an alternative to implement, and guide future management actions in the Preserve.

Purpose of the Plan

The purpose of the plan and EA is to develop a comprehensive strategy and identify techniques for managing the Preserve's water resources in a changing environment, to ensure the preservation of wildlife, historic, wilderness, and recreation values in a diverse desert ecosystem.

Need for Action

The Mojave Desert is a water-scarce environment where most native plants and animals are adapted to survive with limited access to free-standing water and extended periods of drought. A variety of natural and developed water features exist on the landscape, including natural springs, developed springs, wildlife guzzlers, and wells. While many developed water features (or water developments) are important for wildlife conservation, have historical value, or are important for the Preserve's operations, others may not be necessary or may be detrimental to other Preserve resources.

There is uncertainty about the importance of these water resources to the desert ecosystem in the face of regional habitat loss, fragmentation, and climate change; and there is no comprehensive strategy to manage water resources in the Preserve. Considering the Preserve's legislative mandate to "perpetuate in their natural state significant and diverse ecosystems of the California desert," a water resource management plan is needed to:

- identify a proactive, consistent, and Preserve-wide management approach for developed and undeveloped water features;
- identify the type and level of management intervention that is appropriate and necessary to sustain habitat for native wildlife given human influences on climate and habitat fragmentation;
- reconcile competing policy guidance on resource management and wilderness stewardship;

- provide guidance as the Preserve responds to external development threats; and
- improve coordination between the Preserve, California Department of Fish and Wildlife, Bureau of Land Management, other desert national park system units, and stakeholders.

Issues Raised During the Scoping Process

During the scoping period, several issues of concern related to water resources management were identified. The public and interest groups are highly polarized on the issue of water provisioning for wildlife. Some wilderness advocacy groups strongly oppose the presence of guzzlers in wilderness and dismiss the potential for adverse effects on native and nonnative wildlife by eliminating guzzlers. Other groups support the use and expansion of guzzlers, though some recognize that multiple values are at stake when making decisions about water resources in the Preserve. Neighboring wildlife managing agencies in the Mojave region consider guzzlers a routine approach to managing bighorn sheep in the Mojave Desert. The alternatives reflect this range of perspectives.

The key issues identified during scoping included:

- Surface water features,
- Wetland and riparian vegetation,
- Groundwater conditions and availability,
- Wildlife and wildlife habitat,
- Rare, unique, threatened, and endangered species,
- Historic water developments,
- Wilderness character,
- Recreational opportunities and visitor, experience, and
- Regional context.

Impact Topics Retained for Analysis in the EA

The issues listed above form the basis for the impact topics that were selected for detailed analysis in this plan and EA. The topics retained for analysis are:

- Wildlife,
- Cultural resources, and
- Wilderness character.

These impact topics are described in detail in *Chapter 3: Affected Environment*. Environmental setting, regional context, and water resources are discussed in detail in *Chapter 3: Affected Environment* because they are foundational to water resource management, but are not included as resource topics analyzed for impacts in *Chapter 4: Environmental Consequences*.

Issues Considered and Dismissed from Further Consideration

Issues that are not relevant to this plan were eliminated from further consideration and analysis by the planning team. In some instances, issues were dismissed because they relate to resources that are not present in the Preserve. In other instances, Preserve staff considered potential issues for certain resource areas, but because the impacts were considered minimal, those topics were also dismissed from further analysis. Issues considered and dismissed from further analysis are:

- Water resources,
- Vegetation communities,
- Recreation and hunting,
- Preserve operations,
- Geology, geohazards, and soils,
- Air quality,
- Land use,
- Ethnographic resources,
- Socioeconomics, and
- Environmental justice.

Factors Influencing Water Resource Management

The following environmental factors set the context for water resource management in the Preserve. These are described in greater detail in *Chapter 3: Affected Environment* and are the basis for the impact topics analyzed in *Chapter 4: Environmental Consequences*.

Types of Water Features

Big game guzzlers – Large tanks and systems intended to provide water for desert bighorn sheep.

Small game guzzlers – Concrete aprons leading to underground tanks to provide water to game birds.

Springs and seeps – Natural or human-induced water expressions.

Water developments – Excavations, pipes, tanks, and other infrastructure to collect and convey water.

Wells – Hand-dug or drilled vertical holes intended to lift water to the surface.

Ponds and reservoirs – Natural and excavated depressions or embankments that hold surface water.

Environmental Setting

The Preserve includes an ecologically diverse yet fragile desert ecosystem consisting of vegetative attributes that are unique to the Mojave Desert, as well as components of the Great Basin and Sonoran Deserts. The climate is extreme and is characterized by very hot summers and limited precipitation. Changing climate trends are likely to have a profound effect on the relationships between desert ecology, wildlife populations, and the spatial and temporal distribution of available surface water on the landscape.

The Mojave Desert ecosystem has been affected by multiple human pressures. The Preserve lies between Las Vegas, Nevada, and Los Angeles, California, and is bounded by two interstate highways (I-15 and I-40). These and other disturbances associated with human development continue to alter and fragment regional habitat for a variety of wildlife species, including desert bighorn sheep.

Groundwater and Surface Water Resources

Within the broad valleys of the Preserve are deep alluvial groundwater basins that contain centuries-old aquifers. Some of these deep aquifers are associated with perennial springs such as Piute Springs and Soda Springs, which support small riparian ecosystems. The more common types of springs or seeps are those located along the slopes and edges of mountain ranges and fed by small, localized perched aquifers. These small aquifers have limited groundwater storage, resulting in highly variable spring discharge that is correlated with annual precipitation rates. About 311 springs, seeps, and wells and 137 guzzlers (big and small) are known to exist in the Preserve.

Wildlife Conservation and Management

While most native species of plants and animals are adapted to survive in this water-scarce environment, many species use natural or human-made sources of water to survive. As a result of regional loss of habitat connectivity and climate change, some species (such as the desert bighorn sheep) rely on both natural and developed water sources. Other species of native wildlife are less reliant on water features, but use those sources opportunistically.

Three sensitive species are uniquely relevant to the management of natural and developed water resources in the Preserve:

- The Mohave tui chub is a small minnow that is listed as federally endangered and is found in several groundwater-fed ponds in the Preserve.

- The desert tortoise is a federally threatened species, and its habitat is found through most of the lower-elevation portions of the Preserve.
- The desert bighorn sheep is not federally listed, but is managed as a fully protected species by the State of California. Populations in the Preserve rely on developed water sources, or guzzlers.

Designated Wilderness

The 1994 California Desert Protection Act, which established the Mojave National Preserve, also designated almost half of the Preserve (804,949 acres) as wilderness. Almost half of the small game guzzlers and all of the big game guzzlers are located in wilderness. These water features provide some element of habitat for wildlife, and many require routine maintenance to ensure their effectiveness and safety. While wildlife conservation is a purpose of wilderness and some guzzlers may help preserve some qualities of wilderness character, the presence of structures and the use of motorized vehicles or equipment may adversely affect other qualities.

Water Management Plan Alternatives

The following four water resource management alternatives are considered for implementation: one no action alternative and three action alternatives. Each action alternative represents a distinct approach to managing water resources that is intended to achieve a particular set of desired conditions and depends on a particular rationale. The alternatives and their anticipated effects are summarized in Table S-1 and Table S-2 below.

The Mojave Desert is rapidly changing as a result of the combined anthropogenic effects of climate change, habitat fragmentation, and habitat loss. Habitat loss and fragmentation increase the importance of large national parks for wildlife habitat conservation. Each action alternative recognizes the importance of wilderness qualities, the need for active management to support wildlife conservation in the face of anthropogenic change, and the desire to balance sometimes conflicting values and mandates. Each alternative would optimize the use of water developments to meet diverse land and wildlife management objectives by maintaining those that are important to native wildlife populations, removing those that do not contribute to habitat value, and strategically using water developments outside of wilderness to support wildlife conservation.

Alternative 1 – No Action

The NPS would continue current water management practices, which would retain the current number and distribution of water developments and respond to external proposals or initiatives on an ad hoc basis. In particular, water resource management actions related to wildlife, historic features, and preserve operations, and the impacts of those changes, would be addressed on a case-by-case basis based on land designations (e.g., wilderness or critical habitat) without any overarching guidance.

Alternative 2

Alternative 2 emphasizes minimizing water developments in wilderness. The overall management philosophy would be strategic intervention to limit intrusion into wilderness while using a variety of tools to conserve and maintain self-sustaining native wildlife populations. At full implementation, Alternative 2 would result in fewer water developments in wilderness, and in the Preserve overall, compared to the No Action.

Alternative 2 includes the following:

- Three big game guzzlers would be removed, two would be relocated, one would be retained, and two new water sources would be developed.
- Most small game guzzlers would be neglected, removed, or disabled.
- Water developments at most springs would be neglected.
- Other elements, including groundwater resources, water rights, hazardous materials, and other water uses not included above would be monitored and managed proactively.

Alternative 3 (Preferred Alternative)

Alternative 3 emphasizes reducing of the number of water developments in wilderness while supporting native species conservation. The overall management philosophy would be strategic intervention to ensure that native wildlife populations are stable as the overall number of water developments in wilderness is reduced and regional habitat connectivity is improved. Big game guzzlers would be removed from wilderness in a manner that results in no net loss of functioning dry season habitat. At full implementation, Alternative 3 would result in more developed water sources in the Preserve compared to Alternative 2 and the No Action; and one more big game guzzler in wilderness compared to Alternative 2.

Alternative 3 includes the following:

- Two big game guzzlers would be removed, two would be relocated, two would be retained in place, and three new water sources would be developed.
- Most small game guzzlers would be neglected, removed, or disabled, while select non-wilderness guzzlers would be maintained to support native wildlife.
- Water developments at 5 to 10 managed springs would be evaluated for ecological importance and potential maintenance, while most others would be neglected.
- Other elements, including groundwater resources, water rights, hazardous materials, and other water uses not included above would be monitored and managed proactively.

Alternative 4

Alternative 4 emphasizes the use of water developments to augment native wildlife habitat in the Preserve while reducing, where possible, the number of water developments within wilderness. The overall management philosophy would be to use water developments to improve existing habitat in the Preserve and to maintain or develop connections between the Preserve and surrounding habitat in the larger landscape. At full implementation, Alternative 4 would result in more water developments in wilderness compared to the other alternatives, and more water developments in the Preserve compared to the No Action and Alternative 2. There would be the same number of big game guzzlers compared to Alternative 3.

Alternative 4 includes the following:

- One big game guzzler would be removed, two would be relocated, three would be retained in place, and two new water sources would be developed.
- Small game guzzlers would be maintained and improved outside of wilderness to support native wildlife.
- Water developments at 10 to 15 managed springs would be maintained or stabilized, while the rest would continue to be neglected.

- Other elements, including groundwater resources, water rights, hazardous materials, and other water uses not included above would be monitored and managed proactively.

Alternative Objectives and Management Strategies

Each alternative represents a distinct objective and approach to managing water developments in the Preserve, representing different assumptions about environmental conditions and approaches to water resource management and decision making. Four alternatives were retained for detailed analysis and are described in greater detail in the following sections of this chapter.

Alternative 1 (No Action). Manage water developments on an ad hoc basis, often in response to external proposals or directives. All existing water developments would be retained, but would not be rebuilt or replaced.

Alternative 2. Minimize water developments in wilderness while strategically using water developments to conserve native wildlife populations. Under Alternative 2:

- Three big game guzzlers would be removed, two would be relocated, one would be retained, and two new water sources would be developed.
- Most small game guzzlers would be neglected and some would be removed or disabled, while select non-wilderness guzzlers would be maintained to support native wildlife.
- Water developments at 5 to 10 managed springs would be evaluated for ecological importance and potential maintenance, while most others would be neglected.

Alternative 3 (Preferred Alternative). Manage water developments to support native species conservation and population stability while reducing the number of water developments in wilderness. Under Alternative 3:

- Two big game guzzlers would be removed, two would be relocated, two would be retained, and three new water sources would be developed.
- Most small game guzzlers would be neglected and some would be removed or disabled, while select non-wilderness guzzlers would be maintained to support native wildlife.
- Water developments at 5 to 10 managed springs would be evaluated for ecological importance and potential maintenance, while most others would be neglected.

Alternative 4. Manage water resources to augment native wildlife habitat and restore connectivity. Under Alternative 4:

- One big game guzzler would be removed, two would be relocated, three would be retained, and two new water sources would be developed.
- Small game guzzlers would be maintained and improved outside wilderness to support native wildlife.
- Water developments at 10 to 15 managed springs would be maintained or stabilized, while the rest would continue to be neglected.

Table S-1. Water Resource Management Alternatives Summary

	Alternative 1 – No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Big Game Guzzlers				
Guzzler Actions	Continue filling and maintaining guzzlers as needed	• Remove Clark, Piute, and Old Dad guzzlers • Retain Kelso guzzler • Relocate Kerr and Vermin guzzlers to outside wilderness (New Kerr and New Vermin) • Build potential new guzzlers at Vontrigger and Ginn sites • 5 guzzlers within the Preserve, 1 within wilderness	• Remove Clark and Piute guzzlers • Retain Old Dad and Kelso guzzlers • Relocate Kerr and Vermin guzzlers to outside wilderness (New Kerr and New Vermin) • Build potential new guzzlers at Piute North, Vontrigger, and Ginn sites • 7 guzzlers within the Preserve, 2 within wilderness	• Remove Clark guzzler • Retain Piute, Old Dad, and Kelso guzzlers • Relocate Kerr and Vermin guzzlers to outside wilderness (New Kerr and New Vermin) • Build potential new guzzlers at Vontrigger and Ginn sites • 7 guzzlers within the Preserve, 3 within wilderness
Small Game Guzzlers				
Guzzlers in Wilderness	*Common to All Alternatives:* • Neglect all; allow guzzlers to deteriorate over time			
Non-wilderness Guzzlers	• Allow ad hoc maintenance • Neglect all other small game guzzlers	• Evaluate sets of 10 to 15 guzzlers for condition and wildlife use • Repair escape ramps as needed • Maintain or improve a select few for native wildlife • Remove or disable some • Neglect remaining guzzlers	Same as Alternative 2	• Evaluate sets of 15 to 25 guzzlers for condition and wildlife use • Maintain and repair escape ramps as needed • Repair, maintain, or improve for native wildlife • Remove or disable select few
Springs and Water Developments				
Developed Springs	• Allow maintenance of springs per outside requests • Clean up spring sites if needed for visitor safety • Neglect all others	• Evaluate 5 to 7 spring developments per year for ecological importance and condition • Maintain 5 to 10 springs if determined important for native wildlife • Neglect all others	Same as Alternative 2	• Evaluate 5 to 7 spring developments per year for ecological importance and condition • Maintain 10 to 15 springs if determined important for native wildlife • Neglect all others
Wells	Actively close/abandon or maintain wells to comply with state regulations	*Common to All Action Alternatives:* • Maintain 8 NPS water supply wells and 28 grazing/ monitoring wells for administrative purposes • Retain up to 3 wells for future water supply • Add 1-2 wells in the Hole in the Wall area to support Preserve operations • Destroy unused wells		

	Alternative 1 – No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Ponds and Lakes	• Maintain habitat for endangered Mohave tui chub on an ad hoc basis • Neglect other (ephemeral) ponds, with no active management, maintenance, or improvements	*Common to All Action Alternatives:* • Maintain springs for Mohave tui chub and pursue additional restoration sites • Neglect other ponds		
Other Elements				
Deep Alluvial Basin Groundwater	Provide technical review and comments on outside proposals	*Common to All Action Alternatives:* • Monitor groundwater quality and water levels for long-term trends/public health • Develop new water supply wells as needed to support NPS operations • Provide technical review and comments on outside proposals • Pursue legal avenues to prevent or mitigate impacts on Preserve resources • Complete well inventory and destroy abandoned wells according to state code		
Water Rights	Continue filing as directed by NPS Water Resources Division	*Common to All Action Alternatives:* • Evaluate water rights acquired by the Preserve with assistance from NPS Water Resources Division • Develop and assert federal reserved water rights as needed to protect resources		
Other Programs	Identify and mitigate hazardous materials as lands are acquired	*Common to All Action Alternatives:* • Identify and mitigate hazardous materials as lands are acquired • Use water source manipulation to manage livestock grazing per Grazing Management Plan (under development) and consistent with this plan		

Table S-2. Environmental Effects of the Water Resource Management Alternatives

Resource	No Action (Existing Conditions)	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Wildlife – Desert Bighorn Sheep	• No effects • No strategy for long-term management	• Guzzler removal, relocation, and new guzzler implementation would result in a potential 10% decrease in the Preserve's dry season habitat value • Decreased habitat value would occur in the Old Dad/Kelso Mountains and Piute/Castle Mountains. A slight decrease would occur in the Clark Mountains • Increased habitat value in the Mescal/Ivanpah Range and Woods/Hackberry Mountains • Two new water sources would increase dry season habitat value, support migration corridors, and support the expansion and establishment of populations • Guzzler removal/relocation would result in short-term adverse effects on individual sheep • Implementation sequencing to reduce adverse effects, site-specific planning, and monitoring would guard against significant adverse impacts (see Figure 3) • Overall, potential for long-term adverse effects on bighorn sheep is low, due to careful implementation, monitoring, and increased habitat connectivity	• Guzzler removal, relocation, and new guzzler implementation would result in a potential 19% increase in the Preserve's dry season habitat value • Slight decrease in habitat value would result in the Old Dad/Kelso Mountains and Clark Mountains • Increased habitat value in the Piute/Castle Mountains, Mescal/Ivanpah Range, and Woods/Hackberry Mountains • Three new water sources would increase dry season habitat value, support migration corridors, and support the expansion and establishment of populations • Guzzler removal/relocation would result in short-term adverse effects on individual sheep • Implementation sequencing to reduce adverse effects, site-specific planning, and monitoring would guard against significant adverse impacts (see Figure 3) • Overall, some short-term adverse impacts on sheep with the potential for long-term benefits	• Guzzler removal, relocation, and new guzzler implementation would result in a potential 18% increase in the Preserve's dry season habitat value • Slight decrease in habitat value would result in the Old Dad/Kelso Mountains and Clark Mountains • No change to habitat value in the Piute/Castle Mountains • Increased habitat value in the Mescal/Ivanpah Range and Woods/Hackberry Mountains • Two new water sources would increase dry season habitat value, support migration corridors, and support the expansion and establishment of populations • Guzzler removal/relocation would result in short-term adverse effects on individual sheep • Implementation sequencing to reduce adverse effects, site-specific planning, and monitoring would guard against significant adverse impacts (see Figure 3) • Overall, some short-term adverse impacts on sheep with the potential for long-term benefits

Resource	No Action (Existing Conditions)	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Wildlife –General	• Benefits to Mohave tui chub and desert tortoise • Localized benefit from ad hoc maintenance • Localized and low-magnitude impacts from long-term deterioration of water sources • Uncertain wildlife population effects	*Common to All Action Alternatives:* • Benefits to Mohave tui chub and desert tortoise • Localized and small impacts from long-term deterioration of water sources and limited removal of water sources • Localized and small benefits from limited maintenance of non-wilderness water sources • Uncertain wildlife population effects		
Cultural Resources	• Adverse effects on features that are left to deteriorate • Benefits from ad hoc maintenance of historic water features • No comprehensive strategy or compliance approach for treatment of historic water features	*Common to All Action Alternatives:* • Adverse long-term effects from neglect, deterioration, and disabling of other historic water features • Benefits to non-wilderness water features that are maintained and stabilized • Effects would be resolved through a consultation with the State Historic Preservation Office (SHPO)		
Wilderness Character	• Adverse impacts on untrammeled and undeveloped qualities due to the presence of developed guzzlers in wilderness • Benefits to natural qualities from the conservation value of guzzlers to desert bighorn sheep • Overall, small adverse effect on wilderness character	• Benefits to untrammeled and undeveloped qualities from the removal of five big game guzzlers from wilderness • No impacts on natural qualities associated with bighorn conservation • Some adverse impacts associated with spring maintenance in wilderness • Overall benefit to wilderness from the reduction of active guzzler development and maintenance in wilderness	• Benefits to untrammeled and undeveloped qualities from the removal of four big game guzzlers from wilderness • No impacts on natural qualities associated with bighorn conservation • Some adverse impacts associated with spring maintenance in wilderness • Overall benefit to wilderness from the reduction of active guzzler development and maintenance in wilderness	• Benefits to untrammeled and undeveloped qualities from the removal of three big game guzzlers from wilderness; but adverse effects from three guzzlers that would remain • Benefits to natural qualities associated with bighorn conservation • Overall, small adverse effects on wilderness character due to retention of big game guzzlers and maintenance of select springs in wilderness

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CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

Introduction

This Environmental Assessment (EA) and plan evaluates a range of alternatives for water resources management in California's Mojave National Preserve (Preserve). The plan presents and analyzes the potential effects of three action alternatives and a no action alternative, which represents the continuation of current management practices. Based on the analysis of effects, the National Park Service (NPS) will select an alternative to implement, and guide future management actions in the Preserve.

This plan and EA has been developed by an interdisciplinary team of NPS and consultant staff, with input from the public and interested stakeholders. In addition, the California Department of Fish and Wildlife (CDFW) participated as a cooperating agency. See *Chapter 5: Consultation and Coordination* for a full list of participating individuals and entities.

Purpose of the Plan / Environmental Assessment

The purpose of the plan and EA is to develop a comprehensive strategy and identify techniques for managing the Preserve's water resources in a changing environment, to ensure the preservation of wildlife, historic, wilderness, and recreation values in a diverse desert ecosystem.

Need for Action

The Mojave Desert is a water-scarce environment where most native plants and animals are adapted to survive with limited access to free-standing water and extended periods of drought. A variety of natural and developed water features exist on the landscape, including natural springs, developed springs, wildlife guzzlers, and wells. While many developed water features (or water developments) are important for wildlife conservation, have historical value, or are important for the Preserve's operations, others may not be necessary or may be detrimental to other Preserve resources.

There is uncertainty about the importance of these water resources to the desert ecosystem in the face of regional habitat loss, fragmentation, and climate change; and there is no comprehensive strategy to manage water resources in the Preserve. Considering the Preserve's legislative mandate to "perpetuate in their natural state significant and diverse ecosystems of the California desert," a water resource management plan is needed to:

- identify a proactive, consistent, and Preserve-wide management approach for developed and undeveloped water features;
- identify the type and level of management intervention that is appropriate and necessary to sustain habitat for native wildlife given human influences on climate and habitat fragmentation;
- reconcile competing policy guidance on resource management and wilderness stewardship;
- provide guidance as the Preserve responds to external development threats; and
- improve coordination between the Preserve, CDFW, Bureau of Land Management (BLM), other desert national park system units, and stakeholders.

Objectives in Taking Action

Objectives are qualitative statements of values that serve to guide natural resource decision making and the evaluation of success. All water resource management alternatives selected for detailed analysis address the purpose and need for action and meet all objectives to a large degree. The following objectives for water management are based on the enabling legislation for the Preserve, the Preserve's General Management Plan, and other planning documents and mandates, as well as service wide objectives, management policies, and the NPS Organic Act. Plan objectives for each type of water source include:

Key Plan Terms

Water features – All natural or human-made surface water sources known to occur in the Preserve, including springs, wells, guzzlers, lakes, and ponds

Water developments – Excavations, pipes, troughs, or other infrastructure intended to facilitate the use of natural water sources

Guzzlers – Artificial structures developed to collect, store, and convey water specifically for wildlife

Big Game Guzzlers. Conserve desert bighorn sheep habitat in a manner that complements regional sheep conservation goals and is consistent with wilderness values.

Small Game Guzzlers. Identify and manage the appropriate number and distribution of small game guzzlers that is necessary to support wildlife habitat, protect desert tortoise populations, and protect wilderness values.

Historic Water Developments. Maintain historic water developments in a manner that is compatible with their location and condition relative to designated wilderness, and manage the conveyance of water from historic developments in a manner that is consistent with the overall water management approach of each alternative.

Springs. Manage naturally occurring seeps and springs to preserve water sources for wildlife and native riparian vegetation and to minimize impacts from nonnative vegetation.

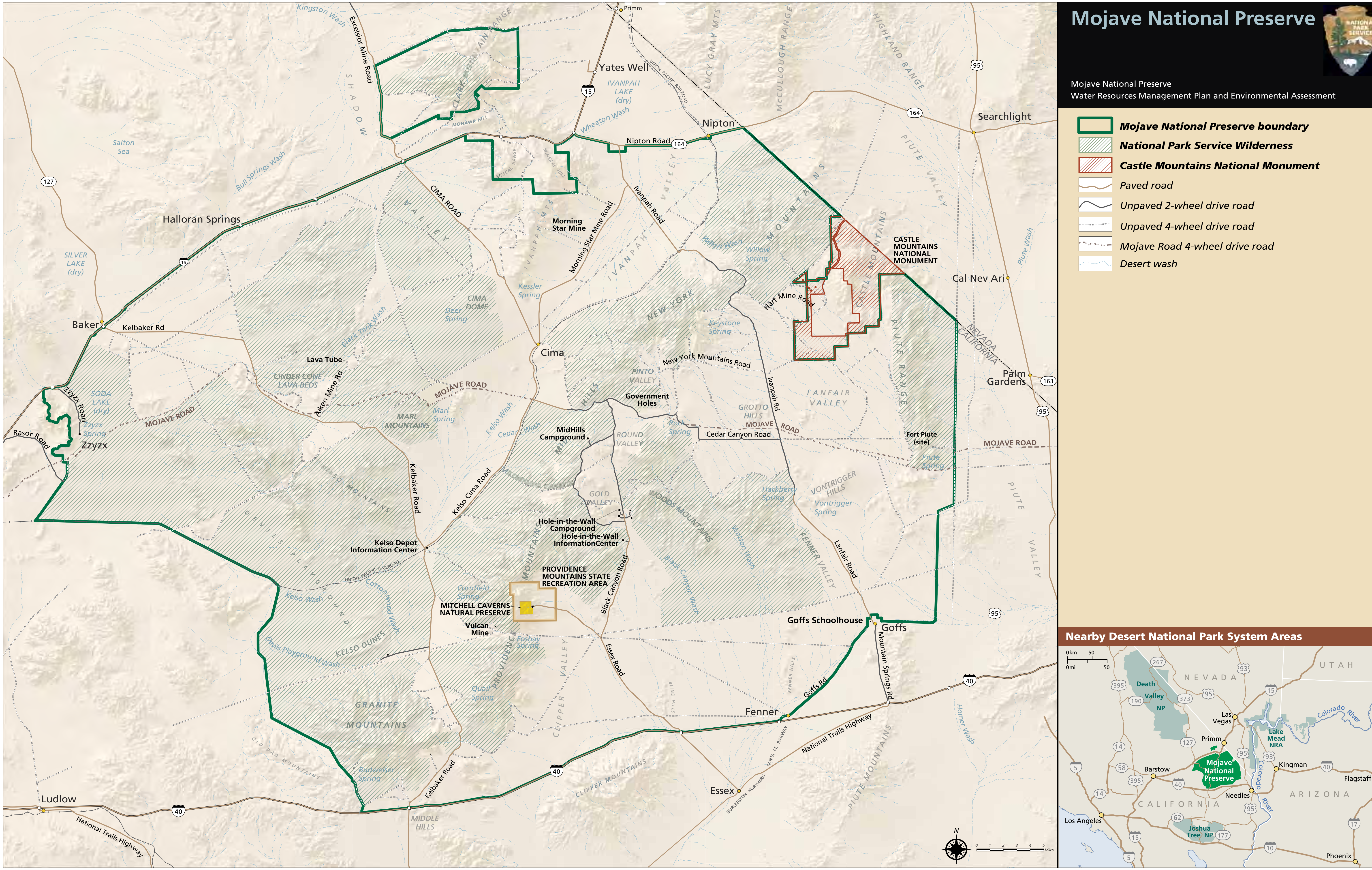
Deep Alluvial Basin Groundwater. Protect deep groundwater resources, and the surface water features that rely on them, through both long-term monitoring and active engagement in regional processes and proposals that may affect those resources.

These objectives are common to all action alternatives, although each has its own management strategies and implementation activities that reflect different objectives to water resources management. The alternatives are described in detail in *Chapter 2: Alternatives*.

Project Location

Located in Southern California, the Preserve is a 1.6-million-acre unit of the national park system, established by Congress on October 31, 1994, by the California Desert Protection Act (CDPA). The Preserve is located in San Bernardino County, about halfway between Barstow, California, and Las Vegas, Nevada. The Preserve is bounded to the north and south by major interstate highways, I-15 and I-40, while the Nevada–California state line makes up most of the eastern boundary (Figure 1). The Preserve headquarters are located in Barstow.

The Preserve is a vast expanse of desert lands that includes vegetation representative of the Great Basin, Sonoran, and Mojave Desert ecosystems. This provides an unusually diverse variety of desert plant and animal life. The Preserve also contains several diverse mountain ranges, the Kelso dune system, dry lake beds, and evidence of volcanic activity (domes, lava flows, and cinder cones).


Mojave National Preserve
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
Mojave National Preserve boundary
National Park Service Wilderness
Castle Mountains National Monument
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
Nearby Desert National Park System Areas
NEVADA
UTAH
CALIFORNIA
ARIZONA
Death Valley NP
Las Vegas
Lake Mead NRA
Colorado River
Primm
Mojave National Preserve
Kingman
Barstow
Needles
Flagstaff
Los Angeles
Joshua Tree NP
Phoenix
Primm
Yates Well
Nipton
Nipton Road
Searchlight
Halloran Springs
Baker
Kelbaker Rd
Zzyzx
Cima
Morning Star Mine
Lava Tube
CASTLE MOUNTAINS NATIONAL MONUMENT
Cal Nev Ari
Palm Gardens
Government Holes
MidHills Campground
Cedar Canyon Road
Fort Piute (site)
MOJAVE ROAD
Kelso Depot Information Center
Hole-in-the-Wall Campground
Hole-in-the-Wall InformationCenter
PROVIDENCE MOUNTAINS STATE RECREATION AREA
MITCHELL CAVERNS NATURAL PRESERVE
Vulcan Mine
Goffs Schoolhouse
Goffs
Fenner
Essex
Ludlow
National Trails Highway
Kelbaker Road
Kelso Cima Road
Black Canyon Road
Essex Road
Ivanpah Road
Lanfair Road
Goffs Rd
Mountain Springs Rd
New York Mountains Road
Hart Mine Road
Cima Road
Excelsior Mine Road
Zzyzx Road
Rasor Road
Aiken Mine Rd
Morning Star Mine Road
Ivanpah Rd
KELSO DUNES
GRANITE MOUNTAINS
NEW YORK
LANFAIR VALLEY
PIUTE RANGE
MIDDLE HILLS
CINDER CONE LAVA BEDS
SODA LAKE (dry)
SILVER LAKE (dry)
IVANPAH LAKE (dry)
NEVADA
CALIFORNIA

Of the Preserve's 1.6 million acres, 804,949 acres are designated as wilderness, and the other half of the Preserve is designated as critical habitat for the federally threatened desert tortoise (*Gopherus agassizii*).

On February 12, 2016, President Obama established the Castle Mountains National Monument (monument) on federal land immediately adjacent to the Preserve, along its northeastern boundary. While this approximately 21,000-acre monument is managed by the NPS and is part of the ecological, hydrologic, and management context of the Preserve, it is not included in this plan. Additional work needs to be completed to inventory water features at the monument and to understand issues related to water resources therein.

Preserve History, Purpose, and Significance

History of Mojave National Preserve

The history of human occupation in the Mojave Desert extends back centuries. In 1776, early explorers were met by members of the Mohave Tribe, who were concentrated along the floodplain of the Colorado River. In the early 1800s, the Mojave Road, originally part of tribal trading routes, became a major route across the desert for European explorers and travelers. By the 1860s, army outposts were established to protect mail carriers and other travelers on the Mojave Road. Soon after the beginning of the mining era, several cattle ranches were established in the vicinity of Government Holes and Cima Dome. Bolstered by the construction of nearby railroads, several other cattle ranches were established and eventually consolidated into the sprawling Rock Springs Land and Cattle Company in 1894. The ranching era lasted through most of the 1900s. Some of the extensive infrastructure to develop and transport water still exists and continues to provide surface water in the Preserve.

In 1994, the CDPA was passed and the Preserve was created from federal lands that were previously administered by the BLM as the East Mojave National Scenic Area. The CDPA also included the designation of 804,949 acres of wilderness.

Purpose of Mojave National Preserve

Congress provided specific direction for the new California desert parks (Mojave National Preserve, Joshua Tree National Park, and Death Valley National Park) and wilderness areas in section 2(b)(1) of the CDPA. These lands were included in the national park system and the national wilderness preservation system to:

- preserve unrivaled scenic, geologic, and wildlife values associated with these unique natural landscapes;
- perpetuate in their natural state significant and diverse ecosystems of the California desert;
- protect and preserve the historical and cultural values of the California desert associated with ancient Indian cultures, patterns of western exploration and settlement, and sites exemplifying the mining, ranching and railroading history of the Old West;
- provide opportunities for compatible public outdoor recreation; protect and interpret ecological and geological features and historic, paleontological, and archeological sites; maintain wilderness resource values; and promote public understanding and appreciation of the California desert; and
- retain and enhance opportunities for scientific research in undisturbed ecosystems.

Significance of Mojave National Preserve

An NPS unit's statement of significance clearly defines the importance of its resources as they relate to the Park (or Preserve) purpose. These statements help set resource protection priorities, identify primary interpretive themes, and develop desirable visitor experiences. Significance in this context is the importance of a feature or an outstanding value. It may be locally, regionally, nationally, or globally significant, unique, extraordinary, or important to our national and cultural heritage. Significance is not used here in a legal sense, such as with the National Environmental Policy Act (NEPA) or the National Historic Preservation Act (NHPA).

The Preserve's General Management Plan includes the following relevant significance statements, which serve as the basis for management actions (NPS 2002). Mojave National Preserve:

- Protects an extensive variety of habitats, species, and landforms unique to the Mojave Desert and is the best place to experience this ecosystem.
- Contains outstanding scenic resources, rich in visual diversity and containing a varied landscape of sand dunes, mountain ranges, dry lake beds, lava flows, cinder cones, Joshua tree forests, and far-reaching vistas.
- Is a naturally quiet desert environment with very dark night skies that offers visitors and researchers opportunities for natural quiet, solitude, and stargazing with few human-caused noise or light glare sources.
- Protects numerous historic sites from early mining, ranching, homesteading, and railroading endeavors that serve as reminders of the bold and tough people who opened the harsh and forbidding western frontier.

Factors Influencing Water Resource Management

Water resource management activities within the Preserve must consider the broad context of activities throughout the Mojave Desert region. The Mojave Desert region consists of a complex mosaic of land management types, proposed and existing development areas, transportation corridors, and ecologically core habitat areas. A long history of land and water development throughout the Mojave Desert has direct implications on both water source availability and wildlife populations in the Preserve. These effects may be compounded by the effects of a changing climate on the desert environment. As the availability of water from natural and artificial sources within the Preserve changes due to climate change or management, maintaining the overall connectivity of ecologically core habitat areas will be important to allow wildlife to migrate and adapt to changing conditions.

As stated above in "Need for Action" section, a variety of ecological, historical, regional, and policy factors influence water resources management in the Preserve, as well as the development of the water resource management alternatives analyzed in this EA. These factors are described below and explored in greater detail in *Chapter 3: Affected Environment*:

Environmental Setting, Climate, and Geology

The Preserve includes an ecologically diverse yet fragile desert ecosystem consisting of vegetative attributes that are unique to the Mojave Desert, as well as components of the Great Basin and Sonoran Deserts. The topography of the Preserve consists of tall, rugged mountain ranges interspersed with broad, flat valleys. The climate is extreme and is characterized by very hot summers and limited precipitation. Changing climate trends are likely to have a profound effect on the relationships between desert ecology, wildlife populations, and the spatial and temporal distribution of available surface water on the landscape.

The Mojave Desert ecosystem has been affected by multiple human pressures. Due to its proximity to Las Vegas, the Preserve's dark night skies are adversely impacted by light pollution. Interstate highways, aircraft overflights (both military and commercial), military training bases, energy transmission corridors, solar energy developments, and motorized vehicle–enabled recreation have greatly reduced and fragmented the habitat available to support a fully functional desert ecosystem.

Groundwater and Surface Water Resources

Within the broad valleys of the Preserve are deep alluvial groundwater basins that contain aquifers. Some of these deep aquifers are associated with perennial springs such as Piute Springs and Soda Springs, which support small riparian ecosystems. The more common types of springs or seeps are those located along the slopes and edges of mountain ranges and fed by small, localized perched aquifers.

Surface water availability for wildlife has been fundamentally altered throughout the history of the Mojave Desert. About half of the Preserve's springs and seeps have been modified at some time to facilitate human uses of the landscape. Starting in the mid-20th century, land management agencies and local volunteers constructed wildlife water sources known as "guzzlers." Guzzlers intercept and store rain water for use by various wildlife species. While many of the developed water sources in the Preserve were originally intended to augment game species populations, over time they may have come to serve a broader ecosystem role.

An estimated 311 springs, seeps, and wells and 137 guzzlers (big and small) are known to exist in the Preserve. For the purpose of this plan and EA, the NPS has categorized the types of water features as (NPS 2010a):

- *Springs*– flowing or ponded springs, seeps, bogs, and tinajas
- *Water Developments* – tunnels, springboxes, adits, excavations, troughs, and pipes
- *Wells* – shallow wells and deep drilled wells
- *Ponds and reservoirs* – ponds, mining pit lakes, and wet playas
- *Guzzlers* – water developments built specifically to collect and distribute water to big game or game birds

Wildlife Conservation and Management

While most native species of plants and animals are adapted to survive in this water-scarce environment, many species use natural or human-made sources of free-standing water to supplement moisture from forage. As a result of regional loss of habitat connectivity and climate change, some species (such as the desert bighorn sheep) rely on both natural and developed water sources to survive. Other species of native wildlife are less reliant on water features, but use those sources opportunistically to enhance habitat and facilitate migration.

The following three sensitive species are relevant to the availability and management of natural and developed water resources:

- The **Mohave tui chub** (*Siphateles bicolor mohavensis*) is a minnow that is federally and state-listed as endangered, and is the only fish native to the Preserve. A small population persists at groundwater-fed pools at Soda Springs (Zzyzx), while another population has been introduced to the pit pond in the abandoned Morningstar Mine. Other thriving populations exist outside of the Preserve.

- The **desert tortoise, Mojave population** (*Gopherus agassizii mohavensis*), is a federally and state-listed threatened species with habitat found at lower elevations in the Preserve. Critical habitat was designated in 1994 before the passage for the California Desert Preservation Act (CDPA).
- The **desert bighorn sheep** (*Ovis canadensis nelsoni*) is managed by the State of California as a fully protected species. Some existing populations are thought to be largely dependent on big game guzzlers in the Preserve, and efforts are underway to improve the size and regional distribution of bighorn sheep populations in the Mojave Desert.

These three species and other wildlife species and their relationship with water resources and management in the Preserve are described in greater detail in *Chapter 3: Affected Environment*.

Designated Wilderness

The 1994 CDPA designated almost half of the Preserve (804,949 acres) as wilderness. Almost half of the Preserve’s small game guzzlers and all of the big game guzzlers are located in wilderness. This presents a dilemma for both water resource management and policy compliance. Most of these water features provide some element of habitat for wildlife, and many require routine maintenance to ensure their effectiveness and safety. These features also fall within the definition of being installations, which are generally not allowed in wilderness.

Other prohibited activities include temporary roads, motor vehicles, motorized equipment, landing of aircraft, and other forms of mechanical transport. The Wilderness Act allows exceptions to this prohibition "as necessary to meet minimum requirements for the administration of the area for the purpose of this Act." This exception gives the agency discretion to engage in these “prohibited uses” if the prohibited use is deemed necessary for management of the area as wilderness. The existence of a prohibited structure, and the mechanized access and tools used for its maintenance, are only permitted if they are determined to be the minimum necessary to preserve wilderness character and achieve wilderness purposes. While wildlife conservation is a purpose of wilderness and some guzzlers may help preserve some qualities of wilderness character (e.g., the “natural” quality associated with wildlife), the presence of developed structures and the use of motorized vehicles or equipment may adversely affect other qualities of wilderness character (e.g., “undeveloped” and “untrammeled”).

Impact Topics

Impact Topics Retained for Analysis

Impact topics represent specific park resources (and can be thought of as “headings” used in the NEPA review) and are described in detail in *Chapter 3: Affected Environment* and analyzed in *Chapter 4: Environmental Consequences*.

Wildlife

The Preserve provides habitat for wildlife species characteristic of southwestern deserts. Approximately 35 different habitat types have been documented, supporting a wide variety of native and nonnative wildlife species, including at least 300 bird, 49 mammal, 38 reptile and amphibian, and 1 native fish species. As previously stated above under “Concerns and Issues,” the long-term management of water resources in the Preserve can have both beneficial and adverse impacts on a variety of native and nonnative wildlife species (including special status species). In particular, desert ungulates and riparian-dependent species rely on available surface water to survive in the Mojave Desert.

Loss of water developments in the Preserve could result in loss of habitat for some species, while others would not be affected. Wildlife species, such as desert bighorn sheep, that persist in small isolated populations are more vulnerable to a loss of habitat and genetic diversity. Changes in water resource management in the Preserve could result in beneficial impacts for other species, such as desert tortoise, as water developments are a potential source of mortality for these species. Because proposed actions could affect habitat and species distribution in the Preserve, this topic was retained for further analysis and focuses on water availability for desert bighorn sheep.

Cultural Resources

The Preserve has a rich cultural heritage spanning both prehistoric and historic eras. Eight sites/districts in the Preserve are currently listed or are eligible for listing on the National Register of Historic Places (NRHP). In addition, 15 cultural landscapes/historic districts and sites have been identified by the Preserve as potentially eligible for listing on the NRHP. Many of the tanks, windmills, pumpjacks, troughs, dams, pipelines, springs, wells, and other features in the Preserve are listed as significant contributing features to the NRHP-eligible cultural landscape districts. The Preserve has identified 85 spring developments that are potentially considered historic. Of the 85 spring developments, 47 were identified to potentially have prehistoric significance. For the purposes of this plan, all water features (except big game guzzlers) are considered potentially eligible historic resources.

Since the proposed management actions have the potential to directly affect the cultural landscape in the Preserve this topic is retained for further analysis.

Wilderness Character

The Preserve has 804,949 acres of designated wilderness, which is nearly half of the land area in the Preserve. The Wilderness Act generally requires that wilderness areas be administered to provide for their protection and preserve their wilderness character. Most of the water resources that are described in this plan are located in wilderness, including 75 percent of the documented springs, nearly half of the small game guzzlers, and all six of the big game guzzlers. Most of these water sources provide some element of habitat for wildlife, and many require routine maintenance to ensure their effectiveness and safety. However, the existence of developed water features, and the mechanized access and tools used for their maintenance, are only permitted if they are necessary to meet minimum requirements for the administration of the area for wilderness purposes.

The presence of structures in wilderness and actions needed to maintain water structures (e.g., the use of motorized vehicles or equipment) could adversely affect certain qualities of wilderness character (i.e., “undeveloped” and “untrammeled”). Therefore, issues associated with wilderness character are retained for further analysis.

Issues Considered but Dismissed from Further Consideration

Issues that are not relevant to this plan were eliminated from further consideration by the planning team. In some instances, issues were dismissed because they relate to resources that are not present in the Preserve. In other instances, Preserve staff considered potential issues for certain resource areas, but because the impacts were considered minimal, they were also dismissed from further analysis. These issues, and the rationale for dismissing them, are described below.

Water Resources

Water resources include groundwater, surface water, and the various types of water features including springs, developments, wells, ponds, and guzzlers. The Preserve contains several deep alluvial groundwater basins that are important hydrological and ecological resources. Some of these deep aquifers are associated with perennial springs, which support small riparian ecosystems. A variety of natural and developed water features exist on the landscape, including natural springs, developed springs, wildlife guzzlers, and wells. An overview of groundwater and surface water resources in the Preserve is presented in the “Water Resources” section in *Chapter 3: Affected Environment*. All water resource management alternatives include some level of management or neglect of water resources, as well as administrative actions to address groundwater and water rights. The adverse and beneficial impacts of actions or neglect on water resources themselves would be similar under all water resource management alternatives and are better described in terms of the effects of those actions on wildlife, and are speculative in terms of their effect and timing. For these reasons, water resources—as a resource in itself—was dismissed from further analysis.

Vegetation Communities

Past inventories have documented more than 900 plant species in the Preserve. Sonoran plant species such as pancake prickly pear (*Opuntia chlorotica*) and smoke tree (*Dalea spinosa*) are found in the southeast portion of the Preserve. Grasslands, sagebrush, blackbrush, pinyon-juniper woodlands, and unique remnant habitats containing small white fir (*Abies concolor concolor*) forests occur in the higher elevations in the Preserve. Upland desert communities make up most of the Preserve’s vegetation. Although wetlands and riparian areas are uncommon in the Preserve, they are disproportionately important from an ecological perspective and are often associated with developed or natural water features.

Following are brief descriptions of the vegetation communities at the Preserve.

- *Upland Desert Communities* – The most common plant communities in the Preserve, from low-elevation basins to the high mountains, are alkali playa, desert wash, creosote bush (*Larrea tridentata*) scrub, desert dunes, cactus-yucca scrub, blackbrush scrub, big sagebrush (*Artemisia tridentata*) scrub, Joshua tree (*Yucca brevifolia jaegeriana*) woodland, and pinyon-juniper woodland.
- *Wetlands and Riparian Areas* – Vegetation in these areas is often dense and fast growing. Dominant tree species in the riparian community vary based on hydrologic conditions at a given site and can include cottonwood (*Populus fremontii*), willows (*Salix* spp.), mesquite (*Prosopis glandulosa* and *P. pubescens*), and tamarisk (*Tamarix ramosissima*). Subcanopy species may include seepwillow (*Baccharis salicifolia*), desert willow (*Chilopsos linearis*), sandbar willow (*Salix exigua*), cattail (*Typha* spp.), and sedges (*Carex* spp.) and rushes (*Juncus* spp.).

Under all water resource management alternatives, changes to vegetation communities, particularly wetland and riparian areas, would be localized and minimal. Localized disturbance to upland desert species could result from proposed management actions (e.g., construction, repairs, and removal of water developments); however, the impacts would be localized and short-term. Disturbed vegetation is expected to recover following management activities. Removal of nonnative phreatophyte vegetation (e.g., tamarisk) from water features would be an ongoing practice that would continue under all water resource management alternatives. Therefore, this topic was dismissed from further analysis.

Recreation and Hunting

Changes to recreational hunting were identified as an issue of concern during the scoping process. Hunting is a unique and important visitor use opportunity in the Preserve. Although hunting is prohibited in most national park system units, it is specifically authorized in the Preserve by the 1994 CDPA. Hunting is reaffirmed as an appropriate activity in the 2001

General Management Plan (GMP), with the goal of providing opportunities for hunters to take game species during the fall and winter, while also providing a park experience with no hunting or shooting during the spring and summer.

The Preserve is one of the few places in California where bighorn sheep hunting is allowed. A very limited number of bighorn sheep licenses are issued throughout the state through a lottery and auction system. The CDFW determines the number of tags to be issued based on population estimates. In the recent past, the CDFW has issued up to three hunting licenses for bighorn sheep within the Preserve (Old Dad and Kelso Peak hunt zone). Therefore, changes to guzzler management is not likely to have an impact on the hunting or the issuance of tags in the Preserve.

In addition to desert bighorn sheep, hunting opportunities in the Preserve include mule deer (*Odocoileus hemionus*), mourning dove (*Zenaida macroura*) and white-winged dove (*Zenaida asiatica*), Gambel's quail (*Callipepla gambelii*), chukar (red-legged partridge) (*Alectoris chukar*), rabbit (cottontail) (*Sylvilagus* spp.), hare (jackrabbit) (*Lepus californicus*), bobcat (*Lynx rufus*), and coyote (*Canis latrans*) (NPS 2009). Under all the water resource management alternatives many of the small game guzzlers and most of the springs would continue to be neglected and would eventually fall into disrepair. Over time, many of these would cease to provide water or habitat for wildlife, including game species. In addition, the action alternatives include select removal of some small game guzzlers and limited maintenance of some water features.

These potential impacts on game species resulting from water resource management are not expected to result in detectable changes in recreational hunting opportunities for the following reasons:

- The greatest change in the number of water features on the landscape would be due to ongoing neglect. This neglect is a continuation of the status quo, would be similar under all water resource management alternatives (including No Action), and the actual effect on wildlife habitat (the point at which an individual water source fails and no longer supports wildlife) would be geographically dispersed and would occur over a very long period, in many cases beyond the horizon of this plan.
- Considering the temporally and spatially dispersed effects of neglect described above, most wildlife species—including mule deer and small mammals—would adjust habitat use patterns over time. This is not unlike the ongoing adjustments that occur between seasons and between wet and dry years as local populations seek favorable forage and water.
- While localized game bird populations may be reduced or may move to locations with better water availability, those changes may not affect hunting availability or success. Literature cited in the Western Quail Management Plan suggests that quail nesting success, and corresponding hunting success, is more dependent on precipitation-driven vegetation than the availability of open surface water (Zornes and Bishop 2009). Annual variations in precipitation, which produces the green vegetation that these birds rely on for their water requirements, will continue to be the main factor affecting hunting quality.
- None of the alternatives change the locations, seasons, or other hunting regulations in the Preserve.

For these reasons, the NPS does not believe changes in the management of water features in the Preserve would result in detectable impacts on the availability or success of recreational hunting in the Preserve. Therefore, recreation and visitor experience was dismissed from further analysis.

Preserve Operations

Under all water resource management alternatives, the Preserve would continue to develop groundwater wells to support Preserve operations as needed. Operations may be supported by wells including administrative support facilities, as well as expanded or relocated campgrounds and visitor centers. This use would be common to all water resource management alternatives, and none would affect the ability of the Preserve to develop or maintain water features for management and operations. Therefore, this topic was dismissed from further analysis.

Geology, Geohazards, and Soils

None of the water resource management alternatives would affect geological features or geohazards in the Preserve. Any management actions that would involve construction could potentially impact soils. However, any such impacts would be small, localized, and would have a negligible effect on soil resources in the Preserve; therefore, these issues were dismissed from further analysis.

Air Quality

Potential sources of air quality emissions resulting from the proposed alternatives would be limited to the infrequent use of vehicles and equipment to implement the management actions over time. Any increase in air emissions from these activities would be extremely minimal and indistinguishable from routine management activities, with negligible impacts on air quality. Therefore, air quality was dismissed from further analysis.

Land Use

None of the alternatives would change the ownership, occupancy, or use of land within the Preserve, within inholdings, or in neighboring communities. Therefore, land use was dismissed from further analysis.

Ethnographic Resources

Ethnographic resources are traditional sites, structures, objects, landscapes, and natural resources that communities define as significant to their way of life. No ethnographic resources or issues have been identified in the Preserve; therefore, this topic was dismissed from further analysis.

Indian Trust Resources and Sacred Sites

The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights. No formerly established or recognized Indian trust resources or sacred sites have been identified at in or near the project area, and this impact topic was dismissed from further consideration.

Socioeconomics

None of the alternatives would affect Preserve visitation, visitor spending, or income to surrounding communities; therefore, this topic was dismissed from further analysis.

Environmental Justice

Executive Order 12898 directs federal agencies to assess whether their actions have disproportionately high and adverse effects on minority and low-income populations. All of the water resource management actions proposed in the alternatives are focused on either scattered and remote water features or administrative efforts to monitor and protect groundwater systems over the long term. None of the proposed water management alternatives would affect visitor access and use of the Preserve, or economic conditions in surrounding communities, and none of the proposed alternatives would have disproportionate effects on minority or low-income populations. Therefore, environmental justice was dismissed from further analysis.

CHAPTER 2: WATER RESOURCE MANAGEMENT ALTERNATIVES

Alternatives Development Process

The National Environmental Policy Act (NEPA) requires federal agencies to evaluate a range of reasonable water resource management alternatives that address the purpose and need for taking action. The Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1502.14) also require that federal agencies analyze a “no action” alternative, which evaluates the future conditions that would result from continuing current management practices and allows the public to evaluate what would happen if no new plan were adopted. In addition to the “no action” alternative, this chapter describes three alternative approaches water resource management in the Preserve. This chapter also provides background information that is necessary to understand the rationale for each action alternative and a discussion of implementation and evaluation methods.

Types of Water Features

Big game guzzlers – Large tanks and systems intended to provide water for desert bighorn sheep

Small game guzzlers – Concrete aprons leading to underground tanks to provide water to game birds

Springs – Natural or human-induced water expressions

Water developments – Excavations, pipes, tanks, and other infrastructure to collect and convey water

Wells – Hand-dug or drilled vertical holes intended to lift water to the surface

Ponds and reservoirs – Natural and excavated depressions or embankments that hold surface water

These water features are described in detail in the “Water Resources” section in Chapter 3: Affected Environment.

The water resource management alternatives for this plan were developed based on an understanding of this plan’s purpose, need, and objectives; the complex resource conditions and issues influencing water management; and public and stakeholder input obtained during the scoping process.

Scoping Process and Public Participation

The planning process began in November 2010 with an internal scoping meeting to understand the need for this plan and define an approach for the planning process. Public scoping began on May 11, 2011, with the publication of the notice of intent in the Federal Register (76 FR 27344). The public was invited to submit comments through July 11, 2011, on the scope of the planning process and to identify potential environmental impacts, issues, concerns, and alternative concepts. The scoping comment period was subsequently extended to August 12, 2011. Four public meetings were held during the scoping period: June 27 (Henderson, Nevada), June 28 (Needles, California), June 29 (San Bernardino, California), and June 30 (Barstow, California). During the scoping period, 67 pieces of correspondence were received. The issues identified during scoping form the basis for the impact topics that were selected for detailed analysis (see “Impact Topics” section in *Chapter 1- Purpose and Need*).

In October 2011, the interdisciplinary planning team participated in a three-day alternatives workshop, which focused on identifying a range of reasonable water management approach alternatives, how various types of water resources in the Preserve would be managed under the alternative approaches, and how those approaches would translate to actual water features. The alternatives development workshop resulted in a range of alternative concepts, an understanding of concepts to be dismissed from further consideration (see discussion at the end of this chapter), and a framework for further alternatives development and refinement. Following the alternatives development workshop, the planning team continued refining the alternative concepts to ensure the alternatives presented for analysis were feasible, logical, met the requirements of NEPA and sound resource planning, and were responsive to the complex, unique, and variable resources in the Preserve. In August 2012, three action alternatives—each proposing a different philosophical and management approach to water resources—were published for review and comment. The comments that were received were integrated into the alternatives that are described in this chapter.

Concerns and Issues Raised during Scoping

During the scoping period, several issues of concern related to water resources management were identified. Issues are problems, opportunities, and concerns related to existing conditions, or those that may arise during implementation of water resource management alternatives. The key issues identified during scoping are summarized below, along with a description of how they are or are not addressed.

Surface Water Features

The appropriate management and disposition of natural and developed surface water features is a central issue to this plan. While some people believe water developments should be removed to promote natural ecosystem processes, others believe all water developments should be maintained or expanded to preserve wildlife habitat. Three action alternatives reflect different philosophical and management approaches to surface water features, which are analyzed under each impact topic. Effects on the physical water features themselves was dismissed as an impact topic.

Wetland and Riparian Vegetation

Many natural and developed surface waters support wetland and riparian vegetation and provide habitat for riparian-dependent plant and animal species. This issue was dismissed from detailed analysis because the actions in this plan would not affect wetland and riparian vegetation. Protection and management of wetland and riparian habitat is an ongoing practice that would not be affected by the water resource management alternatives.

Groundwater Conditions and Availability

Most naturally occurring water features in the Preserve depend on perched aquifers fed by precipitation. Two springs, Piute Springs and Soda Springs, depend on deep alluvial groundwater basins. The relationship between groundwater conditions, water development and extraction proposals, and surface water features in the Preserve should be understood. This topic was dismissed from further analysis as the water resources but is included in *Chapter 3: Affected Environment* because groundwater resources are foundational to water management in the Preserve. While perched aquifers are part of the environmental setting, all water resource management alternatives include measures to protect deep alluvial groundwater basins, and the potential benefits are uncertain.

Wildlife and Wildlife Habitat

Many wildlife species rely on available surface water to survive in the Mojave Desert. While some species are adapted to water scarcity and harsh environmental conditions, others are partially or wholly dependent on natural and developed water features to maintain their current populations. The long-term management of water resources in the Preserve can have both beneficial and adverse effects on a variety of wildlife species. The three action alternatives present different approaches to managing water resources as they relate to wildlife, which are analyzed under the *Wildlife* impact topic.

Rare, Unique, Threatened, or Endangered Species

The Preserve is home to several wildlife species of special concern, the management and health of which are directly or indirectly influenced by water resources. These species include the Mohave tui chub, desert tortoise, and desert bighorn sheep. Long-term water resource management strategies in the Preserve should consider the implications of those strategies on the conservation of these species. All water resource management alternatives include conservation measures for the Mohave tui chub and desert tortoise, while the three action alternatives present different approaches for the desert bighorn sheep. These species are analyzed under the *Wildlife* impact topic.

Historic Water Developments

Many of the existing water features in the Preserve were originally developed to support ranching activities, and most are considered to have historic properties. This plan will consider how the management of historic water developments affects historic features and preservation requirements. The management of historic water features is different in each alternative; the background and effects are analyzed under the *Cultural Resources* impact topic.

Wilderness Character

The Preserve has 804,949 acres of designated wilderness. Many water developments are located in wilderness. This plan considers how these water features are managed in a manner consistent with broader water management objectives while preserving wilderness qualities. The three action alternatives present different approaches to managing water resources within wilderness, which are analyzed under the *Wilderness* impact topic.

Recreational Opportunities and Visitor Experience

Legislation has established hunting as an appropriate recreational activity in the Preserve, as well as the authority of the NPS to manage wildlife populations. Water management strategies for the Preserve will need to consider the effects of various management approaches on recreational hunting, as well as other recreational opportunities that visitors enjoy in the Preserve. This issue was dismissed from detailed analysis because the actions in this plan were determined to not result in detectable impacts on the availability or success of recreational hunting within the Preserve.

Regional Context

A long history of land development, water development, and habitat fragmentation throughout the Mojave Desert has direct implications on both water source availability and wildlife populations in the Preserve. These effects may be compounded by the effects of a changing climate on the desert environment. Long-term water management strategies will need to be considered in context with regional development, changes, and uncertainties. Issues related to the regional context of the Mojave Desert are common to all alternatives and are presented in the "Regional Context" discussion in *Chapter 3: Affected Environment* and cumulative effects analysis for each impact topic in *Chapter 4: Environmental Consequences*.

Water Resource Management Alternatives

The following four water resource management alternatives (alternatives) are considered for implementation: one no action alternative and three action alternatives (see Table 1 for big game guzzler implementation example). Each action alternative represents a distinct approach to managing water resources that is intended to achieve a different set of desired conditions. The different desired conditions represent different emphases in terms of resource values, while the management strategy for each alternative reflects different assumptions about environmental conditions and different approaches to water resource management and decision making.

Alternative Objectives and Management Strategies

Each alternative represents a distinct objective and approach to managing water developments in the Preserve, representing different assumptions about environmental conditions and approaches to water resource management and decision making. Four alternatives were retained for detailed analysis and are described in greater detail in the following sections of this chapter.

Alternative 1 (No Action). Manage water developments on an ad hoc basis, often in response to external proposals or directives. All existing water developments would be retained, but would not be rebuilt or replaced.

Alternative 2. Minimize water developments in wilderness while strategically using water developments to conserve native wildlife populations. Under Alternative 2:

- Three big game guzzlers would be removed, two would be relocated, one would be retained, and two new water sources would be developed.
- Most small game guzzlers would be neglected and some would be removed or disabled, while select non-wilderness guzzlers would be maintained to support native wildlife.
- Water developments at 5 to 10 managed springs would be evaluated for ecological importance and potential maintenance, while most others would be neglected.

Alternative 3 (Preferred Alternative). Manage water developments to support native species conservation and population stability while reducing the number of water developments in wilderness. Under Alternative 3:

- Two big game guzzlers would be removed, two would be relocated, two would be retained, and three new water sources would be developed.
- Most small game guzzlers would be neglected and some would be removed or disabled, while select non-wilderness guzzlers would be maintained to support native wildlife.
- Water developments at 5 to 10 managed springs would be evaluated for ecological importance and potential maintenance, while most others would be neglected.

Alternative 4. Manage water resources to augment native wildlife habitat and restore connectivity. Under Alternative 4:

- One big game guzzler would be removed, two would be relocated, three would be retained, and two new water sources would be developed.
- Small game guzzlers would be maintained and improved outside wilderness to support native wildlife.
- Water developments at 10 to 15 managed springs would be maintained or stabilized, while the rest would continue to be neglected.

Table 1. Water Resource Management Alternatives Summary

	Alternative 1 – No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Big Game Guzzlers				
Guzzler Actions	Continue filling and maintaining guzzlers as needed	• Remove Clark, Piute, and Old Dad guzzlers • Retain Kelso guzzler • Relocate Kerr and Vermin guzzlers to outside wilderness (New Kerr and New Vermin) • Build potential new guzzlers at Vontrigger and Ginn sites • 5 guzzlers within the Preserve, 1 within wilderness	• Remove Clark and Piute guzzlers • Retain Old Dad and Kelso guzzlers • Relocate Kerr and Vermin guzzlers to outside wilderness (New Kerr and New Vermin) • Build potential new guzzlers at Piute North, Vontrigger, and Ginn sites • 7 guzzlers within the Preserve, 2 within wilderness	• Remove Clark guzzler • Retain Piute, Old Dad, and Kelso guzzlers • Relocate Kerr and Vermin guzzlers to outside wilderness (New Kerr and New Vermin) • Build potential new guzzlers at Vontrigger and Ginn sites • 7 guzzlers within the Preserve, 3 within wilderness
Small Game Guzzlers				
Guzzlers in Wilderness	*Common to All Alternatives:* • Neglect all; allow guzzlers to deteriorate over time			
Non-wilderness Guzzlers	• Allow ad hoc maintenance • Neglect all other small game guzzlers	• Evaluate sets of 10 to 15 guzzlers for condition and wildlife use • Repair escape ramps as needed • Maintain or improve a select few for native wildlife • Remove or disable some • Neglect remaining guzzlers	Same as Alternative 2	• Evaluate sets of 15 to 25 guzzlers for condition and wildlife use • Maintain and repair escape ramps as needed • Repair, maintain, or improve for native wildlife • Remove or disable select few
Springs and Water Developments				
Developed Springs	• Allow maintenance of springs per outside requests • Clean up spring sites if needed for visitor safety • Neglect all others	• Evaluate 5 to 7 spring developments per year for ecological importance and condition • Maintain 5 to 10 springs if determined important for native wildlife • Neglect all others	Same as Alternative 2	• Evaluate 5 to 7 spring developments per year for ecological importance and condition • Maintain 10 to 15 springs if determined important for native wildlife • Neglect all others
Wells	Actively close/abandon or maintain wells to comply with state regulations	*Common to All Action Alternatives:* • Maintain 8 NPS water supply wells and 28 grazing/ monitoring wells for administrative purposes • Add 1-2 wells in the Hole in the Wall area to support Preserve operations • Retain up to 3 wells for future water supply • Destroy unused wells		

	Alternative 1 – No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Ponds and Lakes	• Maintain habitat for endangered Mohave tui chub on an ad hoc basis • Neglect other (ephemeral) ponds, with no active management, maintenance, or improvements	*Common to All Action Alternatives:* • Maintain springs for Mohave tui chub and pursue additional restoration sites • Neglect other ponds		
Other Elements				
Deep Alluvial Basin Groundwater	Provide technical review and comments on outside proposals	*Common to All Action Alternatives:* • Monitor groundwater quality and water levels for long-term trends/public health • Develop new water supply wells as needed to support NPS operations • Provide technical review and comments on outside proposals • Pursue legal avenues to prevent or mitigate impacts on Preserve resources • Complete well inventory and destroy abandoned wells according to state code		
Water Rights	Continue filing as directed by NPS Water Resources Division	• Common to All Action Alternatives: • Evaluate water rights acquired by the Preserve with assistance from NPS Water Resources Division • Develop and assert federal reserved water rights as needed to protect resources		
Other Programs	Identify and mitigate hazardous materials as lands are acquired	• Common to All Action Alternatives: • Identify and mitigate hazardous materials as lands are acquired • Use water source manipulation to manage livestock grazing per Grazing Management Plan (under development) and consistent with this plan		

Alternative 1 – No Action

Objective and Approach

The NPS would continue current water management practices, which would retain the current number and distribution of water developments and respond to external proposals or initiatives on an ad hoc basis. Water resource management actions related to wildlife, historic features, and Preserve operations; and the impacts of those changes, would be addressed on a case-by-case basis based on land designations (e.g., wilderness or critical habitat) without overarching guidance.

> **Definitions of Key Planning Terms**
>
> **Objectives** – Qualitative statements of values that serve to guide natural resource decision making and the evaluation of success. All action alternatives meet all objectives to a large degree, while also addressing the purpose and need for actions. (See "Objectives in Taking Action" in *Chapter 1: Purpose of and Need for Action*.)
>
> **Desired Conditions** – Natural and cultural resource conditions that the NPS aspires to achieve and maintain over time. Desired conditions are different for each action alternative, reflecting a different set of values and assumptions about the resources being addressed.
>
> **Indicators** – Specific, measurable physical and ecological variables that reflect the overall condition of the resource.
>
> **Unacceptable Impacts** – Impacts that, individually or cumulatively, would be inconsistent with a park's purpose or values, or impede the attainment of a park's desired future conditions for natural and cultural resources as identified through the park's planning process, or diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values. The NPS will avoid impacts that it determines to be unacceptable.
>
> *Based on NPS Management Policies 2006*

Common Objectives of the Action Alternatives

All three action alternatives are designed to meet common objectives that address the plan's purpose and need (see "Introduction" section in *Chapter 1-Purpose and Need)*.

Wilderness Values and Wildlife Habitat Conservation

The Mojave Desert is rapidly changing as a result of the combined anthropogenic effects of climate change, habitat fragmentation, and habitat loss. Habitat loss and fragmentation increase the importance of large national parks for wildlife habitat conservation. Each action alternative recognizes the importance of wilderness qualities, the need for active management to support wildlife conservation in the face of anthropogenic change, and the desire to balance sometimes conflicting values and mandates.

All action alternatives recognize that the presence of water developments on the landscape supplements free-standing water for many native wildlife species. These supplemental water features are believed to be essential in supporting the conservation of sensitive species such as desert bighorn sheep, mitigating the regional effects of human development on their habitat, and supporting overall biodiversity in the Preserve.

Each alternative would optimize the use of water developments to meet diverse land and wildlife management objectives by maintaining those that are important to native wildlife populations, removing those that do not contribute to habitat value, and strategically using water developments outside of wilderness to support wildlife conservation.

Habitat Connectivity

Within the Mojave Desert ecosystem, native vegetation and wildlife are adapted to survive extreme temperatures, prolonged drought, and limited free-standing water. In this context, many broad-ranging wildlife populations have historically relied on interconnected habitat islands and regional metapopulations to buffer against drought conditions and maintain long-term stability. During extended periods of drought, native wildlife have responded by moving to areas with better habitat, facilitated by the presence of free-standing water features. However, expanding human development in the region conditions and compromising the function of the Mojave Desert as an interconnected regional ecosystem.

Many of these habitat areas and migration corridors have been compromised as a result of decades of human development in the Mojave Desert, while climate conditions are expected to become increasingly dry and severe. In addition, a changing climate is expected to result in increasingly hot, dry, and severe conditions. The loss of habitat and ecosystem function, combined with the anticipated effects of global climate change on the Mojave Desert, is expected to result in more isolated and concentrated wildlife populations in the Preserve and in other areas with protected habitat. Protected areas such as the Preserve provide and maintain islands of wildlife habitat in the face of these changes.

Each of the action alternatives recognizes the habitat fragmentation and addresses the need for improved habitat connectivity for bighorn sheep.

Monitoring and Evaluation

Within the Preserve, there is uncertainty about the relationships between water resources, wildlife populations, climate change, and other resources in the desert environment. To proceed with water resource management in the face of these uncertainties, each alternative is based on a set of reasonable assumptions about the relationship between water resources and other resources. As the Preserve's understanding of these relationships evolves, management actions (in any action alternative) would be adjusted accordingly to achieve desired resource conditions, based on the best available data and professional judgment.

At each step of implementation (see Figure 3), the NPS would evaluate the success of management actions and the results of monitoring, with a focus on use of water sources and associated habitat by native wildlife. The determination of acceptability is based on professional judgment and recommendations from NPS staff and subject matter experts, based on resource specific indicators. Indicators are specific measurable physical and ecological variables that reflect the overall condition of a resource (see Table 3, Table 7, and Table 10). The ultimate decision on acceptability is made by the Preserve superintendent.

Alternative 2

Objective

Alternative 2 emphasizes minimizing water developments in wilderness. The overall management philosophy would be strategic intervention to limit intrusion into wilderness while using a variety of tools to conserve and maintain self-sustaining native wildlife populations.

The NPS would assume that removing or relocating some water developments from wilderness, combined with more efficient use of water developments outside of wilderness, would minimize intrusion into wilderness, preserve wilderness qualities and support wildlife conservation.

Approach

Big game guzzlers would be removed from wilderness in a manner that does not results in unacceptable impacts to dry season habitat value. At full implementation, Alternative 2 would result in fewer water developments in wilderness, and in the Preserve overall, compared to the No Action. Alternative 2 includes the following:

- Three big game guzzlers would be removed, two would be relocated, one would be retained, and two new water sources would be developed.
- Most small game guzzlers would be neglected, removed, or disabled.
- Water developments at most springs would be neglected.
- Other elements, including groundwater resources, water rights, hazardous materials, and other water uses not included above would be monitored and managed proactively.

Desired Conditions

Desired conditions for Alternative 2 are:

Desert Bighorn Sheep:

- Big game guzzlers are removed from wilderness, with minimal net loss of functioning dry season habitat for desert bighorn sheep.
- Almost all sheep use guzzler relocation sites before the old guzzler sites are dismantled.
- Health and physical condition of most sheep are not adversely affected by guzzler removal or relocation
- New guzzlers and relocation sites maintain or improve connectivity between habitat areas.
- The Preserve contributes to regional bighorn conservation strategies.

Other Wildlife:

- Supplemental water for wildlife that is provided by developed springs and small game guzzlers slowly diminishes over time as individual sites continue to deteriorate.

Cultural Resources:

- Historic springs and water developments continue to fall into disrepair, as sites slowly revert to a pre-settlement condition.

Wilderness:

- The adverse effects of the presence and active maintenance of guzzlers and water developments on the undeveloped and untrammeled quality of wilderness are reduced from current conditions.

Rationale

Alternative 2 emphasizes the strategic balance between native wildlife conservation needs and the desire to maintain a natural desert ecosystem. While the presence of water developments helps supplement wildlife habitat, it also runs counter to the role of the Preserve to protect and maintain a naturally functioning ecosystem with limited human intervention. This is even more evident in wilderness areas, where the expectation of many visitors and guiding policies is a natural landscape that is undeveloped and untrammeled, meaning that it is to be free from human control or manipulation.

Understanding the conflicting values, mandates, and objectives of wildlife conservation and wilderness preservation, Alternative 2 seeks to reduce intrusions into wilderness while continuing to support native wildlife populations. Water developments would be located and managed to maximize their value for native wildlife populations while also reducing impacts on natural ecosystem functions within wilderness. This would include removing or disabling some water developments within wilderness and other select areas and establishing new guzzlers or water sources outside of wilderness to support desert bighorn sheep conservation.

Alternative 3 (Preferred Alternative)

Objective

Alternative 3 would emphasize reducing of the number of water developments in wilderness while supporting native wildlife habitat conservation and population stability. The overall management philosophy would be strategic intervention to ensure that native wildlife populations are stable as the overall number of water developments within wilderness is reduced and regional habitat connectivity is improved.

In this alternative, the NPS would assume that removing or relocating some water developments from wilderness (subject to monitoring and adaptive management), combined with implementation of new water developments and more efficient use of existing water developments outside of wilderness, would preserve wilderness qualities and support wildlife conservation and habitat connectivity.

Approach

Alternative 3 would minimize guzzlers within wilderness while optimizing the total number of guzzlers within the Preserve. Big game guzzlers would be removed from wilderness in a manner that results in no net loss of dry season habitat value. At full implementation, Alternative 3 would result in more developed water sources in the Preserve compared to Alternative 2 and the No Action; and one more big game guzzler in wilderness compared to Alternative 2. Alternative 3 includes the following:

- Two big game guzzlers would be removed, two would be relocated, two would be retained in place, and three new water sources would be developed.
- Most small game guzzlers would be neglected, removed, or disabled, while select non-wilderness guzzlers would be maintained to support native wildlife.
- Water developments at 5 to 10 managed springs would be evaluated for ecological importance and potential maintenance, while most others would be neglected.
- Other elements, including groundwater resources, water rights, hazardous materials, and other water uses not included above would be monitored and managed proactively.

Desired Conditions

Desired conditions for Alternative 3 are:

Desert Bighorn Sheep:

- There is no net loss of functioning dry season habitat for desert bighorn sheep.
- Almost all sheep use guzzler relocation sites before the old guzzler sites are dismantled.
- Health and physical condition of most sheep are not adversely affected by guzzler removal or relocation.
- New guzzlers and relocation sites maintain or improve connectivity between habitat areas.
- The Preserve contributes to regional bighorn conservation strategies.

Other Wildlife:

- Native wildlife habitat and connectivity is supported by maintaining a limited number of small game guzzlers and springs outside of wilderness.

Cultural Resources:

- Select historic springs and water developments are maintained and improved in a manner consistent with an approved treatment plan and in consultation with the California State Historic Preservation Office (SHPO), though most continue to slowly deteriorate.

Wilderness:

- The adverse effects of guzzlers and water developments on the undeveloped and untrammeled quality of wilderness are reduced from current conditions.

Rationale

Alternative 3 emphasizes supporting and improving dry season habitat for desert bighorn sheep, regional habitat connectivity, and the need to maintain a natural desert ecosystem. Supplemental water features are assumed to be important tools for mitigating the effects of regional habitat fragmentation and for preserving overall biodiversity. However, while water developments can be useful for habitat conservation, such active intervention runs counter to NPS policies to manage biological resources by relying on natural processes, and to limit human intervention to special cases where such management is necessary (NPS Management Policies 4.4.2). In addition, water developments in wilderness areas run counter to the general prohibition on structures in wilderness and the goal of preserving wilderness in an undeveloped and untrammeled state. As with NPS Management Policies, the Wilderness Act allows for exceptions to this general prohibition when the agency can show the structure to be necessary (see Appendix A – Minimum Requirements Analysis).

Alternative 3 seeks to find a balanced and strategic approach that reduces wilderness intrusion while supporting and potentially enhancing native wildlife habitat. Water developments would be managed to maximize their value for native wildlife populations while reducing impacts on natural ecosystem functions within wilderness. This would include removing some water developments within wilderness while establishing new water sources outside of wilderness to support desert bighorn sheep conservation.

Alternative 4

Objective

Alternative 4 emphasizes the use of water developments to augment native wildlife habitat in the Preserve while reducing, where possible, the number of water developments within wilderness. The overall management philosophy would be to use water developments to improve existing habitat in the Preserve and to maintain or develop connections between the Preserve and surrounding habitat in the larger landscape.

Approach

Alternative 4 would expand the use of water developments to augment existing wildlife habitat and improve connectivity between the Preserve and surrounding habitat. The overall strategy for Alternative 4 is to maintain and expand water resource development to bolster wildlife habitat in the Preserve and to reestablish regional habitat corridors that would allow wildlife populations to better respond to changing conditions. The management strategy emphasizes intervention to improve habitat value and to increase habitat connectivity. At full implementation, Alternative 4 would result in more water developments in wilderness compared to the other alternatives, and more water developments in the Preserve compared to the No Action and Alternative 2. There would be the same number of big game guzzlers compared to Alternative 3.

The NPS would assume that maintaining and expanding water developments would expand the distribution and population sizes of native wildlife species and would help mitigate the effects of human development, habitat loss, and climate change. Alternative 4 includes the following:

- One big game guzzler would be removed, two would be relocated, three would be retained in place, and two new water sources would be developed.
- Small game guzzlers would be maintained and improved outside of wilderness to support native wildlife.
- Water developments at 10 to 15 managed springs would be maintained or stabilized, while the rest would continue to be neglected.
- Other elements, including groundwater resources, water rights, hazardous materials, and other water uses not included above would be monitored and managed proactively.

Desired Conditions

Desired conditions for Alternative 4 are:

Desert Bighorn Sheep:

- There is a net gain in functional dry season habitat for desert bighorn sheep.
- Most sheep use guzzler relocation sites before the old guzzler sites are dismantled.
- Health and physical condition of most sheep are not adversely affected by guzzler removal or relocation.
- New guzzlers and relocation sites maintain or improve connectivity between habitat areas.
- The Preserve provides a foundation for regional bighorn conservation strategies.

Other Wildlife:

- Native wildlife habitat and connectivity is improved by maintaining small game guzzlers and springs outside of wilderness.

Cultural Resources:

- Select historic springs and water developments are maintained and improved in a manner consistent with an approved treatment plan and in consultation with the California SHPO, though most continue to slowly deteriorate.

Wilderness:

- The adverse effects of guzzlers and water developments on the undeveloped and untrammeled quality of wilderness are reduced from current conditions, while the natural quality of wilderness as it relates to wildlife conservation is maintained.

Rationale

Alternative 4 places primary emphasis on the continued use of water developments to support native wildlife species. This is consistent with NPS Management Policies Section 4.4.1.1, which states “in addition to maintaining all native plant and animal species and their habitats inside parks, the Service will work with other land managers to encourage the conservation of the populations and habitats of these species outside parks whenever possible."

Considering these ongoing anthropogenic impacts on the ecosystem, a management approach that emphasizes continued intervention is needed to mitigate human impacts and maintain native wildlife habitat and populations. Continued use of existing water developments is necessary to achieve these objectives, along with the strategic placement of new water developments to improve new habitat areas and connectivity between habitat islands. Although new water development would be focused on non-wilderness areas, the maintenance and conservation of wildlife species as a natural quality in wilderness would be emphasized, while impacts on the undeveloped and untrammeled qualities would be anticipated and tolerated.

Alternatives by Water Feature Type

Big Game Guzzlers

Big game guzzlers (also known as "guzzlers") are large water developments that are specifically intended to support desert bighorn sheep populations. Six big game guzzlers are located in the Preserve: Kerr, Old Dad, Vermin, Clark, Piute, and Kelso. All of these guzzlers are in wilderness. None of the alternatives include the removal of all big game guzzlers in the Preserve, and none involve the construction of new guzzlers in wilderness (Table 2).

Table 2. Summary of Implementation Actions for Big Game Guzzlers

Guzzler	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Clark	Remove	Remove	Remove
Piute	Remove	Remove	Retain
Old Dad	Remove	Retain	Retain
Kelso	Retain	Retain	Retain
Kerr	Relocate	Relocate	Relocate
Vermin	Relocate	Relocate	Relocate
New Water Sources	Yes – Two sites outside wilderness	Yes – Three sites outside wilderness	Yes – Two sites outside wilderness
Total Guzzlers	5	7	7
Within Wilderness	1	2	3
Outside Wilderness	4	5	4

Management Approaches

Potential management approaches considered for big game guzzlers include:

- ***Remove*** – The physical removal of guzzler infrastructure following a short-term shutoff and monitoring period.
- ***Relocate*** – Construct a new guzzler at a nearby suitable location outside wilderness, followed by the physical removal of the existing guzzler and long-term maintenance of the new guzzler.
- ***Retain*** – Continued use and repair of a guzzler in its present location.
- ***New Water Sources*** – Placement of new guzzlers or development of existing springs outside of wilderness to support bighorn and improve habitat connectivity.

Big Game Guzzlers: Alternative 1 – No Action

Under Alternative 1, the current ad hoc program for managing and retaining big game guzzlers would continue. The NPS would continue to work with the CDFW, research scientists, and volunteer groups to monitor the condition of desert bighorn sheep populations and the function of individual guzzlers. Routine and urgent maintenance activities are planned and coordinated with these partners to continue to ensure the safe function of the guzzlers. Typical guzzler management and maintenance activities include replacing or repairing tanks, pipes, and valves; repairing catchment basins; and refilling tanks by truck or by helicopter.

NPS procedures and instruments for guzzler management and maintenance include the following:

- ***Agreements and Authorizations*** – Any non-NPS entity wanting to perform maintenance, repair, or replenishment activities at guzzlers must obtain authorization from the Preserve superintendent. Authorizing instruments include special use permits, memoranda of understanding, and cooperative agreements.
- ***Minimum Requirements Analysis (MRA)*** – Any action that would otherwise be prohibited in wilderness must be reviewed in a minimum requirements analysis (MRA), which documents that the proposed methods for access and guzzler maintenance in wilderness are necessary and are the minimum level of activity that can achieve the project’s outcome.
- ***NEPA Compliance*** – Implementation of specific proposed actions would require additional site-specific impact analysis in an appropriate NEPA document (Categorical Exclusion or EA), and other laws as applicable.

These guzzler management activities would continue on an ad hoc basis in response to immediate problems with guzzler function or project proposals from outside entities. The NPS would not engage in long-term planning for the removal, relocation, or addition of big game guzzlers in the Preserve.

Big Game Guzzlers: Elements Common among Action Alternatives

The common objective for guzzler management actions under the action alternatives is to retain guzzlers that have demonstrated benefits to bighorn sheep populations, relocate guzzlers where doing so is likely to retain benefits to bighorn sheep while reducing impacts on wilderness, remove guzzlers that do not support bighorn sheep populations and that also impact wilderness values, and implement new guzzlers outside wilderness in key areas where benefits to bighorn sheep habitat are likely to result. Removal and relocation of these guzzlers would only occur if monitoring indicated that new relocated guzzlers are sufficiently used by bighorn populations.

All actions within wilderness will be planned and implemented to ensure that the techniques and types of equipment needed minimize impacts on wilderness resources and character. Any future actions that involved 4(c) prohibited uses will be subject to project and site-specific MRA. A draft MRA for this plan is included in Appendix A.

Indicators

Indicators are specific measurable physical and ecological variables that reflect the overall condition of a resource. The variables in Table 3 are useful for understanding the condition of desert bighorn sheep populations and their habitat and their need for guzzlers in the Preserve. Indicators for desert bighorn sheep populations, habitat, and guzzler use include the following:

- guzzler condition – water levels and functionality

- guzzler use – water levels and sheep use
- use of alternative water features – frequency and timing of visits
- bighorn population size – total and local population estimates, distribution, and sex/age ratios
- bighorn behavior – habitat selection, sexual segregation, and visits to water sources
- population health – body condition, mortality, and disease
- habitat quality – amount, timing, and location of precipitation

Note that in some planning processes and monitoring studies, indicators are associated with specific and defined thresholds or standards at which a certain action may be triggered. In this plan, indicators would be used to collect information that is evaluated holistically to develop management actions. No specific triggers or standards are specified.

Table 3. Big Game Guzzler Indicators and Monitoring

Indicator	Potential Monitoring Methods
Guzzler condition	• Storage tank level monitors • Precipitation • Routine inspections for functionality
Guzzler use	• Remote cameras (motion-triggered or time-lapse) • GPS/radio-telemetry collars • Human observation • Storage tank level monitors
Use of alternate water features	• Remote cameras (motion-triggered or time-lapse) • Seasonal surveys of water features in bighorn sheep habitat • GPS/radio-telemetry collars • Human observation
Bighorn population	• Aerial surveys • Remote cameras • GPS/radio-telemetry collars • Human observation • Guzzler use/water levels
Bighorn behavior	• Aerial surveys • Remote cameras • GPS/radio-telemetry collars • Human observation
Bighorn population health	• Remote cameras • GPS/radio-telemetry collars • Autopsy samples (deceased animals) • Fecal nitrogen analysis • Human observation
Habitat context	• Precipitation • Fecal nitrogen analysis • Vegetation sampling

Although some relationships between bighorn and their habitat are known, there are also some basic gaps in knowledge that need to be addressed during the implementation and evaluation process. For example, the amount, timing, and location of precipitation during the winter-spring growing season of the Mojave Desert determines forage availability and quality, which directly contributes to bighorn reproductive success and lamb survival (Wehausen 2005). However, desert bighorn populations in the Preserve have rarely been surveyed multiple times within a year, and there is no reliable or standardized population estimator that allows managers to estimate annual populations. Previous approaches allow for some general or minimum population size estimates that are appropriate to set conservative hunting levels, but these approaches are inadequate for evaluating the effect of guzzler removals on bighorn population size or clearly establishing limits on population level effects from guzzler removals. Other considerations such as disease can override all of these factors.

Monitoring

The monitoring and evaluation under the action alternatives would emphasize tracking bighorn use of water sources as existing water sources are removed or relocated. Monitoring variables would include bighorn populations, use of existing guzzlers, use of alternative water features, and environmental factors such as drought and temperature. In addition, monitoring would occur for as long as needed at both existing and new guzzler locations (with water disabled at original locations) before finalizing relocation.

The NPS proposes the following monitoring approaches to track the indicators for desert bighorn sheep population and guzzler function and use. The data gathered from these approaches will influence implementation decisions associated with the action alternatives (e.g., remove, relocate, retain, or new guzzlers) under the selected alternative.

- Install cameras at water features (motion-triggered and time-lapse) for both guzzlers and nearby springs (all or some sample of water features). These can be used for behavior monitoring, sight/resight population estimates in conjunction with aerial surveys, guzzler use (animals per day or similar metric), sexual segregation, and body condition. This information is most critical for understanding the need for or effectiveness of implementation actions.
- Aerial (helicopter preferred but potentially fixed-wing) surveys can be used to estimate population, distribution, and sex/age ratios. Surveys could include fixed transects, using radio collars to determine mark/resight estimates, or random flights to maximize sample sizes. This is the second highest monitoring priority.
- Guzzler storage tank water level monitoring can be used to assess guzzler use over time. Combined with camera data, monitoring can be used to develop population estimates. Precipitation should be monitored to document and measure rainfall and tank replenishing.
- Satellite upload and/or remote download Global Positioning System (GPS) collars can be used to monitor habitat selection, guzzler use, alternative water feature visits, and mortality. This approach is predicated on having enough collars out in enough different herds or subherds, and personnel to monitor collars and analyze data.
- Samples from recent bighorn sheep mortalities could indicate if death was from respiratory disease, predation, forage or nutrient deficiencies, or dehydration.
- Fecal nitrogen analysis would be used to infer diet, which could be related to herd health or body condition.
- Stealth human observation from high vantage points can be used for counts and water visits. This could be done on an ad hoc basis or with a more standardized approach using NPS employees or volunteers. In cases where a guzzler was disabled, removed, or relocated, bighorn sheep behavior at a dry former guzzler site could influence a decision to reinstate the guzzler.

Table 3 summarizes the relationship between the indicators and the potential approaches to monitor them. The specific methods used for monitoring would vary by alternative and would be determined as part of the implementation process. At each step of implementation, the NPS would evaluate the success of management actions and the results of monitoring, with a focus on the acceptability of change to bighorn populations and other park resources. The determination of acceptability is based on professional judgment and recommendation from NPS staff and subject matter experts. The ultimate decision on acceptability is made by the Preserve superintendent.

Interim Management

Big game guzzlers are currently managed and maintained on an ad hoc basis, typically in response to immediate needs for guzzler repair, refilling, or other issues. These maintenance activities are conducted by volunteer groups, working under the guidance of the CDFW and the approval of the NPS, and often occur in urgent circumstances, when it is apparent a guzzler is not functioning properly during the hot summer season.

Under all action alternatives, these maintenance activities would continue, but would be administered directly by the NPS in collaboration with CDFW and volunteer groups. These activities would be managed under the NPS Volunteers-In-Parks program (see NPS Director's Order [DO] 7), including the completion of an Agreement for Sponsored Voluntary Services (Form 10-85), a job description that clearly describes the work to be completed, and other necessary approvals. This approach to routine and ongoing guzzler management and maintenance would continue under any action alternative until a particular guzzler is subject to implementation actions (including evaluation, disabling, removal, or relocation).

New Guzzler Development

Under all action alternatives, new water sources (potentially at Ginn Spring and Vontrigger Spring) would be developed. Alternative 3 would include a third new water source (Piute North). The NPS would work with CDFW and BLM to place temporary or permanent water developments to encourage the use of existing underpasses. The new water sources would support important corridors that are potentially restorable across I-40 and I-15 (Figure 2). The new Vontrigger Spring source would connect habitat between the Hackberry Mountains and Piute Spring, and would be important for restoring the bighorn sheep migration corridor across I-40. A new water source at Ginn Mine Spring (Ginn Spring) in the Mescal/Ivanpah Range would be important for restoring the bighorn sheep migration corridor across I-15, as it would connect the New York/Castle Mountains and the Clark Mountains. No part of the Mescal/Ivanpah area is designated wilderness. If a population could be established in the Mescal/Ivanpah Range, demographic connectivity would potentially be restored across I-15.

The placement and design of the new guzzlers would emphasize reliability, water storage, and minimal maintenance. Currently, all the existing guzzlers consist of up to three aboveground storage tanks, which usually require manual refilling during hot summer months when water consumption outpaces replenishment from precipitation. Manual refilling typically consists of delivery by water truck, sometimes several times per year. Deteriorating aboveground storage tanks also pose a threat to sheep, as evidenced by the 1995 botulism episode (Swift et al. 2000). This is currently a concern with the Old Dad guzzler.

New guzzlers would take advantage of groundwater storage (as described above) and would also minimize aboveground infrastructure by using existing springs. The Ginn Mine in the Mescal Range (Ginn Spring) and an existing spring at Vontrigger Spring in the Hackberry Range could be modified to bring water to accessible locations using pipes and gravity flow or a siphon to a drinker at a lower elevation. The only additions to these two potential sites would be drinkers and pipes.

Relocation of Kerr and Vermin Guzzlers

Under all action alternatives, the Kerr and Vermin guzzlers would be relocated to suitable nearby locations outside of wilderness. In addition to the location of these guzzlers within wilderness, several functional issues suggest that it is prudent to relocate these guzzlers. Although they support the largest bighorn herd in the Preserve, the guzzlers in the Old Dad/Kelso Mountains can become dry during the hot season and are logistically difficult to refill because they are in rugged, remote locations that are closed to motorized vehicles.

Relocating guzzlers to more accessible, non-wilderness sites could allow for less refilling (by using new guzzler designs at better intake locations) and better access for monitoring and maintenance. Moving a guzzler to a more accessible location, however, may result in reduced use by bighorn due to proximity to human presence. Removal and relocation of these guzzlers would only occur if monitoring indicated that new relocated guzzlers are sufficiently used by bighorn populations.

Relocated guzzler sites would attempt to take advantage of bedrock-constricted channels filled with unconsolidated young alluvium, which naturally collects and stores precipitation. The Vermin relocation site (New Vermin) would take advantage of the watershed at the Big Horn and Old Dad Mountain mines, while the Kerr relocation site (New Kerr) would use the large watershed that is constricted at its outlet by Jackass Canyon. Subsurface (groundwater) storage potential is significantly greater than any tank, is replenished over long periods by precipitation recharge, and is protected from evaporative loss by being underground. A subsurface collection device, such as a french drain, could be buried where groundwater spills over the bedrock restriction, and a large underground tank could be buried in the alluvium farther downgradient such that water collected by the french drain would flow by gravity into the tank. The drinker could be placed farther downgradient to take advantage of gravity flow.

Repair and Improvement for Guzzlers Retained in Place

Guzzlers that are retained may be redesigned and upgraded over time to improve the water collection systems and storage while reducing aboveground infrastructure. In addition to the site improvements described above, other efforts could include the removal of plastic sheeting in water catchment areas or installation of a wellpoint/drive pipe (a hand-driven water pipe that conveys shallow groundwater). The Preserve would cooperate with interested volunteer parties to implement improvements, subject to additional site-specific NEPA compliance.

Guzzler Implementation Sequence and Transitions

Under all action alternatives, at least two new guzzlers would be installed outside of wilderness, one or more big game guzzlers would be removed, and two would be relocated (see Table 2). In each of these cases, implementation would follow a deliberate and phased sequence to minimize unanticipated impacts on bighorn populations. After each step of the sequence (installation, relocation, or removal), the transition of bighorn to the new/relocated water source would be monitored for as long as needed to determine if the actions are successful (i.e., sheep have discovered and are using the new/relocated source and bighorn populations are stable); or if unanticipated or unacceptable impacts on bighorn are occurring. Guzzler actions would begin with the development of a detailed action and monitoring plan, in coordination with CDFW and volunteer parties. Each guzzler action implementation would require site- and task-specific compliance under NEPA to evaluate potential impacts. Under all action alternatives, implementation of actions would be based on the Preserve’s water management priorities

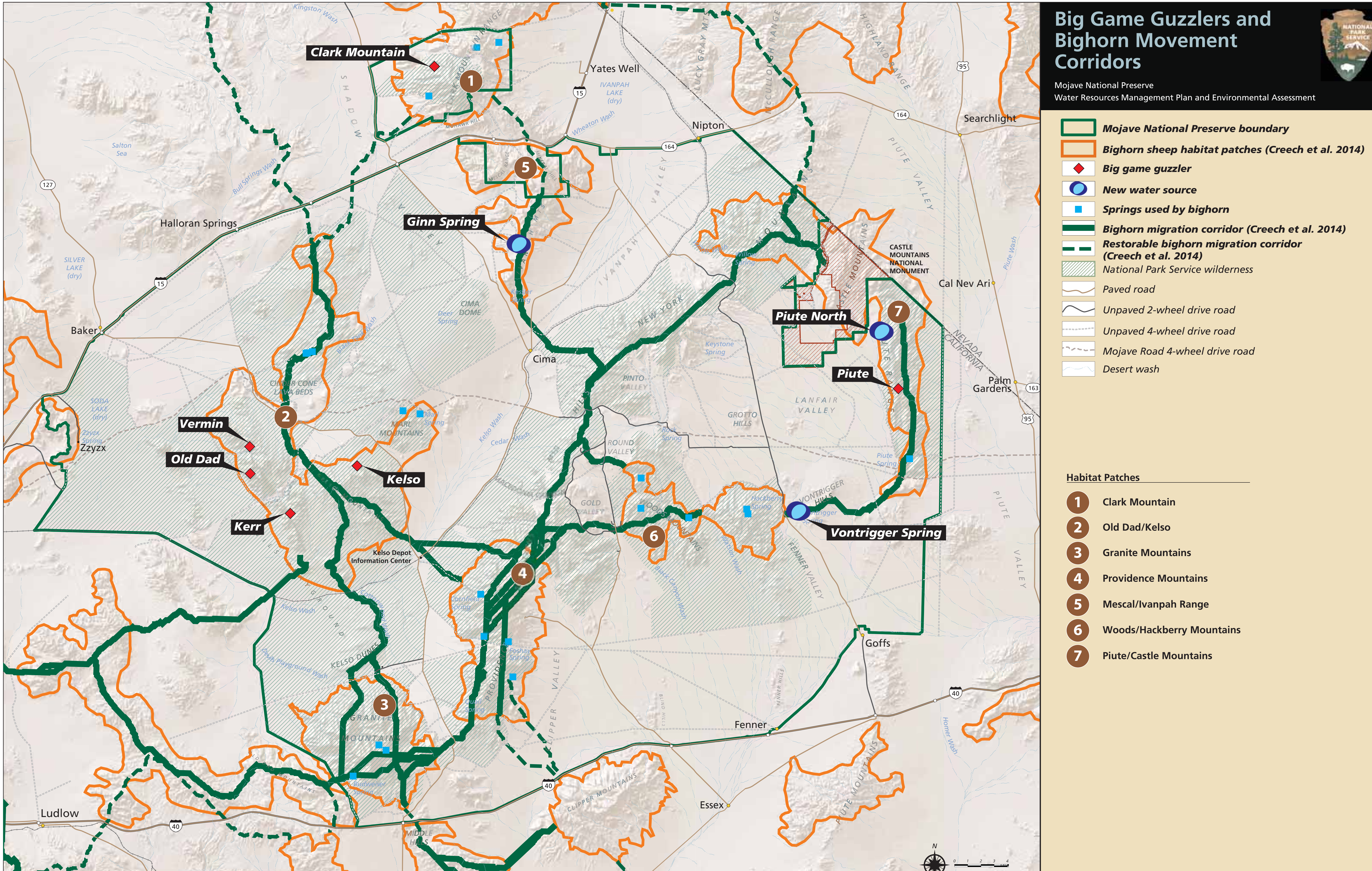
(Table 4). Figure 3 and Figure 4 outline the sequence and transition process, and Table 5 describes the implementation actions under each alternative.

Proposed sites for relocated guzzlers would be determined based on accessibility for maintenance and proximity to known bighorn populations and habitat. Probable relocation sites are shown in Figure 4, which illustrates the implementation scenario for Alternative 3. The existing conditions include all the guzzlers currently located in wilderness (No Action). The transition includes all existing, new, and relocated guzzlers that would be monitored for impacts and use. The final condition illustrates a successful implementation of Alternative 3, with a total of 7 guzzlers (2 retained, 2 relocated, and 3 new).

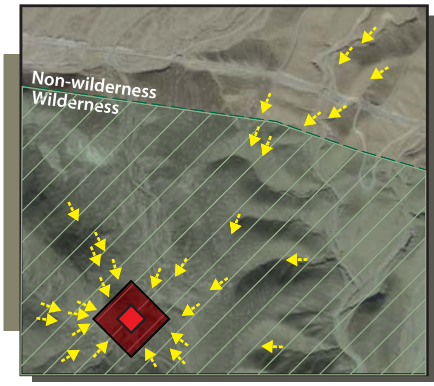
Table 4. Priorities for Big Game Guzzler Actions under Each Action Alternative

Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
1. **Kelso** – retain and maintain 2. **New Kerr and New Vermin** – build and monitor discovery and use; collar Piute ewes 3. **Clark** – continue to monitor for an additional year before disabling and removal 4. **Vontrigger** – build and monitor discovery and use in coordination with monitoring, disabling, and removal of Piute 5. **Ginn Spring** – install new water source 6. **Kerr and Vermin** – monitor for transition to relocated guzzlers, disable, and remove 7. **Old Dad** – monitor use and transition to New Kerr and New Vermin; disable, monitor, and remove 8. **Piute** – monitor transition to Vontrigger, disable, and remove	1. **Old Dad** – rebuild and repair as needed 2. **Kelso** – retain and maintain 3. **New Kerr and New Vermin** – build and monitor discovery and use; collar Piute ewes 4. **Piute North** – build and monitor discovery and use 5. **Clark** – continue to monitor for an additional year before disabling and removal 6. **Vontrigger** – build and monitor discovery and use in coordination with monitoring, disabling, and removal of Piute 7. **Ginn Spring** – build and monitor discovery and use 8. **Kerr and Vermin** – monitor for transition to relocated guzzlers, disable, and remove 9. **Piute** –monitor transition to Piute North and Vontrigger, disable, and remove	1. **Old Dad** – rebuild and repair as needed 2. **Kelso and Piute** – retain and maintain 3. **New Kerr and New Vermin** – build new guzzlers and monitor discovery and use; collar Piute ewes 4. **Clark** – continue to monitor for an additional year before disabling and removal 5. **Vontrigger** – build and monitor discovery and use 6. **Ginn Spring** – build and monitor discovery and use 7. **Kerr and Vermin** – monitor for transition to relocated guzzlers, disable, and remove

For guzzler removals and relocations, the primary approach would be to install a new/relocated water source and to keep both guzzlers in place while bighorn discover and transition to using the new water source. Monitoring would occur for as long as is needed to document the discovery and transition of sheep to the new site. As monitoring indicates and after bighorn have discovered and use the new/relocated source, the existing guzzler would be disabled for an extended period while monitoring of bighorn use continues. Once monitoring has demonstrated that bighorn have successfully adapted to the new site, the old guzzler infrastructure would be removed and the site rehabilitated. If monitoring indicates that unanticipated or unacceptable impacts on bighorn sheep populations are occurring, the NPS may reinitiate use of the old disabled guzzler. (Once they have been physically removed from wilderness, reestablishing guzzlers at old sites would require new analysis and approvals under NEPA and the Wilderness Act. Such an action is not anticipated in this plan and would be pursued as a last resort to mitigate unforeseen circumstances.)

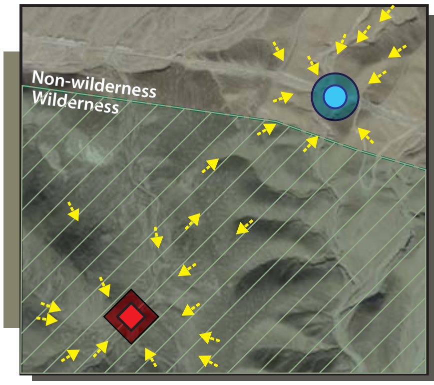


Big Game Guzzlers and Bighorn Movement Corridors
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
Mojave National Preserve boundary
Bighorn sheep habitat patches (Creech et al. 2014)
Big game guzzler
New water source
Springs used by bighorn
Bighorn migration corridor (Creech et al. 2014)
Restorable bighorn migration corridor (Creech et al. 2014)
National Park Service wilderness
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
Habitat Patches
1 Clark Mountain
2 Old Dad/Kelso
3 Granite Mountains
4 Providence Mountains
5 Mescal/Ivanpah Range
6 Woods/Hackberry Mountains
7 Piute/Castle Mountains
Clark Mountain
Ginn Spring
Vermin
Old Dad
Kelso
Kerr
Piute North
Piute
Vontrigger Spring
Yates Well
Nipton
Searchlight
Halloran Springs
Baker
Zzyzx
Cima
Kelso Depot Information Center
Cal Nev Ari
Palm Gardens
CASTLE MOUNTAINS NATIONAL MONUMENT
Goffs
Fenner
Essex
Ludlow



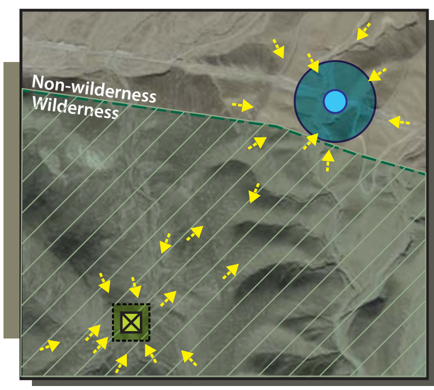
Existing Condition

- Guzzler in wilderness



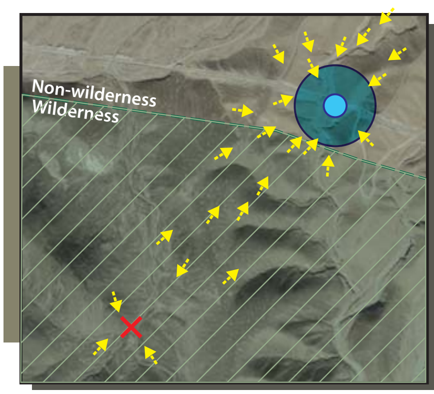
Transition - Step 1

- New guzzler outside of wilderness
- Two guzzlers during monitoring period
- Monitor bighorn use for several years



Transition - Step 2

- Bighorn documented to use new guzzler
- Shut off old guzzler
- Monitor bighorn transition

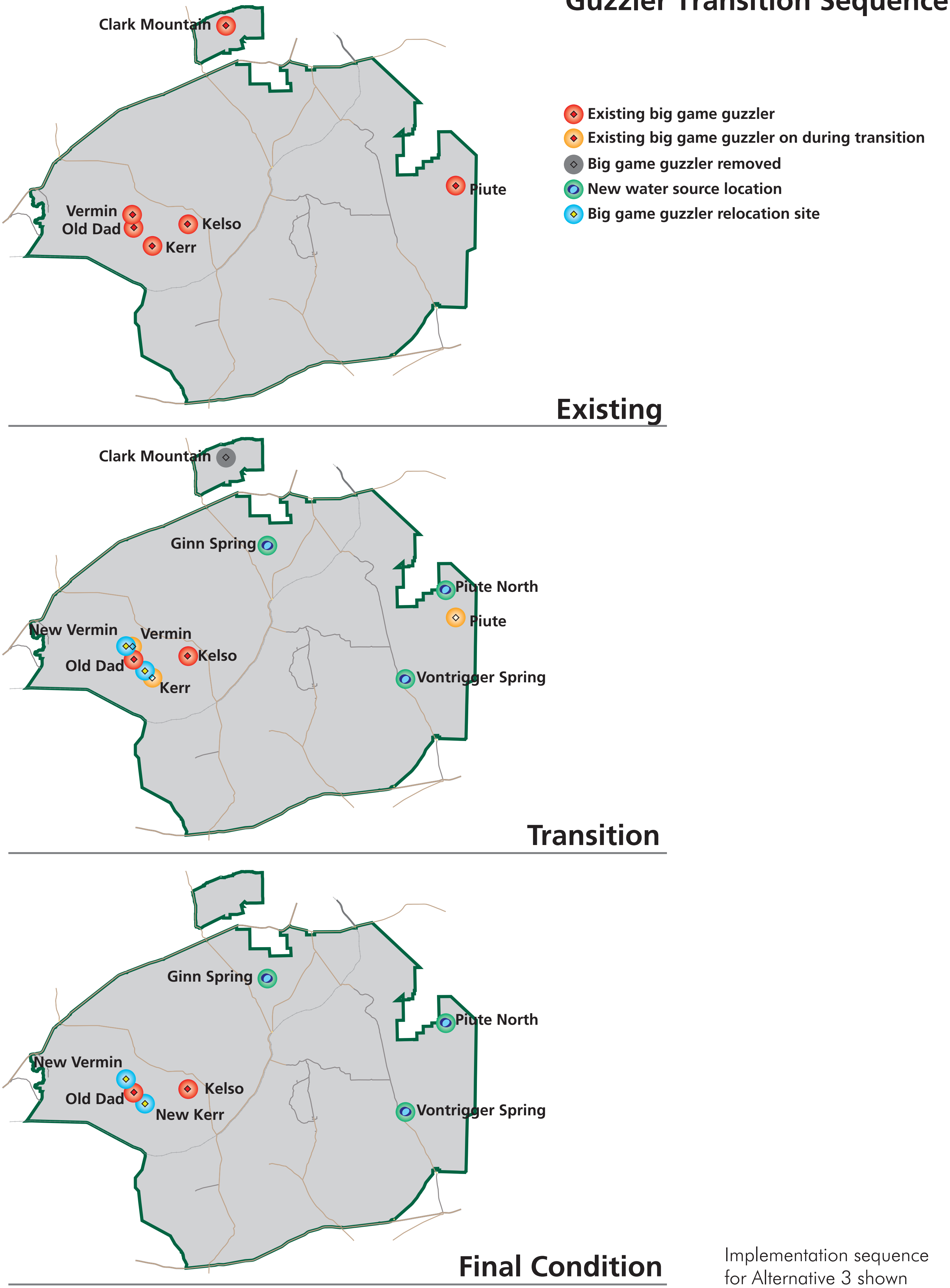


Transition - Step 3

- Bighorn only use new guzzler
- Remove old guzzler
- Continue monitoring

If monitoring indicates that the guzzler transition is not successful, or if severe impacts on bighorn are evident, each step can be reversed to ensure that impacts on bighorn populations are minimal.

Guzzler Transition Sequence



Implementation sequence
for Alternative 3 shown

Table 5. Implementation Actions for Big Game Guzzlers

	No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Objective	Continue current, ad hoc management and maintenance activities	Minimize water developments in wilderness while strategically using water developments to conserve native wildlife populations	Manage water developments to support native species conservation and population stability while reducing the number of water developments in wilderness	Manage water resource to augment native wildlife habitat and restore connectivity
Existing Guzzlers				
Kelso	Filled every year or so depending on precipitation by driving about two miles into wilderness on an existing two-track road	*Common to All Action Alternatives:* **Retain** • Repair as needed		
Old Dad	Can be filled only by helicopter; repair of valves, tanks, pipes, drinker, and other parts done by dropping off equipment from helicopter; volunteers hike to site	**Remove** • Shut off water and initiate monitoring • If monitoring shows bighorn use New Kerr and New Vermin, remove	**Retain** Repair as needed	**Retain** *Same as Alternative 2*
Kerr	Filled every year or so depending on precipitation by driving about one mile into wilderness on an existing two-track road	*Common to All Action Alternatives:* **Relocate** • Identify suitable non-wilderness site • Initiate relocation process • Once new guzzler is established, remove		
Vermin	Filled every year or so depending on precipitation by driving on a cherry-stemmed road and then using a long hose	*Common to All Action Alternatives:* **Relocate** • Identify suitable non-wilderness site • Initiate relocation process • Once new guzzler is established, remove		
Clark	Requires very little to no repair	*Common to All Action Alternatives:* **Remove** • Dismantle and move parts to location outside of wilderness where it could provide more benefits to bighorn		
Piute	Infrequent filling and repair	**Remove** • Shut off water and initiate monitoring • Remove if supported by monitoring	**Remove** • Shut off water and initiate monitoring • Install new water sources in nearby locations • Remove if supported by monitoring	**Retain** • Repair as needed to support regional connectivity

	No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
New Water Sources				
Alternative Approach	No new guzzlers would be permitted in the Preserve	• Two new guzzlers located within the Preserve on non-wilderness land	• Three new guzzlers located within the Preserve on non-wilderness land	• Two new guzzlers located within the Preserve on non-wilderness land
New Water Source Objectives	• None • NPS recommended a translocation to N. Soda (BLM) for Soda Mountain Solar mitigation	*Common to All Action Alternatives:* • Improving regional habitat connectivity • Restoring I-40/I-15 movement corridors • Establishing a new population in the Mescal/Ivanpah Range		
Proposed Locations of New Water Sources	None	• **Vontrigger Spring** –connector between Hackberry and Piute Spring • **Ginn Spring** –connector from New York/Castle north to Clark Mountains, in the Ivanpah Range	• **Vontrigger Spring** –connector between Hackberry and Piute Spring • **Ginn Spring** –connector from New York/Castle north to Clark Mountains, in the Ivanpah Range • **Piute North Guzzler** – located in northern Piute Range; connector between Piute Spring and Castle Mountains	*Same as Alternative 2*
Summary of Guzzler Actions	• Total Guzzlers: 6 • Wilderness: 6 • Non-wilderness: 0 • New: 0	• Total guzzlers: 5 • Wilderness: 1 • Non-wilderness: 4 • New: 2	• Total guzzlers: 7 • Wilderness: 2 • Non-wilderness: 5 • New: 3	• Total guzzlers: 7 • Wilderness: 3 • Non-wilderness: 4 • New: 2
Guzzler Management and Maintenance				
Summary of Management Approach	Guzzler maintenance and refilling occurs on an ad hoc basis under CDFW guidance and with volunteer labor	*Common to All Action Alternatives:* • Guzzlers are repaired or refilled by volunteers under NPS guidance • Ongoing repair continues until implementation actions are initiated		

The general sequence for the implementation of guzzler actions includes the following:

1. Install new or relocated guzzler outside of wilderness, in order of Preserve priorities.
2. Monitor both new/relocated and existing guzzlers for as long as needed to document transition.
3. When bighorn have been documented to use the new guzzler, manipulation/disabling of the existing guzzler can begin.
4. Continue monitoring to document use, transition, and impacts.
5. Remove existing guzzler if monitoring indicates that bighorn have transitioned to using new/relocated guzzler–or–
6. Reinstate existing guzzler if monitoring indicates conditions that are unacceptable or if bighorn are not transitioning to use new/relocated guzzler.

Big Game Guzzlers: Alternative 2

Objective

Under Alternative 2, the NPS would seek to retain a similar number of big game guzzlers (compared to the No Action Alternative) in the Preserve, but to minimize the number of within wilderness wherever possible. The overall management objective would be strategic use of big game guzzlers, to minimize intrusion into wilderness while using big game guzzles as a tool to conserve sustainable native wildlife populations, particularly bighorn sheep.

Approach

Implementation of Alternative 2 for big game guzzlers would consist of installing new/relocated water sources; monitoring discovery, use, and transition of bighorn to new/relocated sources; disabling guzzlers; and eventually removing guzzler infrastructure. During implementation, all guzzlers would continue to be retained and repaired in their current state until they are part of a relocation evaluation process or are physically relocated.

The end state of Alternative 2 would be the long-term use of five guzzlers within the Preserve. Three guzzlers (Clark, Piute, and Old Dad) would be removed, two (Kerr and Vermin) would be relocated out of wilderness, and one (Kelso) would remain in wilderness. Two new water sources (Vontrigger Spring and Ginn Spring) would be permitted within the Preserve on non-wilderness land (Figure 5). Final locations would be determined as part of the implementation process.

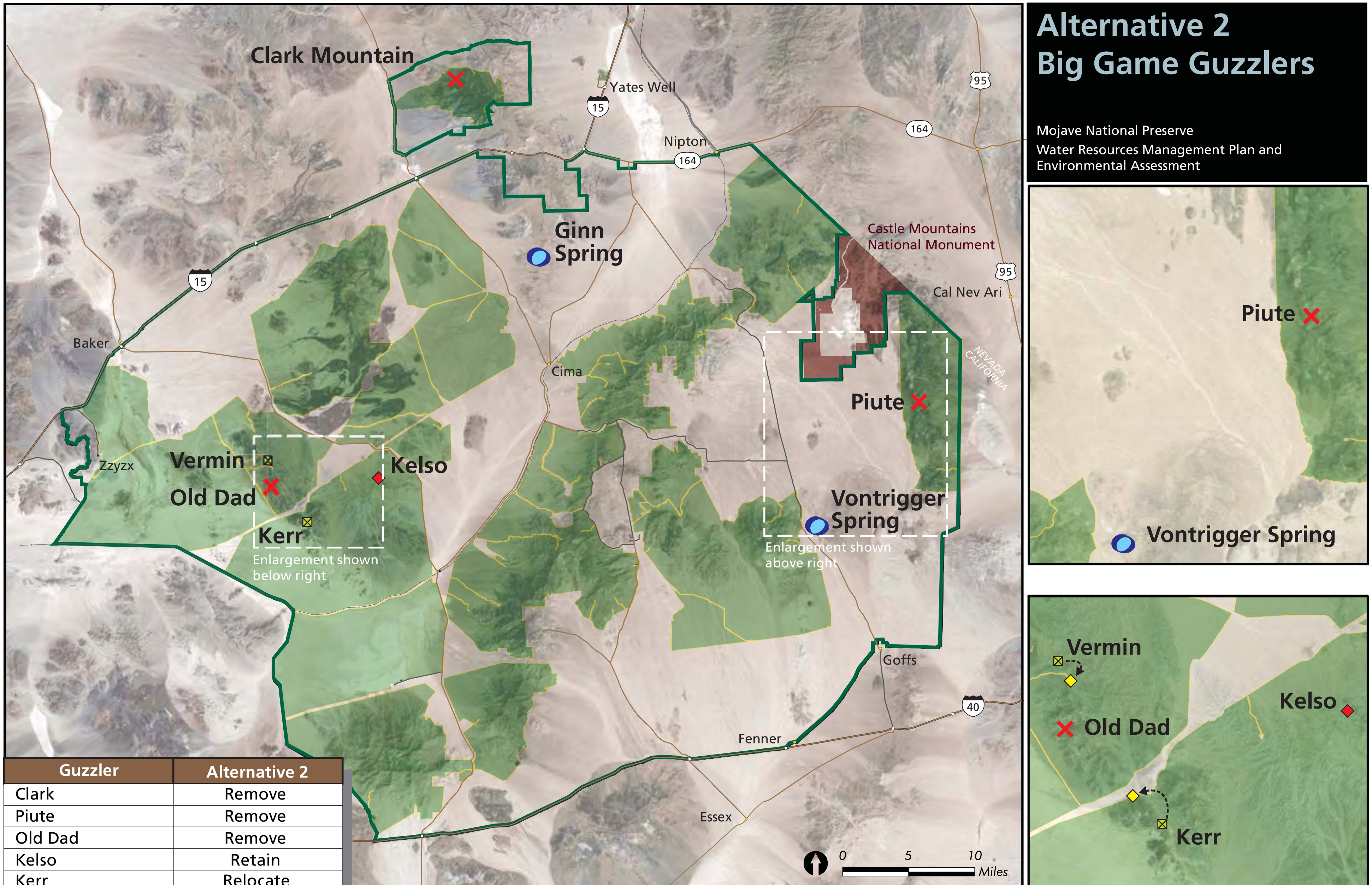
New Water Sources

The NPS would pursue the establishment of two new guzzlers or water sources in non-wilderness locations to support the potential restoration of migration corridors and demographic connectivity across I-40 and I-15, including the establishment of a population in the Mescal/Ivanpah Range (see “New Guzzler Development” above, and Figure 2). The NPS would work with CDFW and BLM to place temporary or permanent water developments to encourage the use of existing underpasses. Potential sites for new water sources are:

- **Vontrigger Spring** –would function as a habitat connector between Piute Spring and the Hackberry Range.
- **Ginn Spring** –would function as a habitat connector between the New York and Castle Mountains to the south and the Clark Mountains to the north.

Alternative 2
Big Game Guzzlers

Mojave National Preserve
Water Resources Management Plan and
Environmental Assessment



Guzzler	Alternative 2
Clark	Remove
Piute	Remove
Old Dad	Remove
Kelso	Retain
Kerr	Relocate
Vermin	Relocate
New Water Sources	Yes – Two sites outside wilderness
Total Guzzlers	5
Within wilderness	1
Outside wilderness	4

Alternative Actions

- Retain guzzler
- Remove guzzler
- Relocate guzzler
- Guzzler relocation site
- New water source location
- Mojave National Preserve boundary
- Wilderness*

*Vermin relocation site is within a non-wilderness area associated with an existing road

Implementation Sequence

Before each implementation step, the Preserve would identify and secure funding and logistical support that is necessary to implement the actions and associated monitoring. Site-specific compliance under NEPA would be completed for each guzzler action. Detailed plans would be developed for guzzler relocations including material, equipment, and personnel costs; logistics; and monitoring. Priorities for guzzler actions include:

1. ***Kelso*** – Retain and maintain as needed in its present location because of its importance for rams and the lack of a nearby relocation site.
2. ***New Kerr and New Vermin*** – Build new guzzlers for relocation of Kerr and Vermin, and monitor for discovery and use.
3. ***Clark*** – Continue monitoring for an additional year, followed by disabling and removal if monitoring data supports action. Infrastructure may be reused at a suitable non-wilderness site.
4. ***Vontrigger Spring*** –Implement new water sources in conjunction with the monitoring and subsequent removal of Piute.
5. ***Ginn Spring*** – Implemented new water source and monitor for discovery and use.
6. ***Kerr and Vermin*** – Monitor as bighorn discover and use New Kerr and New Vermin. Once the relocated sites have been discovered and used by bighorn populations, and transition has been successful, disable and eventually remove the old sites if monitoring supports actions.
7. ***Old Dad –*** Monitor for use and to determine if a transition to New Kerr and New Vermin is possible. If so, continue monitoring use and transition, deactivate, and monitor for transition. Remove after transition is successful, due to its inaccessibility and the absence of a suitable relocation site. Infrastructure would be removed over the long term as resources allow.
8. ***Piute*** – Monitor use, including collaring ewes, to determine if a transition to the new Vontrigger water source is possible. If so, disable guzzler and continue to monitor transition. If transition is successful, remove guzzler if monitoring data supports action.

Proposed relocation sites for Vermin and Kerr guzzlers have been identified in potentially suitable non-wilderness locations near existing guzzlers. Factors considered in identifying relocation sites would include bighorn habitat quality, local terrain and hydrology, accessibility for maintenance, and contributions to regional movement corridors. Final locations would be determined as part of the implementation process. A detailed site-specific monitoring approach would be developed during implementation (see “Monitoring” above).

Big Game Guzzlers: Alternative 3 (Preferred Alternative)

Objective

Under Alternative 3, the NPS would seek to reduce the number of big game guzzlers in wilderness in a manner that results in no net loss of functioning dry season habitat for bighorn. It would emphasize reducing of the number of big game guzzlers in wilderness while improving the overall habitat value for bighorn sheep. The overall management objective would be strategic intervention to ensure that bighorn sheep populations are stable as the overall number of big game guzzlers within wilderness is reduced and regional habitat connectivity is improved.

Approach

Implementation of Alternative 3 for big game guzzlers would consist of installing new/relocated water sources; monitoring discovery, use, and transition of bighorn to new/relocated sources; disabling guzzlers; and eventually removing guzzler infrastructure. All guzzlers would continue to be retained and repaired in their current state until they are part of a relocation evaluation process or are relocated.

If all actions are implemented under this alternative, seven big game guzzlers or alternative water sources would exist in the Preserve. Two guzzlers (Clark and Piute) would be removed, two (Vermin and Kerr) would be relocated out of wilderness, and two would remain in wilderness (Old Dad and Kelso). Three new water sources (Vontrigger Spring, Ginn Spring, and Piute North) would be permitted within the Preserve on non-wilderness land (Figure 6).

New Water Sources

The NPS would pursue the establishment of three new guzzlers or water sources in non-wilderness locations to support the potential restoration of migration corridors and demographic connectivity across I-40 and I-15, including the establishment of a population in the Mescal/Ivanpah Range (see “New Guzzler Development” above, and Figure 2). The NPS would work with CDFW and BLM to place temporary or permanent water developments to encourage the use of existing underpasses. Potential sites for new water sources are:

- **Piute North Guzzler** –would function as a habitat connector between Piute Spring and the Castle Mountains.
- **Vontrigger Spring** –would function as a habitat connector between Piute Spring and the Hackberry Range.
- **Ginn Spring** –would function as a habitat connector between the New York and Castle Mountains to the south and the Clark Mountains to the north.

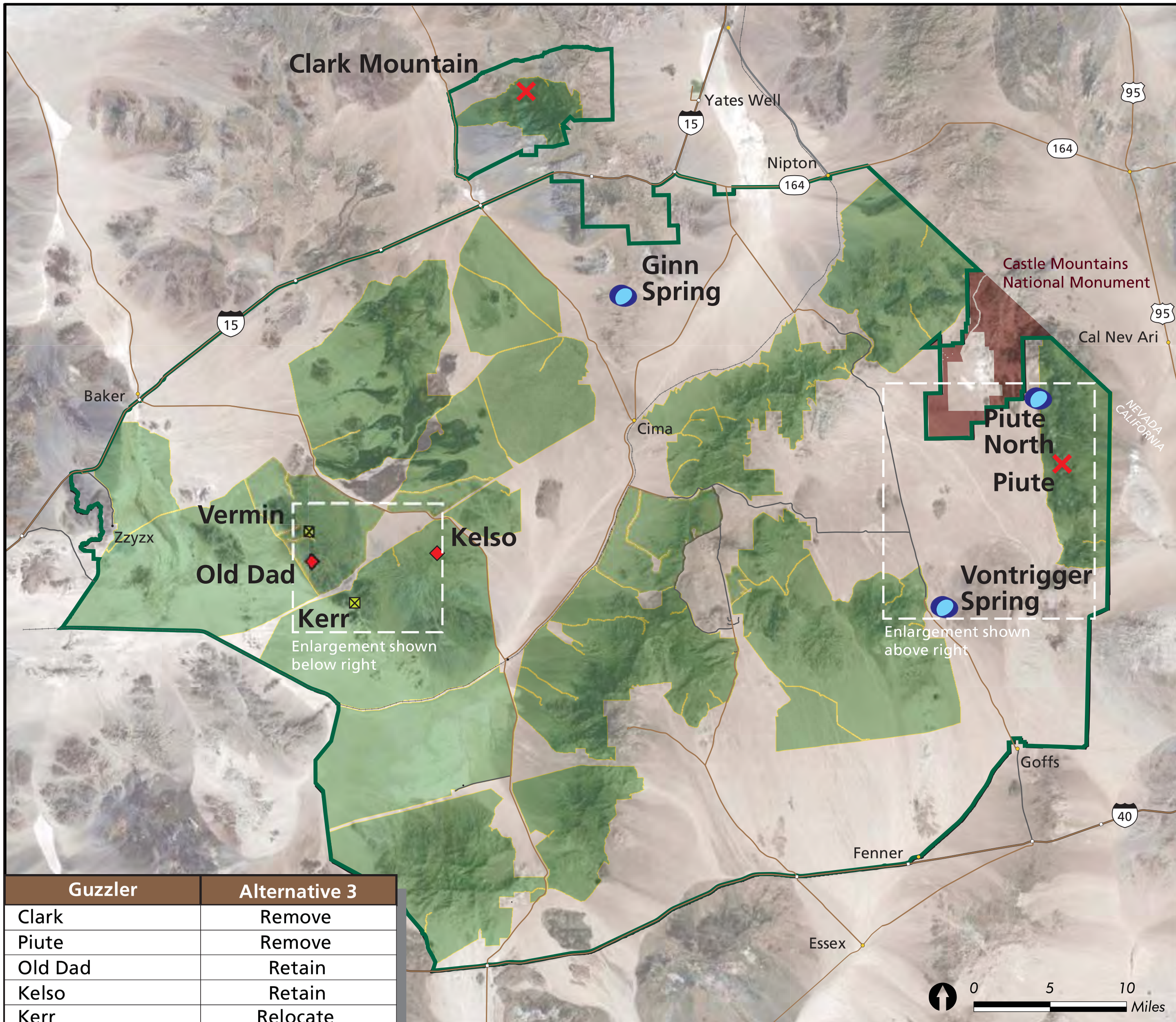
Implementation Sequence

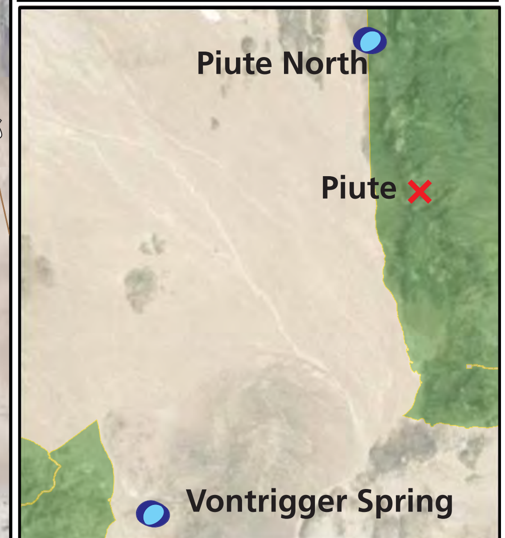
Before each implementation step, the Preserve would identify and secure funding and logistical support that is necessary to implement the actions and associated monitoring. Site-specific compliance under NEPA would be completed for each guzzler action. Detailed plans would be developed for guzzler relocations including material, equipment, and personnel costs; logistics; and other information needed. Priorities for guzzler actions are:

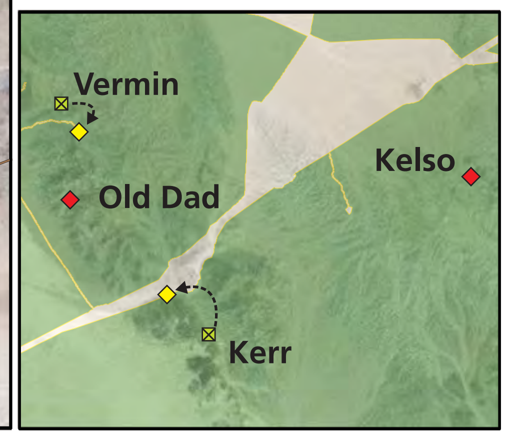
1. ***Old Dad*** – Rebuild guzzler and repair as needed.
2. ***Kelso*** – Retain and maintain as needed in its present location because of its importance for rams and the lack of a nearby relocation site.
3. ***New Kerr and New Vermin*** – Build new guzzlers for relocation of Kerr and Vermin, and monitor for discovery and use.
4. ***Piute North*** – Build new guzzler and monitor for discovery and use. Collar ewes in Piute area to monitor use and transition.
5. ***Clark*** – Continue monitoring for an additional year, followed by disabling and removal if monitoring data supports action. Infrastructure may be reused at a suitable non-wilderness site.
6. ***Vontrigger Spring*** –Implemented new water sources in conjunction with the monitoring and subsequent removal of Piute.

Alternative 3
Big Game Guzzlers

Mojave National Preserve
Water Resources Management Plan and
Environmental Assessment







Guzzler	Alternative 3
Clark	Remove
Piute	Remove
Old Dad	Retain
Kelso	Retain
Kerr	Relocate
Vermin	Relocate
New Water Sources	Yes – Three sites outside wilderness
Total Guzzlers	7
Within wilderness	2
Outside wilderness	5

Alternative Actions

- Retain guzzler
- Remove guzzler
- Relocate guzzler
- Guzzler relocation site
- New water source location
- Mojave National Preserve boundary
- Wilderness*

*Vermin relocation site is within a non-wilderness area associated with an existing road

7. ***Ginn Spring*** – Implement new water sources and monitor for discovery and use.
8. ***Kerr and Vermin*** – Monitor as bighorn discover and use New Kerr and New Vermin. Once the relocated sites have been discovered and used by bighorn populations, and transition has been successful, disable and eventually remove the old sites if monitoring supports actions.
9. ***Piute*** – Monitor use, including collared ewes, to determine if a transition to Piute Spring/Creek and the new Vontrigger and Piute North water sources is possible. If so, disable guzzler and continue to monitor transition. If transition is successful, remove guzzler if monitoring data supports action.

Final locations would be determined as part of the implementation process. Proposed relocation sites for Vermin and Kerr guzzlers have been identified in potentially suitable non-wilderness locations near existing guzzlers. Factors considered in identifying relocation sites would include bighorn habitat quality, local terrain and hydrology, accessibility for maintenance, and contributions to regional movement corridors. Final locations would be determined as part of the implementation process. A detailed site-specific monitoring approach would be developed during implementation (see “Monitoring” above).

Big Game Guzzlers: Alternative 4

Objective

Under Alternative 4, the NPS would seek to maximize the ecological benefits of big game guzzlers and place them in additional locations throughout the Preserve. Emphasis would be on augmenting bighorn sheep habitat value through the use of big game guzzlers in the Preserve while minimizing the number of water developments within wilderness, where possible. Alternative 4 aims to increase bighorn sheep metapopulation resilience by retaining water availability for existing populations, increasing the functional dry season habitat for bighorn sheep, and increasing connectivity between populations.

Alternative 4 seeks to retain and improve existing habitat and connectivity within and adjacent to the Preserve. Recent and past development is restricting bighorn connectivity in the Greater Mojave Desert (Epps et al. 2007; Creech et al. 2014). The current and future impact of climate change, which will result in warmer and drier conditions in the southwestern United States (see “Climate Trends and History” in *Chapter 3: Affected Environment*), is also likely to have a negative effect on bighorn in the region, because herds located in lower-elevation drier mountain ranges have been found to be more likely to be extirpated (Epps et al. 2004). NPS guidance has clearly emphasized the need for parks to cooperate with other agencies to conserve resources both inside and outside of parks and to manage for ecosystem integrity in the face of climate change and other anthropogenic disturbance. The integrity of the larger desert bighorn metapopulation can primarily be maintained through enhancing connectivity and increasing the genetic diversity and population persistence of existing and restorable bighorn herds (Epps et al. 2006; Creech et al. 2014). This alternative seeks to maintain bighorn integrity by expanding the use of guzzlers, as water is considered one of the most limiting factors for many bighorn herds in the Mojave Desert.

Approach

Implementation of Alternative 4 for big game guzzlers would consist of installing new/relocated water sources; monitoring discovery, use, and transition of bighorn to new/relocated sources; disabling guzzlers; and eventually removing guzzler infrastructure (Figure 7). During implementation, all guzzlers would continue to be retained and repaired in their current state until they are part of a relocation evaluation process or are physically relocated.

New Water Sources

The NPS would pursue the establishment of two new guzzlers or water sources in non-wilderness locations to support the potential restoration of migration corridors and demographic connectivity across I-40 and I-15, including the establishment of a population in the Mescal/Ivanpah Range (see “New Guzzler Development” above, and Figure 2). The NPS would work with CDFW and BLM to place temporary or permanent water developments to encourage the use of existing underpasses.

Potential sites for new water sources are:

- **Vontrigger Spring** –would function as a habitat connector between Piute Spring and the Hackberry Range.
- **Ginn Spring** –would function as a habitat connector between the New York and Castle Mountains to the south and the Clark Mountains to the north.

Implementation Sequence

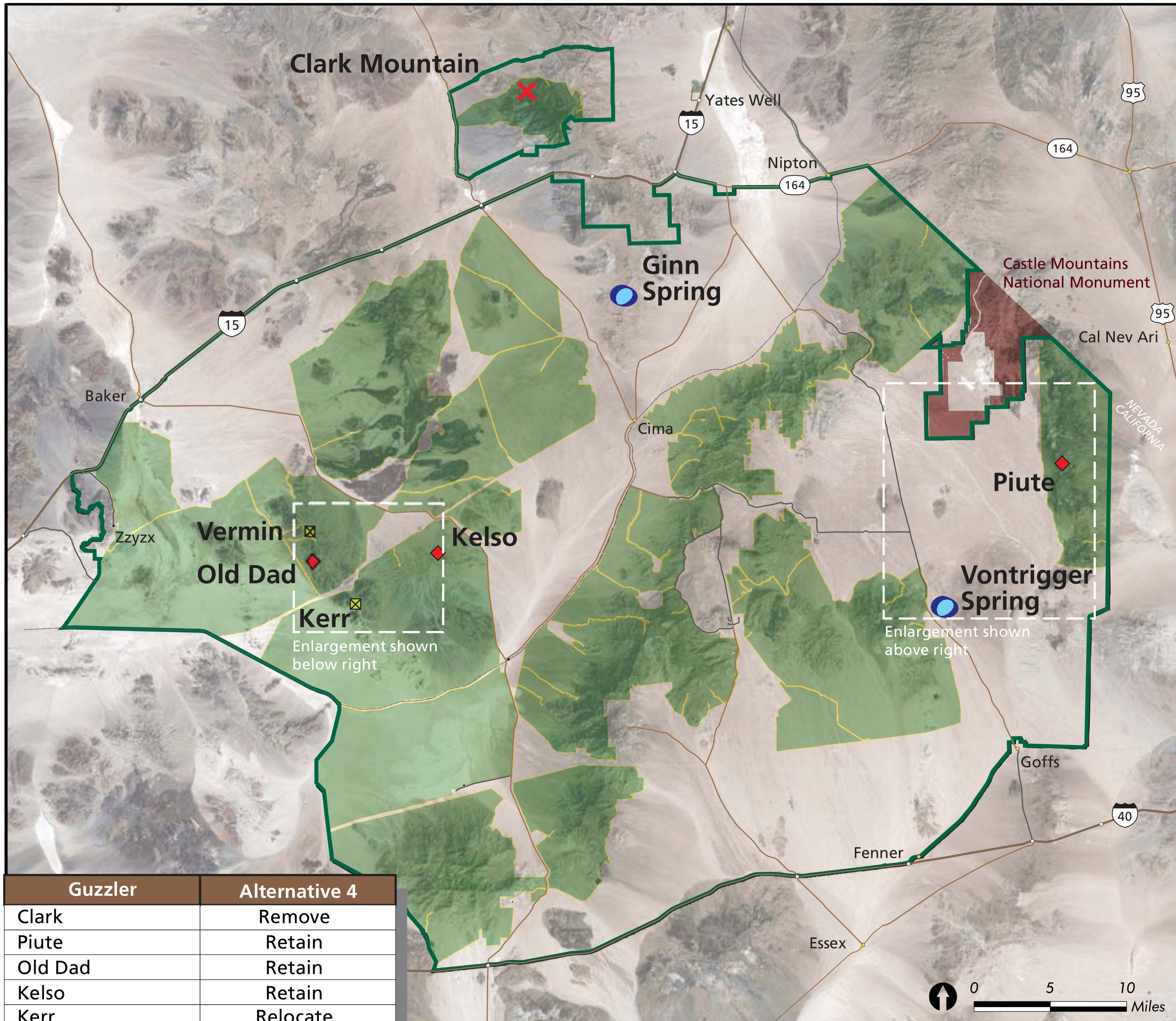
Before each implementation step, the Preserve would identify and secure funding and logistical support that is necessary to implement the actions and associated monitoring. Site-specific compliance under NEPA would be completed for each guzzler action. Detailed plans would be developed for guzzler relocations including material, equipment, and personnel costs; logistics; and other information needed. Priorities for guzzler actions are:

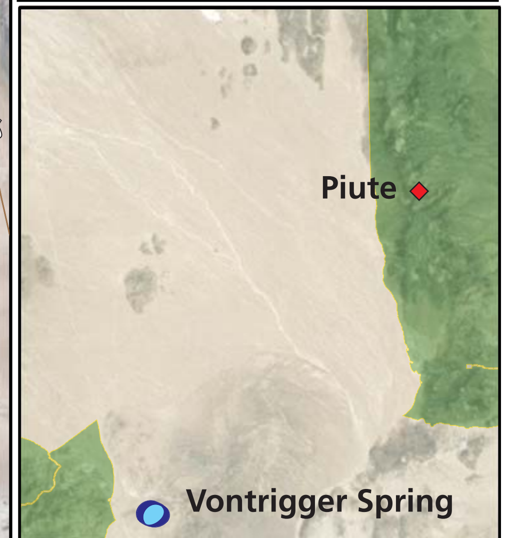
1. ***Old Dad*** – Rebuild guzzler and repair as needed.
2. ***Kelso*** – Retain and maintain as needed in its present location because of its importance for rams and the lack of a nearby relocation site.
3. ***Piute*** – Retain and maintain as needed in its present location.
4. ***New Kerr and New Vermin*** – Build new guzzlers for relocation of Kerr and Vermin, and monitor for discovery and use.
5. ***Clark*** – Continue monitoring for an additional year, followed by disabling and removal if monitoring data supports action. Infrastructure may be reused at a suitable non-wilderness site.
6. ***Vontrigger Spring*** –New water sources would be implemented and monitored for discovery and use.
7. ***Ginn Spring*** –Implement new water sources and monitor for discovery and use.
8. ***Kerr and Vermin*** – Monitor as bighorn discover and use New Kerr and New Vermin. Once the relocated sites have been discovered and used by bighorn populations, and transition has been successful, disable and eventually remove the old sites if monitoring supports actions.

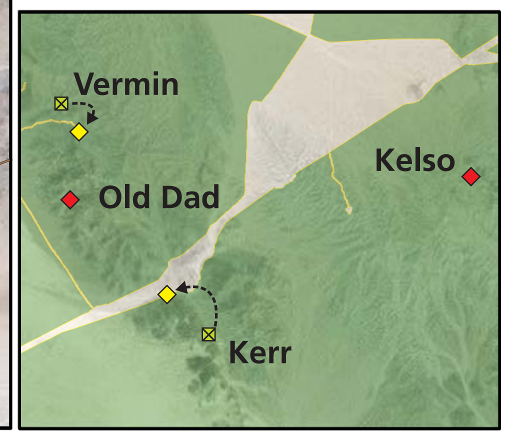
If all actions are implemented under this alternative, three big game guzzlers would be retained in wilderness and four guzzlers would exist in non-wilderness locations within the Preserve. Final locations would be determined as part of the implementation process. A detailed site-specific monitoring approach would be developed during implementation (see “Monitoring” above)

Alternative 4
Big Game Guzzlers

Mojave National Preserve
Water Resources Management Plan and
Environmental Assessment







Guzzler	Alternative 4
Clark	Remove
Piute	Retain
Old Dad	Retain
Kelso	Retain
Kerr	Relocate
Vermin	Relocate
New Water Sources	Yes – Two sites outside wilderness
Total Guzzlers	7
Within wilderness	4
Outside wilderness	3

Alternative Actions

- Retain guzzler
- Remove guzzler
- Relocate guzzler
- Guzzler relocation site
- New water source location
- Mojave National Preserve boundary
- Wilderness*

*Vermin relocation site is within a non-wilderness area associated with an existing road

Small Game Guzzlers

About 131 small game guzzlers are known to exist in the Preserve, nearly half of which (about 60) are located in wilderness. About 26 guzzlers are in designated critical habitat for the desert tortoise.

Management Approaches

Potential management approaches considered for small game guzzlers are:

- ***Evaluate*** – Determine if guzzlers benefit wildlife based on location, proximity to other water sources, condition, and habitat context; and monitor guzzlers to better understand their ecological importance.
- ***Maintain –*** Periodically inspect and make small repairs to guzzlers including retaining wildlife ramps, sealing small holes, removing debris, and other routine tasks to ensure the function and safety of guzzlers.
- ***Repair*** – Perform major repair or rebuild of existing guzzlers including pouring a new concrete apron or replacing the tank.
- ***Retain –*** Allow non-wilderness guzzlers to remain with no new maintenance, pending future evaluations.
- ***Remove or Disable –*** Demolish the apron and fill or remove the tank to render the guzzler permanently inoperable, and restore the site to a natural-looking condition. Some or all of the guzzler material may remain on-site.
- ***Neglect*** – Allow the guzzler to passively fall into disrepair with no maintenance to the extent that it eventually fails to collect or store water.

No maintenance or repair is currently authorized for wilderness small game guzzlers (No Action); nor would any be allowed under the action alternatives. All action alternatives include removing or disabling a select few wilderness guzzlers and neglecting all others. Evaluation, maintenance, repair, and retention only applies to non-wilderness guzzlers.

Table 6 gives a summary of implementation actions for small game guzzlers. None of the alternatives include construction of new small game guzzlers in the Preserve. Any maintenance, repairs, or modifications would be consistent with the guidance of an approved historical condition assessment and treatment plan.

Small Game Guzzlers: Alternative 1 – No Action

Alternative 1 would continue the current management practices for small game guzzlers. All small game guzzlers in wilderness would continue to be neglected. The NPS would continue to coordinate with outside volunteer groups to monitor and retain small game guzzlers, including those determined to be historic under the NHPA. Allowed management activities include routine maintenance of non-wilderness guzzlers and major repairs to the eight non-wilderness guzzlers that have not been recently repaired. However, construction of roads or off-road vehicle travel to access six of those guzzlers would not be allowed. Two of the guzzlers are accessible to vehicles, and the other six would require non-motorized transport of equipment, materials, and personnel for any potential repair projects. These activities would not be authorized in wilderness.

The NPS would continue to allow these maintenance projects on an ad hoc basis in response to immediate maintenance issues or requests from outside organizations. The NPS would not develop any long-term plans for the strategic and systematic removal, addition, or abandonment of small game guzzlers in the Preserve.

Table 6. Small Game Guzzler Implementation Actions

No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Wilderness *About 60 guzzlers*			
Neglect all • No maintenance or improvements	*Common to All Action Alternatives:* **Neglect or Disable** • Disable select few (2 to 4) • Ensure existing escape ramps are in functional condition • Block entrances to prevent desert tortoise entrapment • No other maintenance or improvements		
Non-wilderness *64 recently repaired* *8 subject to additional major repairs; 2 are vehicle accessible*			
• Ad hoc maintenance, in response to outside requests • Neglect all not otherwise treated	**Neglect with Exceptions** • Evaluate sets of 10 to 15 for condition and ecological importance • Maintain escape ramps as needed • Maintain if determined important for native wildlife; phase out maintenance if not important • Remove or disable select few (2 to 4) • Allow major repairs to 2 guzzlers • Repeat with next set of evaluation and treatments	**Neglect or Disable** *Same as Alternative 2*	**Retain with Exceptions** • Evaluate sets of 15 to 25 for condition and ecological importance • Maintain escape ramps as needed • Maintain unless determined not important for native wildlife; phase out maintenance if not important • Remove or disable select few (0 to 2) • Allow major repairs to 8 guzzlers (only 2 are vehicle accessible) • Repeat with next set of evaluation and treatments
Potential Treatment/Condition at Full Implementation (20 years)			
• Major repairs on up to 8 guzzlers • Maintain some non-wilderness • Neglect all others • Result in about 68 functional guzzlers	• Major repairs on up to 2 guzzlers • Remove or disable up to 16 in wilderness; 16 out of wilderness • Maintain some non-wilderness • Neglect all others • Result in about 52 functional guzzlers	*Same as Alternative 2*	• Major repairs on up to 8 guzzlers • Remove or disable up to 16 in wilderness; 8 out of wilderness • Maintain most non-wilderness • Neglect all others • Result in about 60 functional guzzlers

Note: Assumes a 20-year implementation life of this plan, with 5-year evaluation cycles. Guzzlers that are removed or neglected would undergo monitoring and evaluation to ensure they are not ecologically important.

Small Game Guzzlers: Elements Common to All Action Alternatives

Under all action alternatives, the NPS would continue to allow existing small game guzzlers to be retained in the Preserve outside of wilderness.

Implementation Actions

The following implementation decisions or actions for small game guzzlers are common to all action alternatives:

- ***All Areas*** – Inspect and repair wildlife escape ramps on an as-needed basis on all intact guzzlers;
- ***Wilderness*** – Neglect; allow guzzlers to deteriorate over time, with no repairs or improvements; and
- ***Evaluation*** – Evaluate the condition of non-wilderness guzzlers and their contribution to native wildlife (see below).

Upon full implementation under all alternatives, small game guzzlers in wilderness would be neglected (similar to current management) to the point that they are no longer functional. Most small game guzzlers were originally installed to support game bird populations (i.e., quail and chukar), but they also supplement local water features for other desert wildlife. Long-term monitoring of habitat condition and wildlife use near guzzlers will improve our understanding of this relationship.

Within desert tortoise habitat, escape ramps would continue to be repaired as needed on non-wilderness guzzlers, and would be inspected to ensure they are functional on wilderness guzzlers where tortoises may have become dependent. Other wilderness guzzlers would be closed off to prevent entrapment and tortoise fatality, and allowed to deteriorate through neglect. Guzzlers in other non-wilderness areas would be retained, subject to alternative-specific actions (described below).

All actions within wilderness will be planned and implemented to ensure that the techniques and types of equipment needed minimize impacts on wilderness resources and character. Any future actions that involved 4(c) prohibited uses will be subject to project and site-specific MRA. A draft MRA for this plan is included in Appendix A.

Evaluation

All action alternatives would include a long-term evaluation program to better understand the relationship between guzzlers and other developed water features, wildlife habitat, and nontarget native wildlife populations. Evaluation would help the NPS understand the value of these water developments to the native wildlife while also understanding any potential unintended consequences of their existence. This monitoring protocol is not intended to directly influence any specific management actions, but is instead intended to better understand long-term trends throughout the implementation of this plan.

This monitoring effort would be based on spot observations of wildlife presence and behavior before and after implementation of management actions, over a lengthy period, and at multiple sites throughout the Preserve. Evaluation methods would examine diversity of species using guzzlers, survival of game birds (Gambel’s quail) in relation to the presence of guzzlers, and habitat selection and home ranges of game birds in relation to guzzlers.

Indicators

The indicators shown in Table 7 are intended to identify and evaluate the relationship between small game guzzlers and native wildlife populations and to prioritize implementation actions accordingly. The indicators would be monitored, in select groups, throughout the implementation of the plan and would be used to define and prioritize specific management actions. As it is not practical to monitor all small game guzzlers at all times, monitoring would be targeted to specific guzzlers or groups of guzzlers.

Table 7. Small Game Guzzlers – Indicators

Indicator	Potential Monitoring Methods
Guzzler condition	• Neglect wilderness guzzlers • Surveys of non-wilderness guzzlers (every 3 to 5 years)
Wildlife use	• Remote cameras, remote audio recorders • Adult-to-juvenile age ratios of Gambel's quail (survival indicator) • Home range and habitat selection of Gambel's quail sample • Point count or transect surveys of habitat areas surrounding guzzlers
Habitat context	• GIS analysis of reliable nearby water features

Small Game Guzzlers: Alternative 2 and Alternative 3 (Preferred Alternative)

Objective

The objective for small game guzzler management under Alternatives 2 and 3 would be to identify guzzlers that provide additional habitat value for native wildlife and retain the function of those guzzlers, eliminate those that do not provide ecosystem benefits. While most small game guzzlers were originally installed to support game bird populations, they also provide a supplemental water source for other desert wildlife.

Approach

The implementation of Alternatives 2 and 3 would primarily consist of neglect, though some guzzlers could be repaired or retained based on their ecological importance. Up to 2 guzzlers would be subject to potential major repairs, and up to about 32 could be removed or disabled based on site evaluations (see Table 6).

The NPS would neglect all small game guzzlers in wilderness and would remove or disable a select few based on evaluation. Some non-wilderness guzzlers would be retained, repaired, removed, or disabled based on location and evaluations of their ecological importance. Of the eight guzzlers located outside of wilderness that have not been recently repaired, major repairs or rebuilds would be permitted at two locations that are accessible by vehicle, but would not be permitted at the other six locations. Escape ramps would be maintained and repaired on all guzzlers within the Preserve.

Small Game Guzzlers: Alternative 4

Objective

The objective for small game guzzler management under Alternative 4 would be to support the use of guzzlers to augment native wildlife habitat and improve wildlife habitat connectivity in the Preserve and between the Preserve and surrounding habitat areas. The presence of small game guzzlers across the desert valleys of the Preserve is believed to contribute, to some degree, to the movement and persistence of a variety of native wildlife species beyond game birds. Alternative 4 would seek to use small game guzzlers as a tool to support the survival and movement of native wildlife species that would otherwise be vulnerable to the effects of climate change and habitat fragmentation. By providing supplemental water sources, existing small game guzzlers could potentially support the long-term survival of native species that may otherwise be extirpated from the Preserve.

Approach

Implementation actions would primarily consist of neglect, though most non-wilderness guzzlers could be repaired. Up to 8 non-wilderness guzzlers could have major repairs, and up to about 24 could be removed or disabled based on site evaluations (see Table 6).

Similar to Alternatives 2 and 3, under Alternative 4, the NPS would neglect small game guzzlers in wilderness and would remove or disable a select few. Some non-wilderness guzzlers would be retained and improved based on evaluations of their ecological importance, while a select few would be removed or disabled. Major repairs or rebuilds would be allowed at all eight non-wilderness sites that have not been recently repaired. However, road construction or off-road vehicle travel would not be allowed for maintenance at six of those sites, requiring non-motorized transport of equipment, materials, and personnel for the repair efforts.

Springs, Wells, Lakes, and Ponds

The Preserve contains a wide variety of springs, wells, and other water developments. The condition, water reliability, and wildlife use of these features varies from site to site. A total of 244 springs, seeps, and water development features have been identified in the Preserve (Table 8). These include a broad range of surface water expressions, ranging from intermittent seeps, resulting in moist soil, to highly modified human developments and perennially flowing natural springs. These water features also include a few hand-dug wells and two ponds in abandoned open pit mines (see “Water Features” in *Chapter 3: Affected Environment*).

Table 8. Characteristics of Known Springs and Water Developments

Characteristic	Number	% of Total
Total known springs (features)	238*	—
Managed springs (features)	124	52
Located in wilderness	182	76
Total named ponds and lakes	6	—
Total known wells	73	—
NPS water supply wells	8	11
Wells for grazing permits	15	21
Monitoring wells	10	14
Other wells	40	55

*Includes multiple features that are located on the same spring.

Potential Actions for Managed Springs

As described in *Chapter 3: Affected Environment*, the NPS has identified a set of 124 spring features that would potentially be subject to management activity. Potential management approaches considered for springs and water developments are:

- ***Maintain*** – Maintain, stabilize, or improve water conveyance infrastructure (e.g., pipes, valves, or troughs), or natural features such as topography, to promote or improve the conveyance of water.

- ***Evaluate for Wildlife*** – Determine the value and importance of the water source for ecological importance and native wildlife and complete a MRA and historical assessment to support retaining or improving the water infrastructure within wilderness if deemed necessary.
- ***Neglect*** – Allow water development to passively fall into disrepair with no maintenance.

Potential Actions for Wells

As described in *Chapter 3: Affected Environment*, the NPS has identified 73 wells that would potentially be subject to any management activity. Potential management approaches for wells are as follows:

- ***Maintain*** – Maintain well, pump, and associated infrastructure for existing purposes until it is no longer needed.
- ***Destroy*** – Completely and properly seal wells in compliance with State of California standards and regulations, including removal of aboveground infrastructure.

Management actions for springs, wells, lakes, and ponds are summarized in Table 9.

Elements Common to All Alternatives

Springs

None of the alternatives include active demolition and removal of spring developments or the construction of new water developments in the Preserve. Any efforts to retain or improve spring developments would occur on a case-by-case basis as funding and partnerships allow. In addition, any repairs or modifications to historic sites or developments would be consistent with the guidance of an approved historical condition assessment and treatment plan and in consultation with the California SHPO.

Wells

Under all alternatives, the 8 NPS water supply wells would continue to be retained, along with 28 other wells that are associated with grazing permits or water quality monitoring. All other wells that are not needed or used would be destroyed (in accordance with Section 13800 of the California State Water Code), except one to three wells that might be retained for potential future water supply. Two of these retained wells which would be in the Hole in the Wall area. No new wells would be drilled for wildlife purposes.

The NPS water supply wells to be retained are in the following locations:

- Hole in the Wall well
- Kelso Depot
- Kessler Springs Ranch
- Mid Hills Area
- OX Ranch
- Rockin' L well
- Valley View Ranch
- Zzyzx Desert Studies Center

All actions within wilderness will be planned and implemented to ensure that the techniques and types of equipment needed minimize impacts on wilderness resources and character. Any future actions that involved 4(c) prohibited uses will be subject to project and site-specific MRA. A draft MRA for this plan is included in Appendix A.

Table 9. Summary of Actions for Springs, Wells, Lakes, and Ponds

	No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Wells	• Maintain 8 water supply wells • Maintain 28 other wells • Add 1-2 wells in the Hole in the Wall area to support Preserve operations • Destroy unused wells, per state regulations	• Maintain 8 water supply wells • Maintain 28 other wells • Add 1-2 wells in the Hole in the Wall area to support Preserve operations • Destroy unused wells, per state regulations • Retain up to 3 existing wells for future water supply	Same as Alternative 2	Same as Alternative 2
Mohave Tui Chub (MC) Habitat	• Maintain habitat on an ad hoc basis	• Maintain springs for MC habitat; pursue additional sites (5 to 10)	Same as Alternative 2	Same as Alternative 2
Managed Springs	• Maintain springs in response to outside requests • Clean up spring sites if needed for visitor safety	• Evaluate springs for ecological importance and condition (5 to 7 sites per year) • Maintain if determined important for native wildlife (5 to 10 total springs)	Same as Alternative 2	• Evaluate springs for ecological importance and condition (5 to 7 sites per year) • Maintain springs to support native wildlife (10 to 15 total) • Neglect maintenance on those determined not important for native wildlife
All Other Springs	• Neglect all not otherwise treated	• Neglect all not otherwise treated	• Neglect all not otherwise treated	• Neglect all not otherwise treated
Treatment/Condition at Full Implementation (20 years)	• Maintain 36 wells; destroy others • Maintain select springs, per outside requests • Neglect all others	• Maintain 36 wells; retain 3 for water supply; destroy others • Maintain up to 10 springs for MC habitat • Possibly retain up to 10 springs, based on evaluation • Neglect all others	Same as Alternative 2	• Maintain 36 wells; retain 3 for water supply; destroy others • Maintain up to 10 springs for MC habitat • Possibly retain up to 15 springs, based on evaluation • Neglect all others

Springs, Wells, Lakes, and Ponds: Alternative 1 – No Action

Under Alternative 1, the NPS would conduct minimal routine management of springs and water developments in the Preserve. Ongoing management activities would be limited to repairs to fencing or water developments to prevent resource damage or hazardous conditions for visitors, and would be primarily focused on features that have resource or interpretive value or are close to visitor areas. Historic water developments could be restored or stabilized on an ad hoc basis, per outside requests, to mitigate structural deterioration (up to about four per year). Habitat for the Mohave tui chub would be repaired on an ad hoc basis.

Routine "snapshot" monitoring of springs and historic developments by NPS staff and volunteers would continue as resources are available. The Mojave Network Inventory and Monitoring Division would continue to monitor Mohave Chub (MC) Spring and a group of desert springs per approved protocols. Wells would be actively repaired or destroyed, consistent with state regulations, as resources allow. Under this alternative, the NPS would not engage in any long-term or comprehensive plans to systematically remove, disable, repair, or improve springs or other water developments in the Preserve.

Springs, Wells, Lakes, and Ponds: Elements Common to All Action Alternatives

Monitoring

All action alternatives would include a long-term monitoring program to better understand the relationships between spring developments and water availability, and between springs and wildlife populations. This monitoring effort would be based on spot observations of wildlife presence, over an extended period, and at multiple sites throughout the Preserve. This monitoring protocol is not intended to directly influence any specific management actions, but is instead intended to better understand long-term trends throughout the implementation of this plan.

Indicators

The indicators listed in Table 10 are intended to identify and evaluate the relationship between springs and native wildlife populations and to prioritize implementation actions accordingly. The indicators would be monitored throughout the plan and would be used to inform, but not determine, specific management actions. As it is not practical to monitor all springs and water developments every year, monitoring would be targeted to specific areas or groups of springs.

Table 10. Spring and Water Developments – Indicators

Indicator	Potential Monitoring Methods
Water availability	• Precipitation • Annual spring surveys for presence of water • Surveys of nonfunctional spring developments for presence of water
Wildlife use of springs	• Remote cameras • Remote audio recorders • Spot surveys/human observation

Implementation Actions

Implementation actions related to springs, wells, ponds, and lakes that are common to all action alternatives include:

- Maintain MC Spring, Lake Tuendae, West Pond, Morningstar Mine Pond, and potentially Rainbow Wells for Mohave tui chub; additional restoration sites would be pursued

- The NPS would not actively manage, repair, or improve other ponds or lakes in the Preserve
- Destroy any wells that are not needed or used, per state regulations, and
- Retain up to three existing wells in the Preserve for potential future water supply.

Springs, Wells, Lakes and Ponds: Alternative 2 and Alternative 3 (Preferred Alternative)

Objective

Under Alternatives 2 and 3, the NPS would seek to meet varying and competing land and wildlife management mandates by strategically repairing or improving select water features that are important to native wildlife, while allowing most features to continue to deteriorate over time. In the long term, this approach would retain the wildlife value of select water developments while allowing most developments to continue to deteriorate.

Approach

Management actions for springs, wells, lakes, and ponds would be identical under Alternative 2 and Alternative 3. The NPS would retain but neglect most springs and water developments. Maintenance of select springs (up to about 10 total) would be permitted based on evaluation of their ecological importance and condition.

Implementation actions for springs under Alternatives 2 and 3 would include:

- Allow most spring developments to deteriorate over time;
- Evaluate select springs for ecological importance and condition (about 5 to 7 sites per year); and
- Maintain select springs (about 5 to 10 total) if determined to be important for native wildlife.

Springs, Wells, Lakes, and Ponds: Alternative 4

Objective

In Alternative 4, the NPS would seek to support and supplement native wildlife populations to make them less vulnerable to these outside changes. To that end, this alternative would seek to actively retain selected water developments for wildlife. As a result of a long history of human land use in the region, the wide range of water developments are a long-standing component of the Mojave Desert ecosystem. As such, these developments have also become an important source of free-standing water for a wide variety of native wildlife species. Over the long term, as human development and climate change are expected to constrain the availability of habitat and water for many native species, these natural springs and water developments are expected to play an increasingly important role in sustaining native wildlife habitat.

Approach

Overall, this alternative would retain, repair, and improve some water developments, while allowing most developments to continue to deteriorate. The NPS would retain and improve select springs and water developments throughout the Preserve, emphasizing those with greatest ecological importance. Some developed springs would be actively repaired to improve water supply and promote wildlife habitat (up to about 15 total).

Implementation actions for springs under Alternative 4 would include:

- Evaluate select springs for ecological importance and condition (about 5 to 7 sites per year)
- Maintain select springs (about 10 to 15 total) if determined to be important for native wildlife
- Neglect maintenance on those springs determined to be less important for native wildlife
- Allow most spring developments to deteriorate over time

Other Water Resource Management Elements

The following elements of water resources management would be implemented by the NPS under any of the action alternatives.

Deep Alluvial Basin Groundwater

As described in the "Water Resources" section of *Chapter 3: Affected Environment*, the Preserve contains portions of several large alluvial basins that support deep aquifers. These alluvial basin aquifers are important for human use (including water supplies for the NPS, the Union Pacific Railroad [UPRR], and surrounding communities), while they also support several of the key springs and surface water features in the Preserve—most notably the perennial Piute Springs and Soda Springs, which are important surface water and ecological resources.

Under all action alternatives, the NPS would implement the following actions related to deep alluvial basin groundwater:

- Use select existing wells to monitor water levels and water quality for long-term trends
- Monitor groundwater quality as required to protect public health
- Work with partners to investigate and understand groundwater at Soda Springs and other sites
- Develop new wells to support Preserve operations as needed (e.g., administrative support facilities and expanded or relocated campgrounds and visitor centers)
- Provide technical review and comments for water-related issues relative to historical, existing, or proposed developments that may affect Preserve water resources (e.g., historical and ongoing mining operations and groundwater development projects)
- Pursue legal avenues, as necessary, to prevent or remedy impacts on Preserve water resources
- Complete comprehensive inventory of wells in the Preserve; plug and abandon unused and unneeded wells to provide aquifer protection and bring the Preserve into compliance with California state law

Water Rights

The proper ownership and use of water rights is a complex and important property issue in a desert environment. With a long history of land ownership and use under multiple federal agencies, as well as multiple land acquisitions and agreements related to federal lands, the complexity of water rights in the Preserve is both daunting and important. To support long-term stewardship of Preserve resources, it is important that the NPS have a clear understanding of its water rights and any rights that it can assert to respond to changing circumstances.

Under all action alternatives, the NPS would implement the following actions related to water rights:

- Inventory state water rights acquired by the Preserve via historical and future land acquisitions
- Develop and assert federal reserved water rights as necessary to protect Preserve water resources

Other Programs

Hazardous Materials

Under all action alternatives, the NPS would continue to identify and mitigate hazardous materials as lands are acquired. This is not only a legal requirement, but it is also important to retaining the quality and value of scarce water resources in the Preserve.

Grazing Management

Under all action alternatives, the NPS would work to develop and implement a livestock grazing management plan in a manner that is consistent with the other actions in this plan, as well as other goals to manage ecological systems.

Alternatives and Alternative Elements Eliminated from Further Consideration

During scoping and alternatives development, several alternative concepts or elements were suggested by the NPS, stakeholders, and the public that were considered and eliminated from further analysis in this EA. Based on NPS and NEPA guidelines (NPS DO-12), reasons to eliminate alternatives include technical or economic infeasibility; inability to meet project objectives or resolve need; duplication with other, less environmentally damaging or less expensive alternatives; conflict with park/preserve plans, purposes, or other policies; or too great an environmental impact. Alternatives or alternative elements that were eliminated from further consideration are discussed below.

Removal of All Water Developments

Several public scoping participants suggested that all water developments be removed from the Preserve. These suggestions were primarily based on the assertion that the presence of water developments was not consistent with NPS or wilderness policy, that they are the remains of past human development activity, or that they simply are not natural and do not belong in the Preserve. The NPS considered an alternative that removes all water developments, but such an alternative was eliminated from further analysis for a variety of reasons.

There are more than 500 known water features in the Preserve, ranging from large and elaborate guzzler systems to aging pipes protruding from the soil or wet areas behind an earthen dam. Some features are located near roads, while many others are in remote settings. Considering the number and diversity of water features on the landscape, it would be prohibitively difficult and costly to implement a program to remove or disable all water features.

While the NPS acknowledges that water developments are not part of the natural desert ecosystem, many of the guzzlers and nearly all of the developed springs have existed on the landscape for many years and were in place long before the designation of the Preserve as a national park system unit in 1994. As a result, many wildlife populations in the Preserve rely on water developments, and their complete removal could have unacceptable impacts on some populations and would not be consistent with the overall purpose and need for this plan. This is particularly the case for the fully protected desert bighorn sheep, whose population stability and distribution in the Preserve is directly related to existing guzzlers. The NPS believes the full removal of all big game guzzlers from the Preserve would have unacceptable impacts on existing sheep populations, their management, and their contribution to regional conservation efforts for the species.

Removal of All Water Developments from Wilderness

During the early phases of the planning and evaluation process, the NPS considered an alternative that would eliminate all big game guzzlers from wilderness. More specifically, four big game guzzlers would be removed (Clark, Piute, Old Dad, and Kelso), and two (Kerr and Vermin) would be relocated to suitable non-wilderness locations. In this alternative, the NPS had previously assumed that a reduction in the number and distribution of developed water features would result in a long-term shift toward a desert ecosystem that is less reliant on human intervention, and that by applying adaptive management principles this can be achieved without unacceptable impacts on native wildlife populations.

As part of the analysis of alternatives, the NPS discovered that this alternative for big game guzzlers would result in a 56 percent reduction in dry season habitat, based on an updated model of habitat. This magnitude of change—loss of more than half of the dry season habitat for bighorn—would result in an unacceptable loss of habitat for bighorn. Therefore, this alternative concept was eliminated from further analysis and consideration.

Significant Expansion of Water Developments

One alternative concept that was considered and eliminated is the significant expansion of water developments in the Preserve for the purposes of maximizing wildlife habitat or promoting hunting and wildlife viewing opportunities. As described above, many water developments currently exist in the Preserve, and many local and regional wildlife populations have become dependent on the availability of water in certain locations. Likewise, it is well understood that past and present human developments have compromised the function of the Mojave Desert ecosystems and that those effects are likely to be compounded by climate change.

While the NPS acknowledges the potential role of water development in mitigating anthropogenic impacts and promoting native wildlife conservation, the expansion of water developments would need to be limited, strategic, and reasoned. For example, Alternative 4 includes the possibility of limited guzzler expansion for the purposes of improving habitat connectivity for native wildlife species. Such water development expansion would be considered credible and appropriate because of its potential value to native wildlife conservation. The expansion of water development beyond those specific objectives, or for the purposes of expanded hunting opportunities or nonnative species habitat, is not considered appropriate for this plan or compatible with the GMP and NPS policy. Therefore, the alternative concept of significant expansion of water development was rejected from further analysis.

Prohibition of Hunting

Some members of the public wanted the NPS to consider prohibiting hunting in the Preserve. These comments were generally based on the belief that hunting is not appropriate in any unit of the national park system, or that the sole basis for retaining water developments in the Preserve is to support hunting, and, therefore, if hunting were prohibited, water developments would no longer be necessary. Any alternative concepts that prohibited hunting in the Preserve were eliminated from further consideration and analysis. The 1994 CDPA, the action by the U.S. Congress that established the Preserve, specifically directs the NPS to "permit hunting, fishing, and trapping on the lands and waters within the preserve in accordance with applicable Federal and State laws." This provision for public hunting in the Preserve is further affirmed by the 2001

GMP. Most hunting in the Preserve occurs during a limited season, while hunting for desert bighorn sheep is limited to a very small (0 to 4) number of tags. The prohibition of hunting was not considered as an element of this plan.

CHAPTER 3: AFFECTED ENVIRONMENT

Introduction

This chapter describes the unique factors that influence water resource management in the Preserve and the resources that could be affected by the implementation of any of the alternatives described in *Chapter 2: Alternatives*. The resource descriptions provided in this chapter serve as a baseline to compare the potential effects of the management actions proposed in the alternatives. The following resource topics are described in this chapter:

- Environmental Setting
- Water Resources
- Wildlife
- Cultural Resources
- Wilderness Character

Environmental setting and water resources are important for context and are foundational for water resource management, but are not resources that are analyzed for effects. Resource issues that were considered and dismissed from further analysis are listed in *Chapter 1: Purpose of and Need for Action* and are not discussed further in this EA. A description of the effects of the proposed alternatives on wildlife, cultural resources, and wilderness character is presented in *Chapter 4: Environmental Consequences*.

Environmental Setting

The Preserve includes an ecologically diverse yet fragile desert ecosystem consisting of vegetative attributes that are unique to the Mojave Desert, as well as components of the Great Basin and Sonoran Deserts.

Topography

The topography of the Preserve is characteristic of the mountain and basin physiographic pattern, with tall mountain ranges separated by corresponding valleys filled with alluvial sediments. Primary mountain ranges in the Preserve, from west to east, include the Granite, Kelso, Providence, Clark, New York, and Piute Mountains. Major alluvial valleys include Soda Lake (dry lake bed), Shadow Valley, Ivanpah Valley, Lanfair Valley, and Fenner Valley. Other physiographic features include the Kelso Dune system, Cinder Cone lava beds, and Cima Dome. The Preserve encompasses a 7,000-foot elevational range, with its highest point at Clark Mountain (7,929 feet [2,417 meters]) and its lowest point at Soda Lake (932 feet [284 meters]) (U.S. Geological Survey [USGS] 2009).

Geologic Overview

The geologic history of the Mojave Desert is typified by northwest striking faults active in the Late Cenozoic, which are associated with the greater San Andreas Fault System. Faulting was active into the Quaternary period and produced primarily northwest-trending mountain ranges (Bedford 2003). Geologic formations in the Preserve generally consist of consolidated rocks in the mountains and hills and the unconsolidated deposits in the valleys. The mountains consist primarily of igneous and metamorphic rocks of the Paleogene age (formerly referred to as pre-Tertiary age) of between 66 and 23 million years ago. In the valleys, the unconsolidated Pleistocene deposits (about 1.6 million years old) consist of gravels, sand, silt, and clay (NPS 2005a) containing deep aquifers (NPS 1999). Several of the highest mountain ranges, including the Clark, Ivanpah, and Providence Mountains, contain outcrops of carbonate sedimentary rocks in which cavities and caverns (such as Mitchell Caverns) have formed in dissolved limestone formations. Examples of past volcanic activity are found throughout the Preserve in cinder cones, lava flows, the Cima Dome formation, and the Hole in the Wall area (USGS 2009).

Climate Trends and History

The Mojave Desert is in the rain shadow of the San Gabriel and San Bernardino Mountains to the west and is characterized by very hot summers and cool winters. Climate conditions are among the most extreme and variable in the world, with significant changes in temperature and precipitation based on elevation, time of day, and season (NPS 2006).

Precipitation historically has ranged from 4 inches (10 centimeters) in lower areas such as Soda Lake to more than 12 inches (30 centimeters) annually in the New York Mountains. Summer precipitation comes in short, localized, and intense thunderstorms. Most precipitation occurs between November and March, when low-intensity frontal storms produce soaking rains and occasional light snowfall. Average annual potential evapotranspiration greatly exceeds the average annual precipitation, except during short periods during the winter, which is when most runoff and groundwater recharge occurs (Dekker and Hughson 2014; Hevesi et al. 2003; NPS 1999).

Events in the tropical Pacific and northern Pacific Ocean are linked to short-term variation in precipitation across the Mojave Desert region and are generally related to El Niño (increase in sea-surface temperature) and La Niña events (decrease in sea-surface temperature). El Niño events produce above-normal precipitation more frequently and result in significantly higher precipitation amounts compared with La Niña events (NPS 2006). Over much of the past 15 years, the Mojave Desert region has generally been in a La Niña cycle, resulting in lower precipitation and drought conditions (Hereford et al. 2002).

Historical precipitation records show multiyear droughts from the 1890s, through the 1960s. The wettest period in the last century was between 1976 and 1998 (NPS 2006; Abatzoglou et al. 2009; Hughson et al. 2011). The southwestern United States has been in a state of drought for well over a decade, with observed increased seasonal and average annual temperatures (Cook et al. 2009; Loehman 2010). Over the 2010–2013 period, the Mojave Desert region experienced an average temperature increase of 1- to 2-degrees and a precipitation decrease of up to 4 inches (10 centimeters), compared with long-term averages (WRCC 2013). This current multiyear drought is among the most extreme in 500 years (Cook and Krusic 2004; Loehman 2010).

Climate Projections

Reconstructions of the Earth’s climate over the past 2,000 years have shown that while temperature fluctuations have varied, each of the last three decades has been successively warmer at the Earth’s surface than any preceding decade since 1850. The period from 1983 to 2012 was likely the warmest 30-year period of the last 1,400 years in the Northern Hemisphere (Intergovernmental Panel on Climate Change [IPCC] 2015).

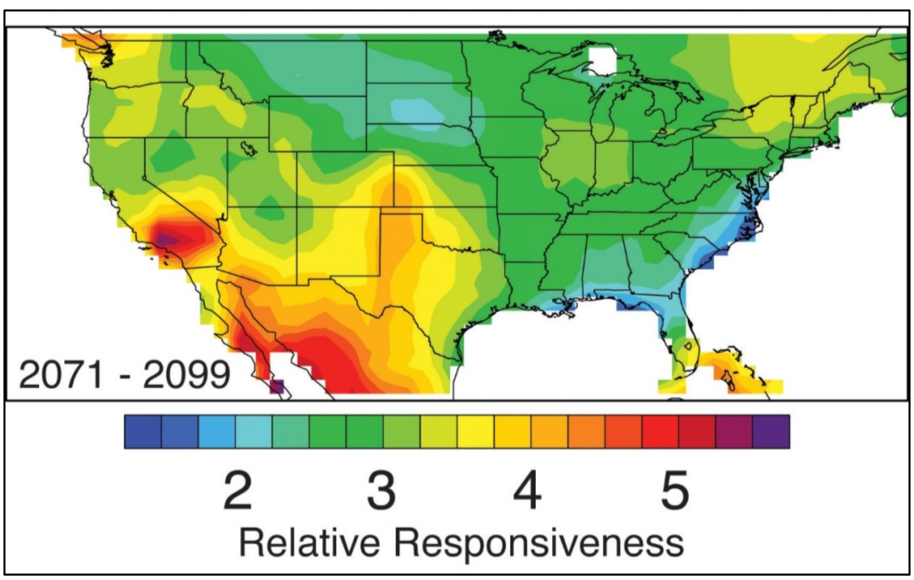
General effects of climate change are not uniform across regions (Brekke et al. 2009). Climate models predict that the arid regions of the southwestern United States will become increasingly dry and that a transition to a more arid climate is already underway (Seager et al. 2007; Lenart et al. 2007; Loehman 2010). Precipitation data going back to 1895 demonstrate this trend, with the four driest years occurring in 2013, 2014, 2002, and 2007; and the wettest year in the Mojave Desert occurring in 2005 (Hughson et al. 2011; WRCC 2017). Southern California, including the Mojave Desert, is predicted to be one of several climate change “hotspots,” with a more arid climate and increased variability of precipitation from year to year (Diffenbaugh et al. 2008) (Figure 8). Climate models predict a general drying trend: with increasing air temperatures and reduced precipitation (Seager et al. 2007). Projected changes to the climate in the southwestern deserts include the following:

- Continued increases in temperature, but at a rate faster than observed in recent decades (Loehman 2010)
- Periods of extreme temperatures (heat waves) may increase in frequency, intensity, and duration over the next century (Diffenbaugh et al. 2005)
- Intensification of extreme hot periods, combined with warm-season drying (Diffenbaugh and Ashfaq 2010)
- Precipitation events (e.g., intense rain and associated flooding) are expected to be more extreme and occur roughly twice as often as they historically have (Kharin et al. 2007)

Arid ecosystems are particularly sensitive to climate change because the organisms in these regions are already adapted to live near their physiological limits for water and temperature stress. Slight changes in temperature and precipitation patterns in arid ecosystems can significantly alter the composition, abundance, and distribution of species (Loehman 2010). Temperature-related changes to ecosystems are likely to lead to an upward elevational shift of some woodland and montane communities, an expansion of desert scrub communities, and a northward migration of southwestern deserts.

Increased temperatures, reduced winter frost, and drought could also facilitate the expansion of forest pathogens and increased mortality of pinyon-juniper woodlands (Hughson et al. 2011). Recent droughts have resulted in widespread and significant mortality of shrubs and perennial grasses in parts of the Sonoran and Mojave Deserts (McAuliffe and Hamerlynck 2010; Hereford et al. 2006; Loehman 2010). The ecosystem effects of climate change have already shown effects on some desert wildlife species, including desert bighorn sheep (Epps et al. 2006), and biologists are increasingly concerned about extirpation or extinction of some species due to shrinking or disappearing habitats (NPS 2006).

Figure 8. U.S. Climate Change Hotspots



Source: Diffenbaugh et al. 2005

Changing climate conditions in the southwestern deserts, including increased temperatures, reduced precipitation, lower snowpack, and increased evapotranspiration, are likely to result in significant changes to the hydrologic cycle and water sources for both human use and ecosystem function. In desert systems like those found in the Preserve, this would likely result in reduced infiltration of precipitation into perched aquifers that are the source for many of the seeps, springs, and developed water features. Reduced recharge to deep alluvial aquifers will limit groundwater availability for water supply, though the effects may take centuries (Hughson et al. 2011).

In summary, the combined effects of cyclical drought and a changing climate are expected to result in a continued warming and drying trend for the Mojave Desert region, more variable precipitation when it does occur, and a reduced availability of surface water in the Preserve (Dekker and Hughson 2014).

Regional Context

Figure 9 shows the Preserve and surrounding region and highlights development, transportation corridors, and other factors contributing to the regional context. Existing and planned land management or development projects in the Mojave Desert region that are relevant to this plan and the resources affected by this plan are described below under the broad topics of existing infrastructure, federal land management, energy development, water development, and proposed development projects.

Existing Infrastructure

Modern human development of the Mojave Desert over the past century has resulted in a patchwork of developed areas and disturbed corridors. These include but are not limited to:

- I-15 to the north
- I-40 to the south
- UPRR, which traverses the Preserve
- Mountain Pass mine, north of the Preserve
- Numerous abandoned mines
- Numerous highways and roads
- Transmission lines traversing the Preserve
- Gas and petroleum pipelines
- Canals and aqueducts
- Small towns, ranches, and other settlements

While the Mojave Desert remains a vast and undeveloped landscape, the culmination of these and other developments has resulted in the fragmentation of natural habitat and movement corridors for broad-ranging wildlife species, such as desert bighorn sheep (Epps et al. 2007 and Creech et al. 2014).

Federal Land Management

Most of the land in the Mojave Desert is owned by the federal government, most of which is managed by the BLM. In addition to the Preserve, the NPS manages three other major sites in the Mojave Desert: Joshua Tree National Park, Death Valley National Park, and Lake Mead National Recreation Area. The Department of Defense (DOD) manages five major military installations in the Mojave Desert: Fort Irwin National Training Center (Fort Irwin), Twentynine Palms Marine Corps Air Ground Combat Center (Twentynine Palms), China Lake Naval Air Station (China Lake), Nellis Air Force Base (Nellis) and Edwards Air Force Base (Edwards).

Preserve Projects and Plans

The Preserve has several recent or current projects, including:

- West Pond EA to improve habitat for the Mohave tui chub;
- Translocation of Bighorn Sheep to Eagle Crags Mountains 2005 Finding of No Significant Impacts (FONSI) to augment the bighorn population at China Lake;

- Abandoned Mine Safety Installations 2011 FONSI to implement abandoned mine safety options;
- Barber Peak Trail Loop Reroute 2011 FONSI to avoid the Hole in the Wall campground; and
- Ivanpah Desert Tortoise Research Facility to support tortoise population recovery efforts.

Military Land Expansion

Since 2000, the U.S. Army has been working to expand Fort Irwin by about 110,000 acres. The 2008 EA and Finding of No Significant Impact authorized the translocation of Mojave Desert tortoise from Fort Irwin to adjacent BLM lands (BLM 2008). As of 2016, translocation of tortoises is complete.

Likewise, the U.S. Marine Corps has been preparing to expand Twentynine Palms (DOD 2012). The expansion will be analyzed in a supplemental Environmental Impact Statement (EIS) to the 2012 EIS for the acquisition and expansion of the military installation. Translocation of desert tortoises onto BLM land is also proposed, but the efforts have been complicated by concerns about impacts on desert tortoise populations and have included plans for tortoise translocation, fencing, and monitoring. Translocation plans are currently on hold until the analysis is complete.

National Monument Designation

In February 2016, President Obama designated three new national monuments in the Mojave Desert, encompassing 1.8 million acres: Mojave Trails National Monument, Sand to Snow National Monument, and Castle Mountains National Monument.

Mojave Trails National Monument (1.6 million acres) is located south of the Preserve and was established to protect historic resources including Native American trading routes, World War II–era training camps, and historic Route 66. It also includes areas with geological and ecological importance, as well as 350,000 acres of previous designated wilderness. It is managed by the BLM.

Sand to Snow National Monument (154,000 acres) is located southwest of the Preserve at the transition between the desert ecosystem of Joshua Tree National Park and the high-elevation forests within San Bernardino National Forest. It is co-managed by the BLM and U.S. Forest Service. It includes numerous archeological sites, diverse ecological resources, and recreation assets.

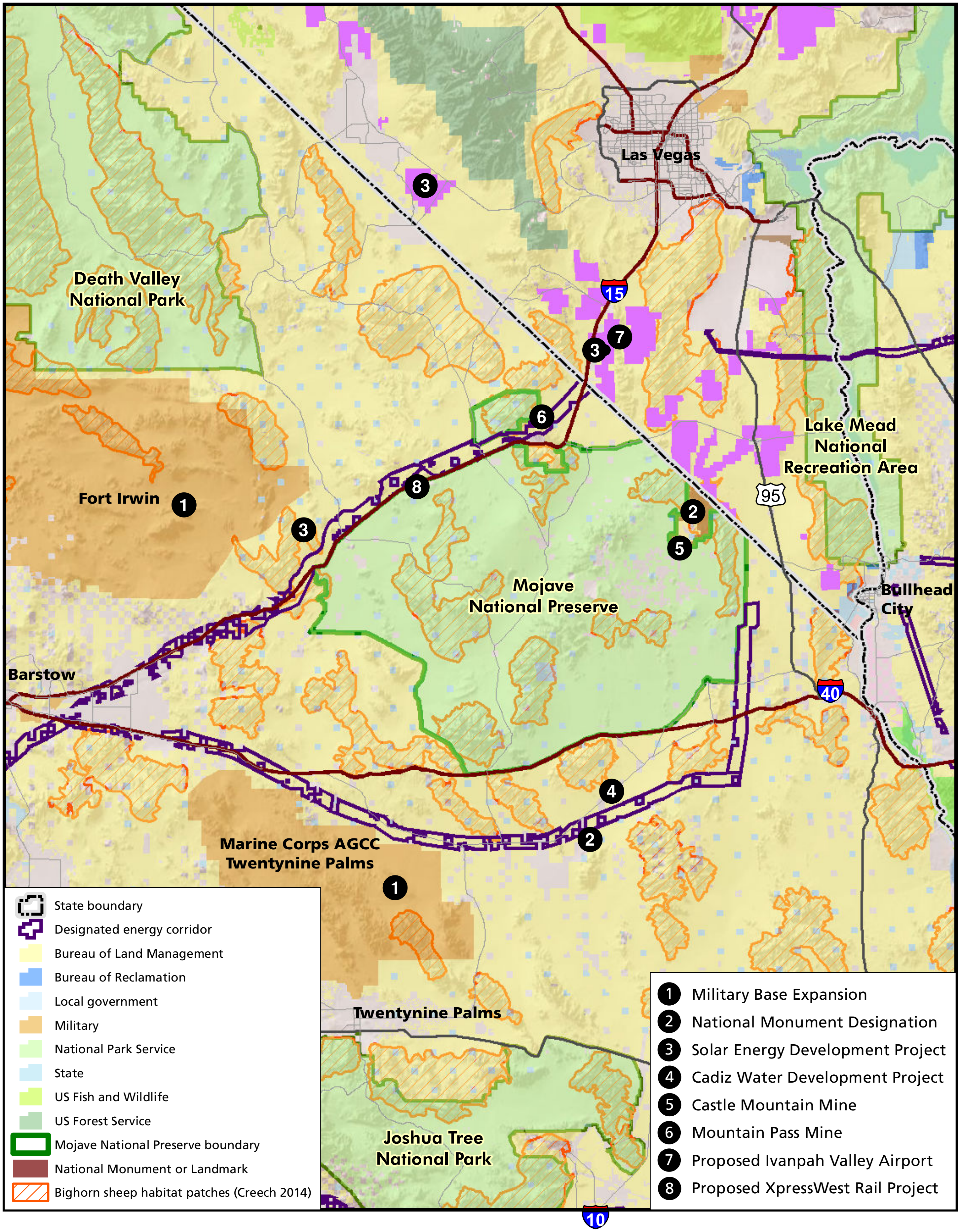
Castle Mountains National Monument (20,920 acres) is immediately adjacent to the Preserve and includes portions of the Castle Mountain Range and Lanfair Valley. It is managed by the NPS. This monument provides an important connection for wildlife (including desert bighorn sheep), and the valley floor includes an important alluvial aquifer. The monument surrounds the existing Castle Mountain Mine, which is located on private land and is not part of the monument designation.

Energy Development

In the past decade, the Mojave Desert has become an attractive location for large utility-scale solar energy development. Federal land management plans and multiple solar projects have been proposed and completed in the recent past.

Western Solar Plan

In 2012, the BLM, in cooperation with the Department of Energy (DOE), prepared a programmatic EIS to evaluate the potential environmental, social, and economic effects associated with the development and implementation of agency-specific programs that would



Las Vegas
Death Valley National Park
Fort Irwin
Lake Mead National Recreation Area
Mojave National Preserve
Bullhead City
Barstow
Marine Corps AGCC Twentynine Palms
Twentynine Palms
Joshua Tree National Park
15
95
40
10
State boundary
Designated energy corridor
Bureau of Land Management
Bureau of Reclamation
Local government
Military
National Park Service
State
US Fish and Wildlife
US Forest Service
Mojave National Preserve boundary
National Monument or Landmark
Bighorn sheep habitat patches (Creech 2014)
1 Military Base Expansion
2 National Monument Designation
3 Solar Energy Development Project
4 Cadiz Water Development Project
5 Castle Mountain Mine
6 Mountain Pass Mine
7 Proposed Ivanpah Valley Airport
8 Proposed XpressWest Rail Project

facilitate utility-scale solar energy development in six western states: Arizona, California, Colorado, Nevada, New Mexico, and Utah (BLM 2015).

The Western Solar Plan included amendments to 89 BLM land use plans, including the CDCAP, not only to support solar energy development on public lands, but also to minimize potential environmental, cultural, and socioeconomic impacts. As part of the Western Solar Plan, the BLM identified priority areas (solar energy zones or SEZs) that are well suited for utility-scale production of solar energy, variance areas outside of SEZs where solar development would be open to applications, and areas to be excluded from utility-scale solar energy development (BLM 2015).

The two closest SEZs to the Preserve are Riverside East SEZ in Riverside County, California, and Dry Lake SEZ in Clark County, Nevada (BLM 2014). Both SEZs are more than 50 miles from the Preserve; however, several variance areas are directly adjacent to the Preserve.

Desert Renewable Energy Conservation Plan

In 2016, the BLM, in cooperation with the U.S. Fish and Wildlife Service (USFWS), California Energy Commission, and CDFW, released the final programmatic EIS and Land Use Plan Amendment to streamline the permitting of renewable energy projects while advancing federal and state natural resource conservation goals within the Mojave and Colorado/Sonoran Deserts in seven counties in California, including San Bernardino County, where the Preserve is located. The DRECP is intended to conserve special status species habitat and vegetation communities within areas managed under the CDCAP, while designating approximately 388,000 acres for renewable energy development and an additional 40,000 acres for potential development after further environmental review. Approximately 10 million acres of BLM land within the area would be designated for conservation or recreation and therefore would not be available for renewable energy development.

Solar development focus areas are located approximately 10 miles from the Preserve’s western boundary, and a variance area is located approximately 20 miles from the southern boundary. Most of the Preserve is bounded by BLM land that is managed for conservation or recreation and would be removed from consideration for industrial renewable energy development under the DRECP.

Ivanpah Energy Solar Development Project

Located about 15 miles north of the Preserve in the Ivanpah Valley, the 4,000-acre Ivanpah solar electric generating system is currently the largest solar thermal power plant in the world (BrightSource Energy 2015). Due to charges of numerous bird deaths (more than 2,000 wild birds died at the plant between March and August in 2015) and accusations of production shortfalls, the solar plant risked being shut down in the beginning of 2016. However, in March 2016, the California Public Utilities Commission gave the project one year to increase its electricity production to fulfill its supply commitments (Martin 2016), and as of February 2017, it has begun to meet its contractual obligations and will continue to operate (Ryan 2017).

Silver State South Solar Project

In February 2014, the BLM approved the development of a 350-megawatt solar energy facility on approximately 2,400 acres of public lands adjacent to the town of Primm, Nevada (north of the California/Nevada border). The Silver State South Solar Project is adjacent to the Silver State North Project, the first solar plant on public lands to deliver power to the grid (BLM 2014). Construction of Silver State South began in September 2014.

Stateline Solar Farm Project

In February 2014, the BLM approved the development of a 300-megawatt solar facility two miles south of the California/Nevada border and 0.5 mile west of I-15 northeast of the Preserve. The project is currently under construction and encompasses approximately 1,685 acres of public land (BLM 2012).

Soda Mountain Energy Development Project

In April 2016, the BLM approved the Soda Mountain Energy Development Project on 1,767 acres of BLM-managed land about six miles southwest of Baker, west of the Preserve. The facility is in an area of disturbed land that includes I-15 and an active utility corridor for oil and gas pipelines, electricity transmission and communication lines, and facilities (BLM 2013).

The BLM's approved design intends to ensure that the project will not interfere with future efforts to reestablish desert bighorn sheep movement across the interstate highway. There are currently no bighorn sheep on the north side of I-15 in the project area, largely because the highway creates a significant barrier. In reducing the project by nearly 455 acres, the smaller footprint preserves a connectivity point across the highway in the event that bighorn sheep populations are reestablished north of the highway in the future. The smaller footprint will also require less water for construction and operations (Department of the Interior [DOI] 2016). Implementation timeline for the project is unknown.

Water Development

Cadiz Valley Water Conservation, Recovery, and Storage Project (Cadiz Project)

Cadiz, Inc. owns 45,000 acres of land in three areas of the Mojave Desert, near the Preserve to the south. The primary property is in the Cadiz and Fenner Valleys (Cadiz Property) on approximately 34,000 acres of land. Other properties are located in the Piute Wash and near Danby Dry Lake. All three properties are underlain by deep alluvial basin groundwater supplies. Over the last 20 years, Cadiz, Inc. has maintained an agricultural operation at its Cadiz Property. The agricultural operation uses groundwater for irrigation of all crops in production through a network of seven existing water production wells.

The groundwater beneath its Cadiz Property is confined within a closed basin that ultimately flows to two saline groundwater sinks (Bristol and Cadiz Dry Lakes). The proposed water storage project would extract water within the aquifer system to create a local water supply alternative for Southern California water providers. Water would be delivered through an underground conveyance pipeline to the Colorado River Aqueduct for delivery to water users (Cadiz, Inc. 2015). The proposed project involves the Cadiz, Fenner, Bristol, and Orange Blossom Wash Watersheds.

Castle Mountain Mine – Water Extraction

The Castle Mountain Mine is northeast of the Preserve and includes portions of the Castle Mountains and Lanfair Valley. The mine is immediately surrounded by the newly established Castle Mountains National Monument. The Castle Mountain Mine is a heap-leach gold mine that was purchased by NewCastle Gold in 2012, with multiple water extraction wells in the Lanfair Valley basin aquifer. Exploration is currently underway at the Castle Mountain Mine site (NewCastle Gold 2017).

Proposed Transportation Development Projects

Several other regional transportation and infrastructure projects have been proposed or planned in the Mojave Desert near the Preserve.

Ivanpah Valley Airport

A new airport to serve the Las Vegas region has been proposed near Primm, Nevada, north of the Preserve. Clark County purchased 6,000 acres of land for the facility, but no development plans have been implemented.

XpressWest (formerly Desert Xpress)

This project is a proposed high-speed passenger railroad between Las Vegas and Southern California. Construction began in 2017 on the first phase of the project, running about 185 miles from Las Vegas to Victorville, California, following the I-15 right-of-way. An environmental review is expected in 2017 for the second phase, which would extend the track 50 miles from Victorville to existing commuter rail service in Palmdale (Department of Transportation [DOT] 2011).

If implemented, these projects could influence or affect resources in the Preserve. However, at this time, these projects are considered speculative.

Water Resources

Groundwater

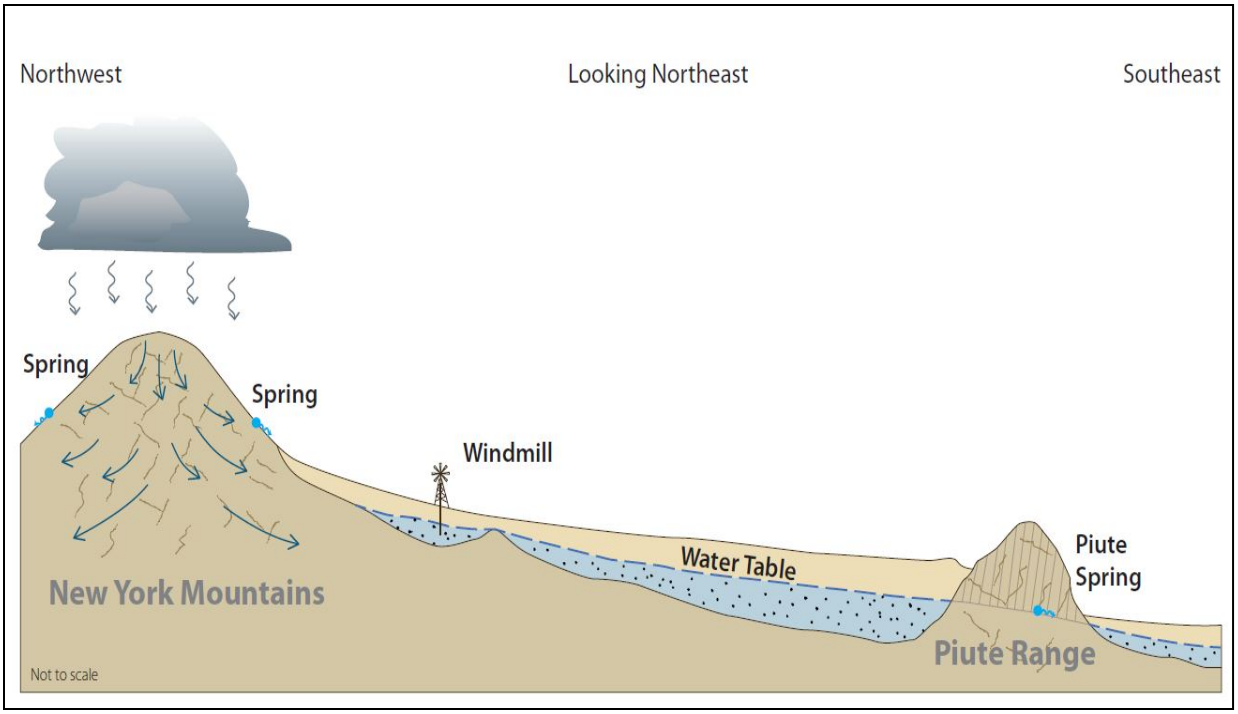
Groundwater is the primary water resource in the Preserve. It occurs primarily in alluvial aquifers and fractured bedrock and carbonate systems. Most of the groundwater recharge in the Preserve results from precipitation seeping into bedrock fractures or running off and infiltrating into alluvium along the edges of mountains or through alluvial fans and arroyo channels (Izbicki et al. 1995). The valleys themselves have limited surface recharge due to low-permeability geologic layers and deep vadose zones (NPS 1999). Greater precipitation and recharge occur at higher elevations along the upper edges of the drainage basins, Although all parts of the Preserve receive occasional precipitation, most precipitation falls at higher elevations, such as the New York Mountains. From higher-elevation areas, some of the precipitation infiltrates and flows through bedrock fractures, eventually surfacing as springs or discharging to the alluvial fill. Additional recharge comes from infiltration of infrequent runoff at lower elevations and subsurface connections between basins (NPS 1999).

Figure 10 illustrates the relationship of precipitation, fractured bedrock, and alluvial aquifers using a cross-section of the Lanfair Valley between the New York Mountains and the Piute Range in the northeast part of the Preserve (which is representative of typical systems in the Preserve).

Groundwater withdrawal and discharge in the Preserve occurs through springs, seeps, wells, and subsurface flow into adjacent groundwater basins; or at points where an aquifer is intercepted by a constructed feature (e.g., a windmill-powered well) (NPS 1999; California Department of Water Resources [CDWR] 2004a, 2004b). As discussed under “Climate Trends and History” above, potential evapotranspiration exceeds precipitation except during portions of the winter months, which limits runoff and groundwater recharge.

Springs and seeps appear when groundwater is forced to the surface by an impermeable geologic stratum below, with a fault line or fissure above. Typically, a spring or seep will flow for a short distance until the water is absorbed back into the penetrable alluvial material in arroyos typical to the region (NPS 1999).

Figure 10. Illustrative Cross-Section of Lanfair Valley



Source: Freiwald 1984.

Fractured Bedrock Groundwater

Groundwater percolating through fractured bedrock supports most of the springs and other water features in the Preserve. Springs and seeps near the base of the mountains are typically the result of geologic conditions, such as a change in rock type, fault, or surface erosion, that expose fractures. The consolidated rocks that form the mountains in the Preserve have limited permeability except for the fractures, and where volcanic and carbonate strata occur. Thus, water storage in fractured bedrock is limited, which results in fluctuations of spring and seep flow in direct relationship to the amount of recent precipitation (NPS 1999).

Alluvial Basin Aquifers

Large valleys in the Preserve are filled with unconsolidated sediments that have collected over millions of years. These sediments, which range from hundreds to thousands of feet deep in the central portion of larger basins, form the deep alluvial basins and associated groundwater aquifers in the Preserve. While groundwater recharge from precipitation and runoff is an ongoing process, much of the water in these deep aquifers was recharged more than 20,000 years ago, during wetter climatic periods (NPS 1999). Groundwater in deep alluvial basins throughout the Mojave Desert is a valuable water source for human use, some of which is being extracted through deep well pumping (CDWR 2003).

Surface Water

Except for occasional flood flows, surface water in the Preserve is limited to short stretches of flowing water below large springs, spring pools, and excavated ponds that intercept groundwater. In addition, numerous small springs and seeps are the most common water sources in Mojave landscape (see “Water Features” section below).

Streams

The best examples of flowing streams in the Preserve are the drainages immediately below large springs where some surface water is reliably found for some distance before it disappears into the alluvium. These areas generally support small bands of wetland and riparian vegetation. The most prominent example of a perennial stream is Piute Springs near the eastern edge of the Preserve, while Cornfield Creek (near Kelso) and Rock Creek (near Government Holes) are ephemeral. Rapid runoff from snowmelt or large storms will also produce surface runoff through otherwise dry arroyos and washes, which can sometimes result in flash flooding (NPS 2009).

A short reach of the lower end of the Mojave River is located near the far western tip of the Preserve. Regionally, the Mojave River is an important water source, flowing east from the San Bernardino Mountains for more than 100 miles. It is usually dry on the surface because most of the water sinks into the porous alluvium of the river channel, providing recharge to the immediate floodplain aquifer and large regional aquifer, both of which are important water supplies for human uses (USGS 2001).

Lakes and Ponds

Ponds and lakes in the Mojave Desert are few, and most have been constructed. The two most prominent open water bodies are the Morningstar Mine Pit Lake and the ponds at Soda Springs.

Morningstar Mine Pit Lake. The Morningstar Mine was an open pit heap-leach gold mine that ceased operation in 1992. The mining operations intercepted a perched aquifer, which required continuous dewatering during operation. Now, the lake at the bottom of the pit is the largest fresh water body in the Preserve, with water levels that have remained fairly constant and with good water quality. The Morningstar Mine Pit Lake was stocked with the endangered Mohave tui chub in 2011. Another example of a mine pit lake is the Vulcan Mine Pit Lake.

Soda Springs Ponds. The Soda Springs complex is located on the far western edge of the Preserve, at the base of the Soda Mountains at the site of the former Zzyzx Resort. This complex includes two constructed ponds and natural spring-fed pools. The Soda Lake aquifer and local recharge are believed to feed Soda Springs (Dickey et al. 1979; Bilhorn and Feldmeth 1985). MC Spring is the primary surface expression of these springs and supports a population of the endangered Mohave tui chub (MC Spring itself is also characterized as a spring and is discussed further under “Springs” below).

A constructed pond, called Lake Tuendae, at Soda Springs is fed by a well completed in the Soda Lake aquifer (Bilhorn and Feldmeth 1985). This pond and several others nearby were constructed as part of the 1940s-era resort development. Lake Tuendae provides habitat for the Mohave tui chub but requires periodic maintenance to clean out cattails and silt (Woo and Hughson 2003).

West Pond is another constructed pond located a short distance southwest of Lake Tuendae. Until a fish kill in 1981, it provided habitat for the Mohave tui chub (Dirling 1997). West Pond intersects the water table of the Soda Lake aquifer, and salinity in the pond had increased due to evaporation, making it unsuitable as Mohave tui chub habitat (Woo and Hughson 2003; Dirling 1997). In 2016, the NPS completed the restoration of West Pond by pumping out the brine, maintaining the surface water elevation, and planting vegetation along the bank. This significantly improved the salinity of the pond, and signs of increased waterfowl use have been observed.

Water Features

A wide variety of water features are in the Preserve, many of which have been modified by human activity. Table 11 lists the number of each type of water feature in the Preserve, Figure 11 describes each, and Figure 12 shows the locations of known water features.

Table 11. Water Features in the Preserve

Water Feature Type		Number	Notes
Springs		238	Most have been developed or manipulated; 182 are located in wilderness
Wells		73	Includes water supply, monitoring, and grazing permit wells
Lakes and ponds		6	Includes mine pit lakes, constructed ponds, and numerous uninventoried stock ponds
Big game guzzlers		6	All are located in wilderness
Small game guzzlers		131	60 are in wilderness; 64 have been recently repaired

Figure 11. Surface Water Feature Expressions in the Preserve

Water Features in Mojave National Preserve

Springs

Flowing spring – (*rheocrene*) a spring that flows directly out of the ground into a perennial or ephemeral stream or may disappear into the ground some distance from the source. *Example: Piute Spring*.

Ponded spring – (*limnocrene*) a pond or small wetland. *Example: MC Spring*. Note that the existence of open water may be the result of regular maintenance, such as at MC Spring, which requires regular removal of vegetation to maintain an open water zone.

Bog – (*helocrene*) a diffuse upwelling seep in an area of boggy or marshy ground. In the Preserve, these are often seasonally ephemeral. *Example: Mid Hills Spring.*

Buried spring – (*hypocrene*) water occurring in an underground tunnel or hole that does not flow to the surface. *Example: Henry Spring.*

Verdant seep – a small zone, typically in or near the channel of an arroyo or canyon, of near-surface moist soil characterized by vegetation; in some cases, these seeps have been developed for livestock. *Example: Cliff Canyon Spring.*

Hanging seep – similar to a verdant seep but emerging from a steep slope or cliff. *Example: Cave Spring.*

Tinaja – a pool in a bedrock depression. In the Preserve, tinajas typically occur in the channel of a mountainous canyon along a reach free of sediment. *Example: Rock Spring*.

Piute Spring supports a flowing stream and riparian habitat

Mid Hills Spring is an ephemeral bog

MC Spring is an open pond and wetland

Developments

Excavation – a subvertical hollow dug into sediments, typically paleospring deposits, creating a seepage face in moist to saturated soil. *Example: Mail Spring.*

Tunnel – a subhorizontal tunnel excavated into sloping sediments intersecting a shallow water table. Ponded water remains inside the tunnel or is brought to the surface by gravity flow through a pipe. Where a pipe exists, it is usually connected to a drinker trough, often some distance away. *Example: Silver-Lead Spring.*

Springbox – a shallow well into near-surface groundwater connected to a subhorizontal pipe placed below the water table. Water leaves the springbox by gravity flow through the pipe to a drinker trough. *Example: White Rock Spring.*

Adit – a large subhorizontal tunnel, often excavated in fractured rock. An adit is distinguished from a tunnel by larger size, greater length, and rock versus sediment, and is sometimes associated with mining activity. Water is brought to the surface by gravity flow through a pipe. *Example: Budweiser Spring.*

Pipe – gravity flow from a pipe derived from an unknown source. This term is included to describe features where the actual water source is unknown. *Example: South Hackberry Spring.*

Mail Spring is an excavated seepage face in spring deposits

Cut Spring is piped from a springbox to a concrete drinker

Budweiser Spring water source is in a tunnel excavated in granitic rock

Wells

Shallow (hand dug) – a well often only a few feet deep that may or may not be shored. A shallow well is distinguished from a springbox by the need to lift water. *Example: Bolder Spring.*

Drilled – a well excavated by rotary drilling. Drilled wells range in depth from several feet up to 1,400 feet (427 meters) for some UPRR wells and the Kelso Depot water supply well. Typically, these wells are completed with metal or PVC casing. Lift is provided by a windmill or submersible pump. Many have been abandoned by welding a metal cap to the top of the casing. Some have been destroyed, while others remain as open boreholes. *Example: Watson Well.*

Watson Well is a capped drilled well

Shallow well at Bolder Spring

Ponds and Reservoirs

Wet playa – a terminal basin playa with near-surface groundwater that becomes an ephemeral lake following heavy precipitation. *Example: Soda Dry Lake.*

Ephemeral pond – a natural depression for runoff, often modified by earthwork to hold more water. *Example: Ford Dry Lake.*

Pit lake (groundwater) – open pit mining excavation into a perched aquifer. A pond is formed in the bottom of the open pit after termination of mining and dewatering. *Example: Morningstar Mine.*

Pit lake (surface water) – precipitation collected in the bottom of an open pit mine forming an ephemeral pond, typically with poor water quality. *Example: Vulcan Mine.*

Excavated pond – a pond constructed by excavating into shallow groundwater that may need regular refilling by pumping water. Distinguished from a groundwater pit lake by intent and purpose. Distinguished from a stock pond by permanence. *Example: Lake Tuendae.*

Stock pond – a basin excavated in sediments usually for livestock watering. Typically, these take advantage of natural drainage features and hold water only intermittently. *Example: Lecyr stock pond.*

Ford Dry Lake following a rainy season

Morningstar Mine groundwater pit lake

Guzzlers

Big game guzzler – a water collection system consisting of a check dam in a natural drainage piped to one or more storage tanks that supply water to a small drinker. In the Preserve, these were built for bighorn sheep but may be used by other animals. *Example: Kerr guzzler.*

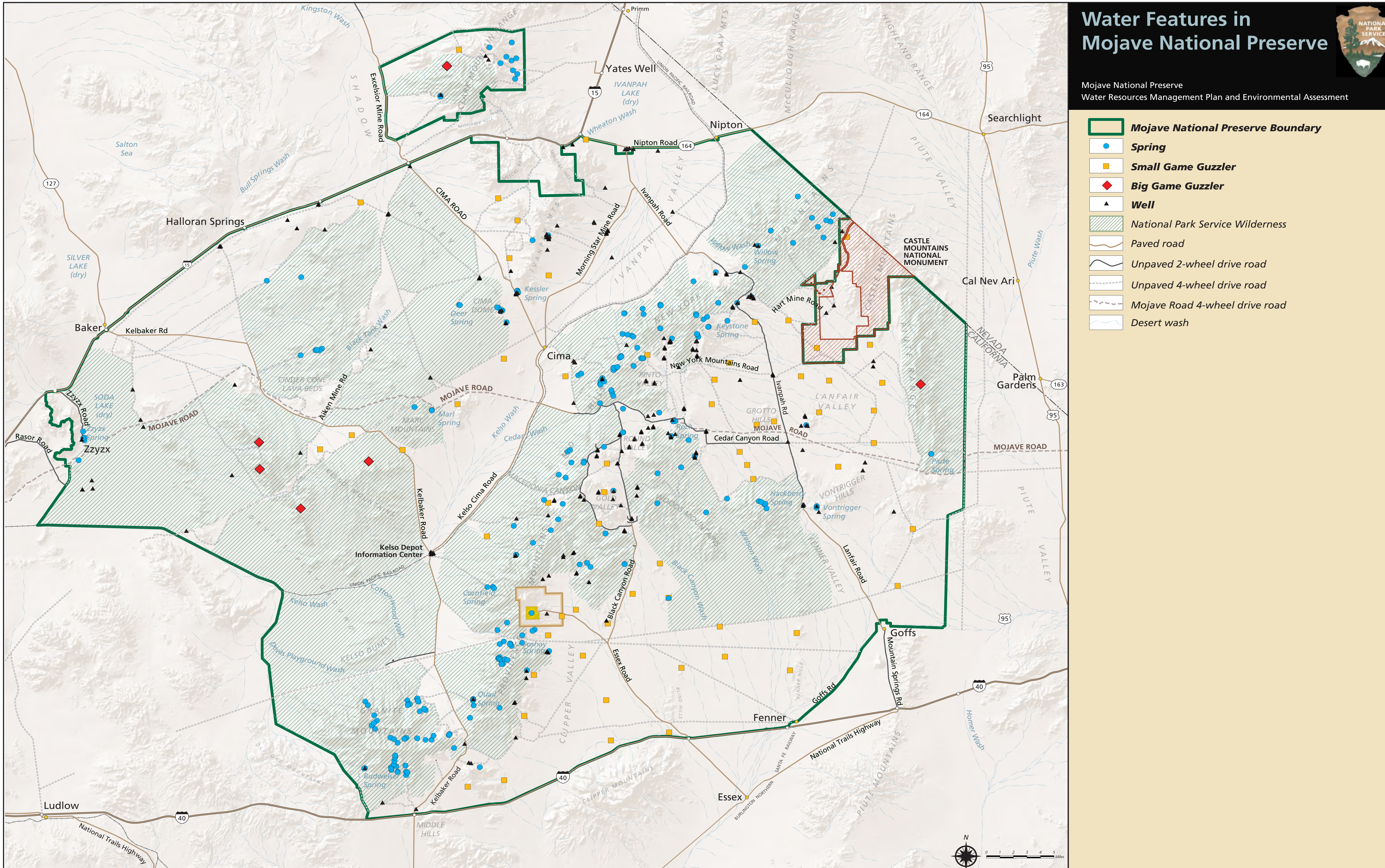
Small game guzzler – also known as gallinaceous guzzlers as they are intended for gallinaceous bird species. These guzzlers consist of a concrete apron leading to a subsurface concrete or fiberglass storage tank. Birds and small animals enter the storage tank through a small opening.

Large tanks at a big game guzzler

Small game guzzler with a concrete apron and underground tank

Combinations

Features can occur in various combinations, such as a verdant seep with a tunnel, or a bog plus a well. Features may also vary seasonally and may be described by combinations of terms, such as *ephemeral excavated flowing spring* (e.g., Mail Spring following a rainy season). Many features exist somewhere between definitions. For example, Ivanpah Spring could be either a tunnel or an adit, while Cane Spring could be either a bog or a pond.



Water Features in Mojave National Preserve
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
NATIONAL PARK SERVICE
Mojave National Preserve Boundary
Spring
Small Game Guzzler
Big Game Guzzler
Well
National Park Service Wilderness
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
CASTLE MOUNTAINS NATIONAL MONUMENT
Primm
Yates Well
IVANPAH LAKE (dry)
Nipton
Nipton Road
Searchlight
Cal Nev Ari
Palm Gardens
NEVADA
CALIFORNIA
Halloran Springs
Baker
Kelbaker Rd
Cima
CIMA ROAD
Morning Star Mine Road
Ivanpah Road
New York Mountains Road
Hart Mine Road
Cedar Canyon Road
MOJAVE ROAD
Zzyzx
Zzyzx Road
Rasor Road
SODA LAKE (dry)
SILVER LAKE (dry)
Salton Sea
Kingston Wash
Excelsior Mine Road
Aiken Mine Road
Kelso Cima Road
Kelbaker Road
Kelso Depot Information Center
Black Canyon Road
Essex Road
Lanfair Road
LANFAIR VALLEY
Goffs
Goffs Rd
Mountain Springs Rd
Fenner
Essex
National Trails Highway
Ludlow
Kelso Wash
Devils Playground Wash
Keystone Spring
Willow Spring
Kessler Spring
Deer Spring
Marl Spring
Rock Spring
Hackberry Spring
Vontrigger Spring
Piute Spring
Cornfield Spring
Budweiser Spring
Quail Spring
Zzyzx Spring
MIDDLE HILLS

Springs

The most numerous water features in the Preserve are springs and seeps. A *spring* has visible flow, while a *seep* occurs where the ground surface is occasionally wet and riparian vegetation is often present (NPS 1999). For the purposes of this plan, both types of water features are referred to as "springs." Springs in the Preserve can be broadly classified by their topographic location as either montane or valley basin springs (Dekker and Hughson 2014). There are 238 recorded locations of springs and seeps in the Preserve (see Table 12 and Figure 14) (NPS 2010b, 2013b). While some provide reliable surface water all the time, others are reduced to a small muddy patch or even disappear during dry years. The NPS does not have uniform monitoring of all criteria at all springs, particularly the presence of surface water, which is evaluated by citizen-scientist volunteers on a sporadic basis for some springs.

Table 12. Documented Springs in the Preserve

Spring Characteristics	Documented	% of Total	Notes
Total known springs	238	n/a	Current inventory; actual number is uncertain
Located in wilderness	182	76	N/A
Historic	85	36	Based on NPS field evaluation
Prehistoric	47	20	Based on NPS field evaluation
Less than 500 meters to road	120	50	Proximity of access for potential management
Water observed	218	92	Based on volunteer monitoring of water presence

Montane springs are most common and are typically found in canyons, ravines, arroyos, or other drainage features at the base of mountain ranges between 4,000 and 6,000 feet (1,219 and 1,829 meters) in elevation. Most of these springs are fed by a mountain watershed catchment area with the sediment and fractured bedrock capacity to store precipitation in a shallow aquifer (see Figure 13). Surface water expressions occur where shallow bedrock is exposed, subsurface drainage channels are constricted, or a geologic structure such as a fault, a dike; or contacts of different rock types intercepts subsurface flows (Dekker and Hughson 2014).

Springs that are caused exclusively by geological structures, such as those on Cima Dome or Mail Spring, are less common and may have a perennial water supply despite their small watershed. In many cases, multiple water expressions occur in proximity, resulting in a group or complex of associated springs (Dekker and Hughson 2014).

Valley basin springs occur at the low point of large alluvial basins that are fed by runoff from a large watershed area. The two springs in the Preserve fed by deep alluvial aquifers are Piute Spring, which is believed to be fed at least in part by the Lanfair Valley aquifer, and Soda Springs, which are believed to be fed by a

Natural Springs

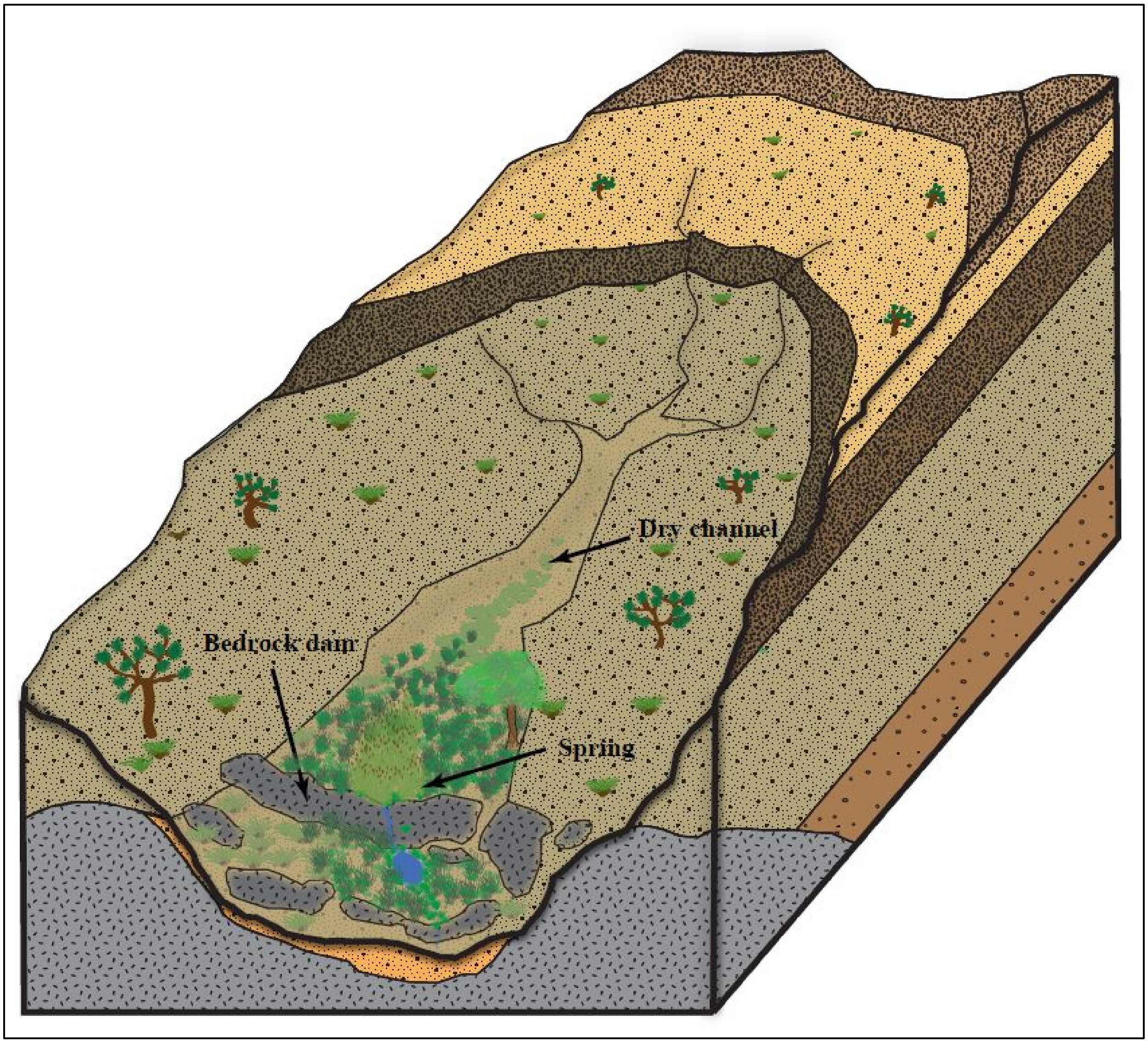
"Natural" springs are those that are physically unaltered and surface water expressions occur without human intervention or development. Natural springs are rare since most water sources have been manipulated by humans at some time. There are many examples of "natural-looking" or undisturbed seeps and springs in the Preserve. While some of the more remote examples may be truly untouched by human intervention, most of these were developed or manipulated at some time, and those interventions are no longer evident.

- Piute Spring and Soda Springs are the best examples of springs that are reliable in the absence of human intervention—both are valley basin springs fed in part by deep alluvial aquifers.
- Arrowweed and Kessler Springs are two examples of springs that were highly developed in the past and now have a natural appearance because the developed infrastructure has deteriorated or has been removed.

combination of mountain front and deep alluvial aquifers. Piute Spring is an important perennial water resource that provides openly flowing water and supports riparian vegetation for about one mile downstream from its source (Lilburn Corporation 1997), while Soda Springs include Lake Tuendae and MC Spring, which provides habitat for the endangered Mohave tui chub. As surface expressions of deep alluvial aquifers, Piute Springs and Soda Springs are vulnerable to excessive groundwater extraction.

While a few springs are known to occur as natural water expressions, about half of the springs have been modified, developed, or enhanced to facilitate human activity related to mining or ranching (see Figure 11). Typical water developments include excavations, tunnels, springboxes, adits, check dams, pipes, tanks, and troughs, which were intended to create or improve surface water expressions. In many cases, water discharge depends on developments (such as tunnels and pipes) (Dekker and Hughson 2014). When those developments are removed or are in disrepair, the discharge is diminished or ceases altogether.

Figure 13. Montane Spring Schematic

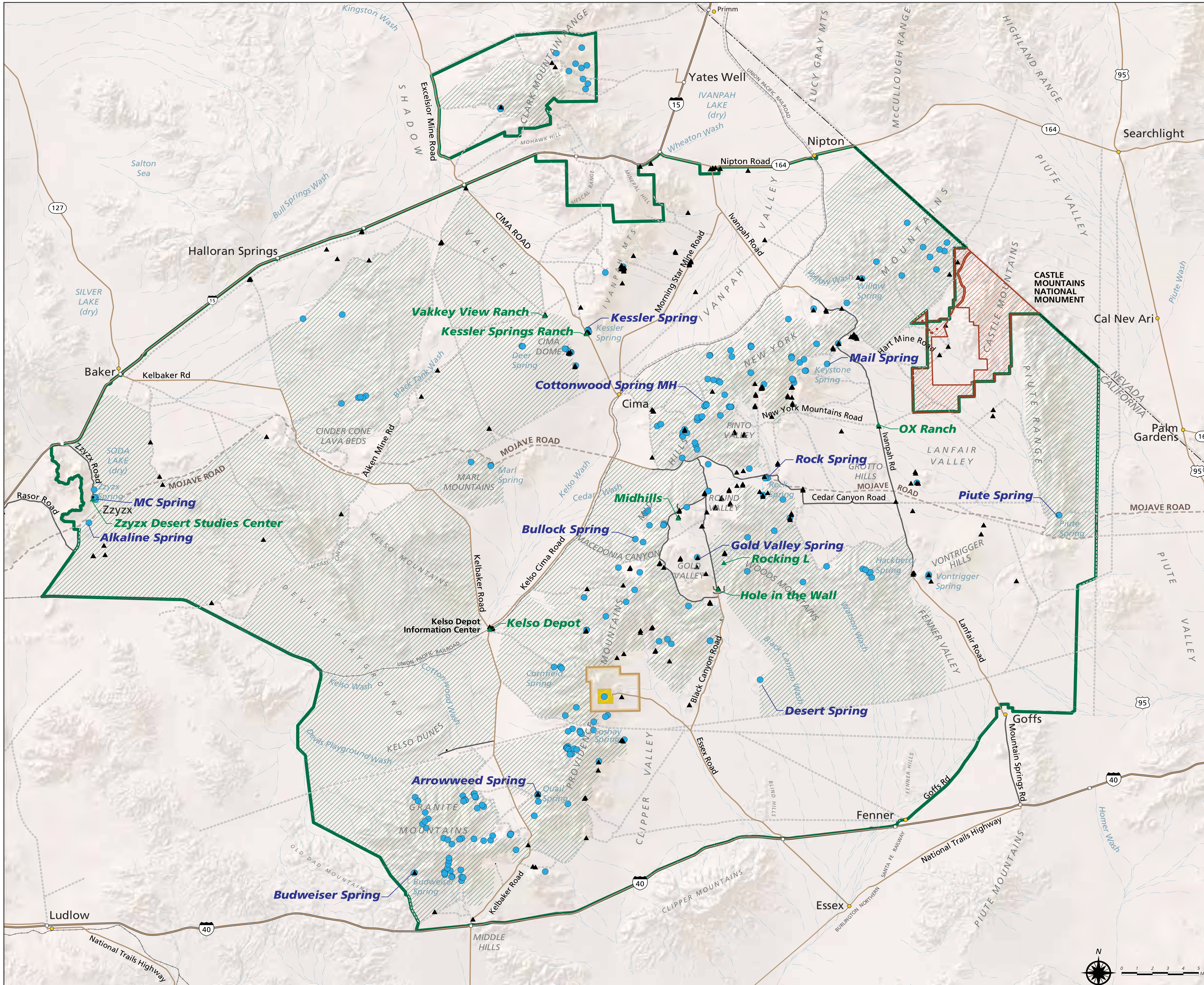


Source: Dekker and Hughson 2014.

Springs and Wells

Mojave National Preserve
Water Resources Management Plan and Environmental Assessment

- **Mojave National Preserve boundary**
- **Spring**
- **NPS water supply well**
- **Well**
- National Park Service wilderness
- Paved road
- Unpaved 2-wheel drive road
- Unpaved 4-wheel drive road
- Mojave Road 4-wheel drive road
- Desert wash



Wells

The installation of wells was an important component of the original ranching and railroad development in what is now the Preserve. There are 73 documented wells in the Preserve, of which 8 are used for NPS water supply and 15 are used to support grazing permits (Figure 14). Wells are vertical excavations to access water, which is mechanically lifted to the surface. While some shallow hand-dug wells exist in the Preserve, most are drilled wells that range in depth from several feet to about 1,400 feet (427 meters) below the surface (Table 13).

There is currently a plan to add a new water supply well in the Hole in the Wall area of the Preserve to support NPS operations. Other known wells in the Preserve are used for water quality monitoring, or are not in use (Table 13). Another 19 private wells are located on private land within inholdings or adjacent to the Preserve. About 49 additional wells in the Preserve have been destroyed in the past (NPS 2008, 2010b). The exact number and status of wells in the Preserve is not known. Historic hand-dug wells are listed and described separately under “Springs.”

Table 13. Water Supply Wells in the Preserve

Well	Characteristics	Notes
Kelso Depot	1,400′ depth	Drilled during renovation of depot
Kessler Springs Ranch	Unknown	Water supply for ranch house; good production
Mid Hills area	123′ depth	Supplies Mid Hills campground
OX Ranch	700–800′ depth (est.)	Well and windmill; supplies ranch headquarters; believed to have caved in
Rockin’ L	Unknown	Supplies campground and fire center
Hole in the Wall	Unknown	
Valley View Ranch	200′ depth (est.)	Supplies ranch house and corrals
Zzyzx Desert Studies Center (DSC)	50′ depth	Water supply for DSC and fire suppression

According to State of California regulations, a well is considered “abandoned” or permanently inactive if it has not been used for one year, unless the owner demonstrates the intention to use the well again (Water Well Standards, Section 115700 of the California Health and Safety Code). All abandoned wells should be destroyed (Section 22, General Requirements of the California Health and Safety Code).

Guzzlers

Throughout the southwestern United States, wildlife managers and conservation groups have constructed water development structures to enhance wildlife habitat by providing reliable water sources. These wildlife water developments are referred to as “guzzlers.” Most guzzlers in the Mojave Desert region have been constructed to promote populations of game birds (such as quail and chukar) and ungulates (such as desert bighorn sheep) (Rosenstock et al. 1999). The two main types of guzzlers in the Preserve are big game guzzlers and small game guzzlers, described as follows.

Big Game Guzzlers

In the Preserve, there are six big game guzzlers, which are all built and maintained to support desert bighorn sheep populations but may be used by other animals (Figure 15). Big game guzzlers in the Preserve typically consist of a water collection system with a check dam or impermeable apron in a natural drainage to collect surface water runoff, which is then piped to one or more large storage tanks. From the storage tanks, a pipe supplies water to a small drinker box for wildlife use. A float valve in the drinker box controls the water flow. The six big game guzzlers are:

- ***Kerr*** – Old Dad Mountains, south of Jackass Canyon
- ***Kelso*** – Kelso Mountains near Kelso Peak (a.k.a. John Doll)
- ***Vermin*** – Old Dad Mountains
- ***Old Dad*** – Old Dad Mountains
- ***Piute*** – Piute Range, north of Piute Spring
- ***Clark*** – Clark Mountains (a.k.a. Bickett-Landell).

Kerr guzzler, Mojave National Preserve (NPS photo)

All of the big game guzzlers are in wilderness designated by the 1994 CDPA. This has proven to be a challenge for the maintenance, monitoring, and water replenishment necessary for the guzzlers to function. Many of these activities require motorized vehicle access to bring in materials, tools, and equipment. In cases where replenishment is needed, proximate access by large (300- to 500-gallon) water tank trucks with motorized pumps and hoses is needed to refill depleted storage tanks. The NPS has allowed these activities under special use (NPS 2008). Most of the maintenance and replenishment activities are conducted by volunteers.

Small Game Guzzlers

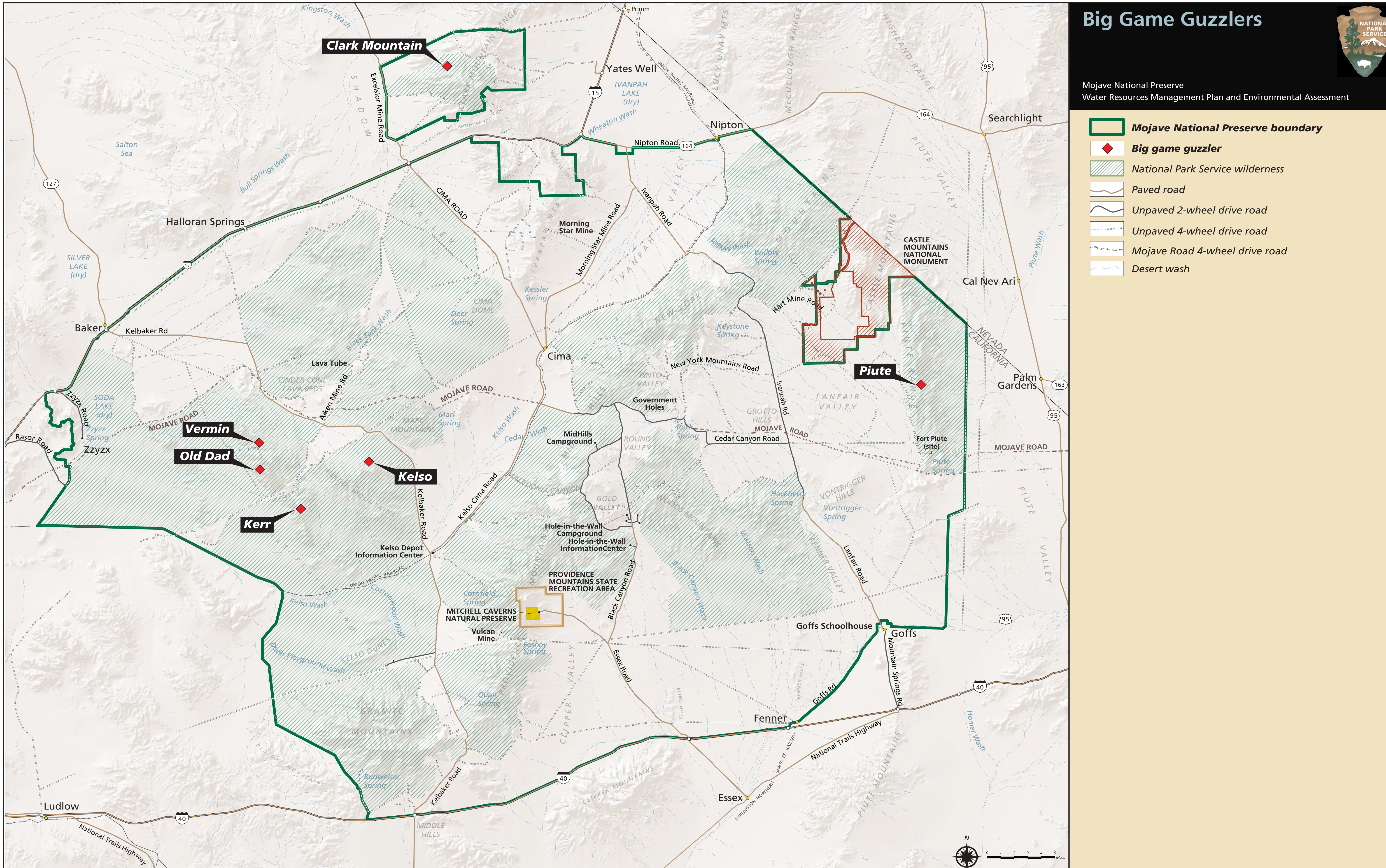
In the Preserve, numerous small game guzzlers are located in diverse types of habitat and in various stages of function. A total of 131 small game guzzlers are documented to exist in the Preserve, of which 71 are located outside of wilderness and 26 are in desert tortoise critical habitat (see Table 14 and Figure 17). Small game guzzlers are also known as game bird guzzlers and gallinaceous guzzlers, as they are intended for gallinaceous bird species.

Small game guzzlers typically consist of a concrete apron leading to a subsurface concrete or fiberglass storage tank. Birds and small animals enter the storage tank through a small opening. Most guzzlers are close to roads or broad washes (Whitaker et al. 2004).

Table 14. Small Game Guzzler Status

Status	Documented Number (% of Total)
Total small game guzzlers	131
Located in wilderness	60 (42)
Located outside of wilderness	71 (54)
Repaired 2006–2013	64 (49)
In desert tortoise critical habitat	26 (20)

Source: NPS 2013a.


Big Game Guzzlers
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
NATIONAL PARK SERVICE
Mojave National Preserve boundary
Big game guzzler
National Park Service wilderness
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
Clark Mountain
Piute
Vermin
Old Dad
Kelso
Kerr
Primm
Yates Well
Nipton
Searchlight
Cal Nev Ari
Palm Gardens
Halloran Springs
Baker
Zzyzx
Cima
Goffs
Goffs Schoolhouse
Fenner
Essex
Ludlow
CASTLE MOUNTAINS NATIONAL MONUMENT
PROVIDENCE MOUNTAINS STATE RECREATION AREA
MITCHELL CAVERNS NATURAL PRESERVE
Kelso Depot Information Center
Hole-in-the-Wall Campground
Hole-in-the-Wall Information Center
MidHills Campground
Government Holes
Morning Star Mine
Lava Tube
Vulcan Mine
Fort Piute (site)
MOJAVE ROAD
Kelbaker Rd
Kelbaker Road
Nipton Road
Ivanpah Road
Ivanpah Rd
Cima Road
Kelso Cima Road
Black Canyon Road
Essex Road
Lanfair Road
Cedar Canyon Road
New York Mountains Road
Hart Mine Road
Morning Star Mine Road
Aiken Mine Road
Excelsior Mine Road
Zzyzx Road
Rasor Road
Goffs Rd
Mountain Springs Rd
National Trails Highway
NEVADA
CALIFORNIA
N
Miles

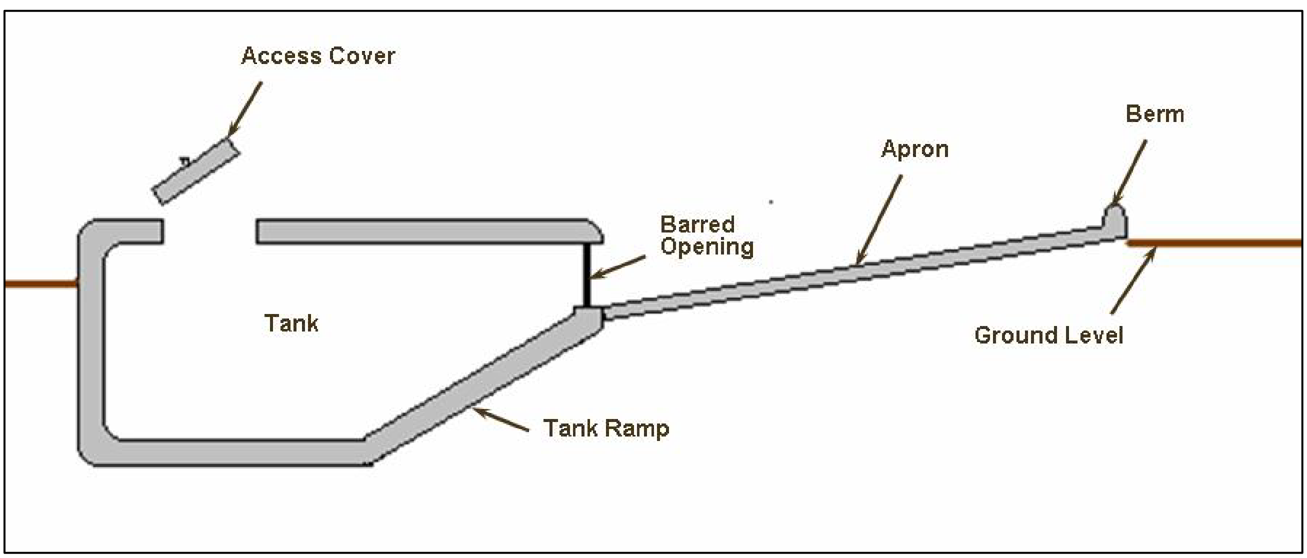
Small game guzzler, Mojave National Preserve (NPS photo)

Most small game guzzlers have ramps installed made from wire mesh or other coarse material that allows wildlife that enter the water to escape. These were installed because of concerns about mortality of desert tortoise drowning in guzzlers (Hoover 1995; Bleich et al. 2005). A schematic of a typical small game guzzler is shown in Figure 16.

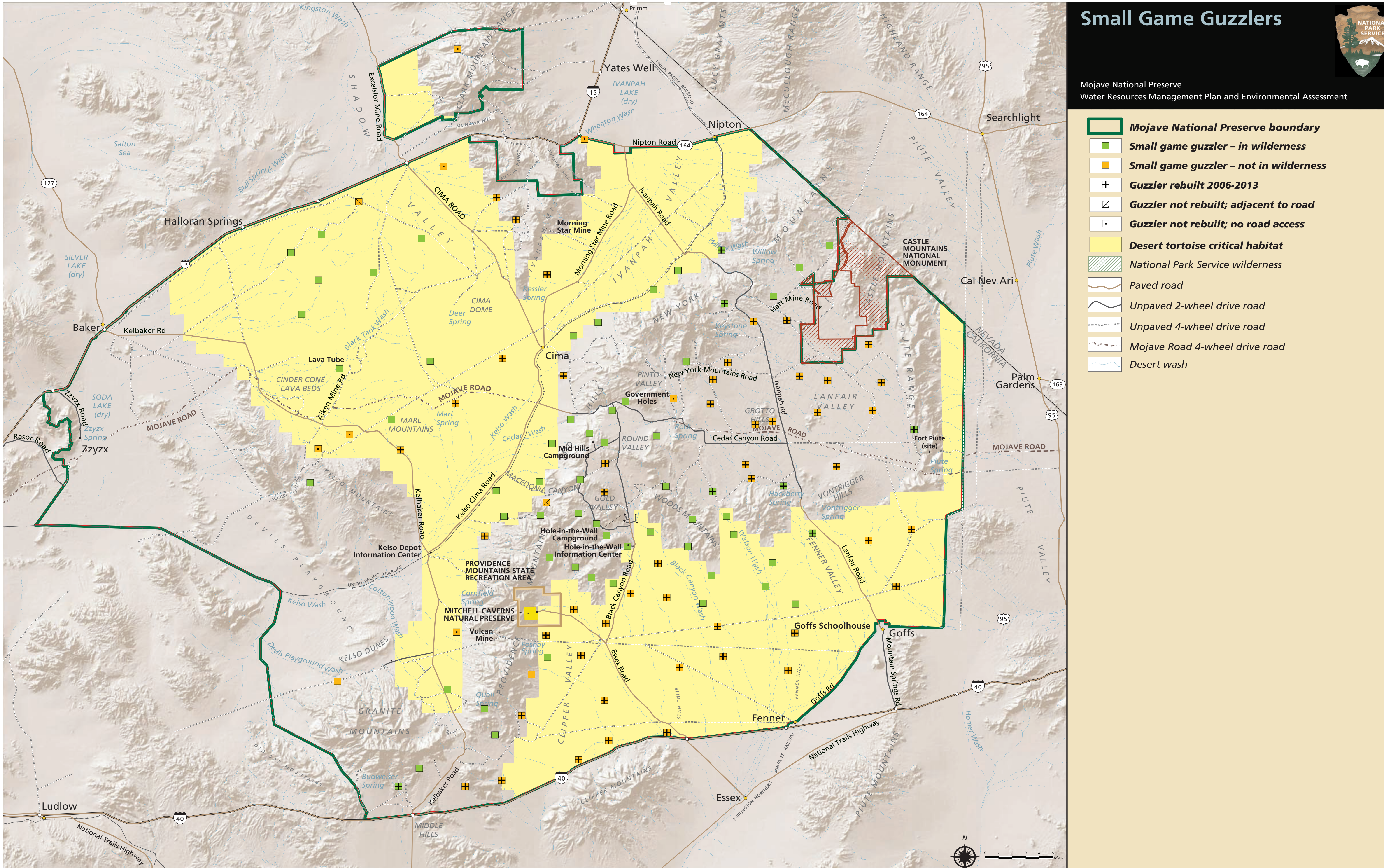
Between 2006 and 2013, volunteers repaired or rebuilt 60 guzzlers in non-wilderness locations. While about four wilderness guzzlers were repaired at some point, none of the wilderness guzzlers have been repaired in at least the past decade. Small game guzzlers that were repaired or rebuilt between 2006 and 2013 are not expected to require additional major repairs within the 20-year life of this plan.

Eight non-wilderness guzzlers have not been recently rebuilt and could be subject to major repairs or rebuilds during the life of this plan. However, only two of these are adjacent to existing roads. The remaining six would require non-motorized access for equipment, materials, and personnel.

Figure 16. Typical Small Game Guzzler Cross-Section



Source: Whittaker et al. 2004.


Small Game Guzzlers
NATIONAL PARK SERVICE
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
Mojave National Preserve boundary
Small game guzzler – in wilderness
Small game guzzler – not in wilderness
Guzzler rebuilt 2006-2013
Guzzler not rebuilt; adjacent to road
Guzzler not rebuilt; no road access
Desert tortoise critical habitat
National Park Service wilderness
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
Primm
Yates Well
Nipton
Searchlight
Halloran Springs
Baker
Zzyzx
Cima
Cal Nev Ari
Palm Gardens
Goffs
Fenner
Essex
Ludlow
CASTLE MOUNTAINS NATIONAL MONUMENT
Kelso Depot Information Center
PROVIDENCE MOUNTAINS STATE RECREATION AREA
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Hole-in-the-Wall Campground
Hole-in-the-Wall Information Center
Mid Hills Campground
Goffs Schoolhouse
Lava Tube
Morning Star Mine
Government Holes
Vulcan Mine
Fort Piute (site)
CIMA DOME
CINDER CONE LAVA BEDS
MARL MOUNTAINS
IVANPAH VALLEY
LANFAIR VALLEY
KELSO DUNES
GRANITE MOUNTAINS
CLIPPER VALLEY
PROVIDENCE MOUNTAINS
NEW YORK MOUNTAINS
PIUTE RANGE
CASTLE MOUNTAINS
MOJAVE ROAD
Kelbaker Road
Kelso Cima Road
Cima Road
Ivanpah Road
Nipton Road
Morning Star Mine Road
New York Mountains Road
Cedar Canyon Road
Black Canyon Road
Essex Road
Lanfair Road
Goffs Rd
Mountain Springs Rd
Hart Mine Road
Aiken Mine Rd
Zzyzx Road
Rasor Road
Excelsior Mine Road
National Trails Highway
NEVADA
CALIFORNIA

Wildlife

Desert Bighorn Sheep

Desert bighorn sheep (*Ovis canadensis nelsoni*) inhabit desert mountain ranges throughout the Sonoran, Mojave, and Great Basin Deserts. Their habitat is typically rough, rocky, and broken by canyons and washes (Hansen 1982), with vegetative communities ranging from upland pinyon-juniper to desert scrub (Browning and Monson 1980). Forage, water, and escape terrain are considered crucial components of desert bighorn habitat (Risenhoover and Bailey 1985; Turner 1973; Krausman et al. 1989). Bighorn sheep favor open terrain and generally avoid dense vegetation that blocks their visibility of predators. Their diet includes cacti, grasses, herbaceous plants, shrubs, and trees. Bighorn sheep diet varies by season because new plant growth is most nutritious. Compared with populations in higher mountain ranges, lower-elevation bighorn populations typically have poorer forage quality and are subject to higher temperatures and less precipitation (Epps et al. 2004). The availability of forage close to water is an important component of bighorn sheep habitat (Leslie and Douglas 1979).

Population Status

Desert bighorn sheep are found in most of the Preserve's mountainous terrain, with the largest populations occurring in the Old Dad Mountain, Kelso Peak, and Clark Mountain areas. Currently, six desert bighorn sheep populations occur in the Preserve. These populations are generally considered to occur in the Old Dad/Kelso/Indian, Clark, Granite, Providence, Woods/Hackberry, and Piute/Castle habitat patches. Potential habitat also occurs in the Mescal/Ivanpah Range, which is currently unoccupied by bighorn sheep.

The current population of desert bighorn sheep in the Preserve is estimated to be between 680 and 1,075 individuals. Throughout the region, bighorn populations have become increasingly isolated and vulnerable to loss of habitat and genetic diversity, due primarily to a combination of habitat fragmentation and climate change (Epps et al. 2005; Longshore et al. 2009; Creech et al. 2014).

Desert bighorn sheep are classified by the State of California as a *Fully Protected* species (California Fish and Game Code 4902; see http://www.dfg.ca.gov/wildlife/nongame/t_e_spp/fully_pro.html).

Movement and Persistence of Populations

Desert bighorn sheep are most active during daylight and move to steeper terrain at night. During summer, bighorn typically rest in the shade during the hottest part of the day. Desert bighorn habitat areas are often small and isolated. Flat sparsely vegetated desert valleys between rugged mountain ranges results in a naturally fragmented distribution (Bleich et al. 1990) and typically populations number fewer than 100 individuals (Torres et al. 1994). These conditions leave desert bighorn populations vulnerable to detrimental changes in habitat availability because of low female dispersal rates and the long distances between populations (Epps et al. 2004; Epps et al. 2007). Epps et al. (2004) found that elevation, precipitation, presence of reliable natural springs, and absence of domestic sheep allotments positively correlated with persistence of desert bighorn sheep populations. In addition, genetic and demographic connectivity are important for bighorn sheep metapopulation dynamics and the recolonization of habitat patches that have become extirpated, and maintaining intact habitat patches and corridors between patches is vital to metapopulation viability (Creech et al. 2014).

Regarding connectivity and fragmentation between bighorn populations, Creech et al. (2014) described the importance of demographic and genetic connectivity of bighorn metapopulations, and Bleich et al. (1996) suggested that populations less than 15 kilometers (9.3 miles) apart were likely to be connected by dispersal, unless they were fragmented by anthropogenic barriers. These dispersal distances may be greater when favorable escape terrain is available (Epps et al. 2007). In the Mojave Desert, barriers to bighorn dispersal primarily consist of highways (including I-40 and I-15), but also include aqueducts, mining operations, and urban development (Epps et al. 2005) (see Figure 9). Desert bighorn sheep rarely cross these continuously fenced barriers, which likely has reduced connectivity among bighorn populations as well as those of other species (Epps et al. 2005). In their study of genetic diversity of bighorn populations relative to human-made barriers, Epps et al. (2005) found that the genetic diversity in populations that were completely isolated by barriers had declined as much as 15 percent over a period of 40 years. However, population translocations may be effective in restoring populations. Other opportunities to mitigate the effects of barriers include the use of bridges over major roads for bighorn to cross, as on I-95 in Arizona (Epps et al. 2007).

Remote camera image of bighorn drinking from a guzzler (NPS photo)

Wildlife species such as desert bighorn sheep that persist in small, isolated populations are vulnerable to loss of habitat and genetic diversity (Epps et al. 2006). Isolated populations may serve as indicators for the effects of climate change since the effects may be more quickly detectable. A review of the status of bighorn sheep indicated that this is already occurring: the range of bighorn sheep in California has contracted, and at least 26 populations have become extinct (Epps et al. 2003). Over the past century, this has been concurrent with a 20 percent decrease in precipitation and an increase in temperatures in the region (Epps et al. 2004). After investigating the correlation between habitat elevation and genetic diversity, Epps et al. (2006) concluded that both genetic diversity and population extirpation rates were consistent with increasing temperature and aridity, and that further temperature increases and reductions in precipitation will result in even more loss of genetic diversity and the eventual extirpation of more populations in low-elevation habitat. Epps et al. (2006) also observed that populations had the greatest genetic diversity when suitable habitat persisted and connectivity with other populations was in place, which underscores the importance of maintaining connectivity between populations with more favorable habitats. These higher-quality habitat areas (which are less vulnerable to the effects of climate change) could serve as refugia for genetic diversity during drought and source populations for recolonization in periods of more favorable climate. Conversely, isolated bighorn populations in the Mojave Desert typically support too few sheep to persist for more than a few decades, as genetic drift and inbreeding eventually result in extinction (Schwartz et al. 1986).

In recent years, more arid climatic conditions have been documented in the southwestern United States, including less precipitation (Seager et al. 2007) and shifts in timing of precipitation (Weltzin et al. 2003) (see the climate discussion in the “Environmental Setting” section of this chapter). These changes may lower the reproductive success of bighorn sheep (Douglas and Leslie 1986; Wehausen et al. 1987) and may increase the probability of population extirpation (Epps et al. 2004). The predicted transition to a more arid climate and resultant impacts on desert bighorn sheep populations indicate that the use of water developments may be an important conservation tool to maintain available habitat, particularly in instances where loss of available water has been exacerbated by anthropogenic activities (Longshore et al. 2009).

Disease

Disease has also been a major limiting factor for bighorn populations, especially those in the Mojave Desert. Gross et al. (2000) found that disease, even of mild severity, has a profound influence on bighorn sheep population dynamics. Disease, more than habitat loss and fragmentation, may be the factor that ultimately results in extirpation of a population (Gross et al. 2000).

In recent years, pneumonia epidemics have spread through bighorn populations in many western states. The disease typically enters a population that has no resistance, and, as a result, animals can become infected and die at a high rate. The few animals that survive become carriers, infecting newborn lambs that often die within a few months of birth. This typically causes a long-term decline in a population that can last for more than a decade. Gross et al. (2000) found that even a single disease event depressed population growth for periods that exceeded two decades.

In 2013, *Mycoplasma ovipneumoniae* (pneumonia) caused a bighorn die-off in the Preserve and surrounding region. The outbreak was first detected in the Old Dad/Kelso area of the Preserve and was first reported in mid-May. By the end of 2013, impacted herds included all mountain ranges in the Preserve, South Bristol, Marble, and Clipper Mountains south of I-40, and the Spring Mountains in Nevada.

In 1995, a considerable number (at least 45) of bighorn sheep died as a result of toxic contamination from *Clostridium botulinum* (botulism) in water tanks at the Old Dad Peak guzzler in Mojave National Preserve (Swift et al. 2000). It is speculated that, due to a malfunction, the drinker basin had gone dry while there was still water in the tank. Seeking water from the tank, it is believed, several bighorn sheep dislodged the hatch to access water. As the water level receded, several lambs fell into the tank and drowned. The decaying lamb carcasses provided a substrate for the growth of botulism. The adult sheep were subsequently exposed to the toxin as they attempted to drink from the contaminated tank. Swift et al. (2000) note that this event demonstrates the importance of guzzler placement and maintenance to prevent bighorns from accessing or breaking through the top of the tank.

Hunting

The Preserve includes two bighorn sheep hunt zones established by CDFW:

- Zone 2, which includes the Kelso Peak/Old Dad Mountains area
- Zone 3, which includes the Clark Mountains and a large area north of I-15

A very limited number of bighorn sheep licenses are issued throughout the state through a lottery and auction system. The CDFW determines the number of tags to be issued based on population estimates. The season extends from early December to February 1. The numbers of tags issued in recent years are as follows (CDFW 2013-17):

- 2013 – Three in Zone 2; two in Zone 3
- 2014 – Zero in Zone 2; one in Zone 3

- 2015 – Zero in Zone 2; one in Zone 3
- 2016 – One in Zone 2; two in Zone 3
- 2017 – Zero in Zone 2; two in Zone 3

Use of Water Sources

The importance of perennial water as a limiting factor for desert bighorn sheep populations is an area of ongoing research. Some authors have found that populations exist year-round in mountain ranges without perennial water (Krausman et al. 1985), and some historical observations pointed out that desert bighorn sheep did not use artificial water when naturally occurring water was available, and that plant succulence played an important role as a water source (Wilson 1971). Many desert ecologists consider the availability of perennial water to be one of the primary factors influencing the distribution of bighorn sheep (Monson and Sumner 1980; Gunn 2000; Turner et al. 2003; Cain 2006; Bleich et al. 2009). During summer months, water sources are considered an essential component of suitable habitat for nearly all desert bighorn sheep populations (Bleich et al. 1997; Andrew et al. 1999; Turner et al. 2004; Oehler et al. 2005; Sappington et al. 2007). Turner (1973) found that bighorn sheep must have access to sources of free-standing water to maintain water balance, and Mahon (1971) noted that water availability may be a limiting factor in the reproduction of desert bighorns since ewes require sufficient water to lactate properly. While Krausman et al. (1985) observed two adult female bighorn sheep that did not drink during a 10-day summer study, Welles and Welles (1961) noted that bighorn sheep visited water every 3 to 5 days, on average, during the summer.

The availability of water influences the distribution of bighorn sheep (Jaeger 1994; Bleich et al. 2009) and plays an important role in population persistence (Epps et al. 2004; Bleich et al. 2009). Bleich et al. (2009) found that the availability of high-quality habitat for bighorn sheep increased with the availability of water sources, while Epps et al. (2004) found that populations at lower elevations (below about 1,500 meters/4,900 feet) and in areas with the lowest annual precipitation (less than 8 inches/200 millimeters) were much more likely to become extinct and, therefore, are much more vulnerable to the decreased precipitation anticipated to occur with climate change (Epps et al. 2004).

Dry Season Habitat

"Dry season habitat" is defined as suitable habitat close to reliable water sources that is used by desert bighorn sheep during the hot summer months (July through September).

Dry season habitat is the quantitative basis for comparing changes between the plan alternatives (see *Chapter 4: Environmental Consequences*).

Artificial water sources, such as guzzlers, have been used for decades to enhance and restore habitat for desert bighorn sheep (Halloran and Deming 1958; Weaver et al. 1958; Werner 1984). Most researchers agree that artificial water sources support or increase some, but not all, desert bighorn populations (Rosenstock et al. 1999). In some mountain ranges, bighorn sheep have been shown to be restricted to areas with available water sources during the hot season (Blong and Pollard 1968; Leslie and Douglas 1979; Cunningham and Ohmart 1986). Jaeger (1994) found that female bighorn sheep moved to areas with more water sources, both natural and artificial, at the start of the dry season and dispersed from these areas at the end of the hot season. Studies in Joshua Tree National Park predicted that without artificial water development, up to 47 percent of summer habitat for bighorn sheep in the park would be lost (Longshore et al. 2009). Gunn (2000) observed that it often takes three to seven years for bighorn sheep to habituate to the use of newly established water sources.

Research in Cabeza Prieta National Wildlife Refuge in the Sonoran Desert (southern Arizona) found that during years with above-normal precipitation, perennial sources of free-standing water did not result in significant changes in diet, foraging area characteristics, movement rates, home range size, productivity, or juvenile recruitment for desert bighorn sheep (Cain 2006). However, during periods of drought, forage quality and quantity was a more important limiting factor than water availability, since the presence of artificial water sources was not sufficient to prevent drought-related mortalities of bighorn sheep (Cain 2006). In another study, Cain et al. (2007) reported that higher mortality rates were observed during drought conditions in habitats that had water compared with those where water was removed, suggesting it was unlikely that the presence of water structures was adequate to prevent mortality during droughts and that forage plays a dominant role in determining home range sizes, areas used, and movement rates.

Bighorn Habitat in the Preserve

Desert bighorn sheep show preference for rugged topography with sparse vegetation and seasonal access to water. Key factors in determining favorable habitat include proximity to a perennial water source, rugged topography with steep slopes (more than 25 percent and sometimes greater than 60 percent), and accessible escape terrain (with slopes greater than 80 percent) (Darby 2015; Bristow et al. 1996; Turner et al. 2004). Areas with dense or tall shrub and forest vegetation communities (such as pinyon juniper, Joshua tree, chaparral, and creosote) are less preferred by bighorn. The importance of water is seasonal, as it is most important during the months of June, July, and August (dry season) or during droughts (Darby 2015).

To support this planning process, NPS staff developed an index to quantitatively compare the dry season habitat value across the Preserve. Using environmental variables and data collected from GPS-collared bighorn ewes in the Old Dad/Kelso area, a linear model was developed relating habitat variables (e.g. elevation, distance to water) to bighorn utilization (Hughson 2018—Appendix B). The Old Dad, Kerr, and Vermin guzzlers are located in the Old Dad/Kelso area. Ninety-three percent of the collared ewes remained within 2.5 kilometers of these guzzlers during dry season; therefore, a radius of 2.5 kilometers (1.55 miles) around water sources was the dry season habitat area that was analyzed. Figure 18 shows the distribution of collared ewes in the Old Dad/Kelso Peak area (Hughson 2018).

From the model, it can be inferred that ewes using the Old Dad/Kelso area during the dry season prefer to be near water and at relatively high elevations. Distance to water and elevation showed the strongest correlation with habitat utilization by bighorn ewes; slope and terrain ruggedness showed weaker correlations. Although alluvial soils and creosote-Mojave yucca communities appeared to correlate with utilization, they could not be used in prediction given the restricted area of the data used for model training.

A dry season habitat value index was developed based on the model results. The contribution of each existing big game guzzler to dry season habitat is expressed as a percentage of the Preserve's overall dry season habitat quality (Figure 19). A more detailed summary of the index and habitat model is in Appendix B (Hughson 2018).

Relationship of Desert Bighorn Sheep Populations to Water Sources

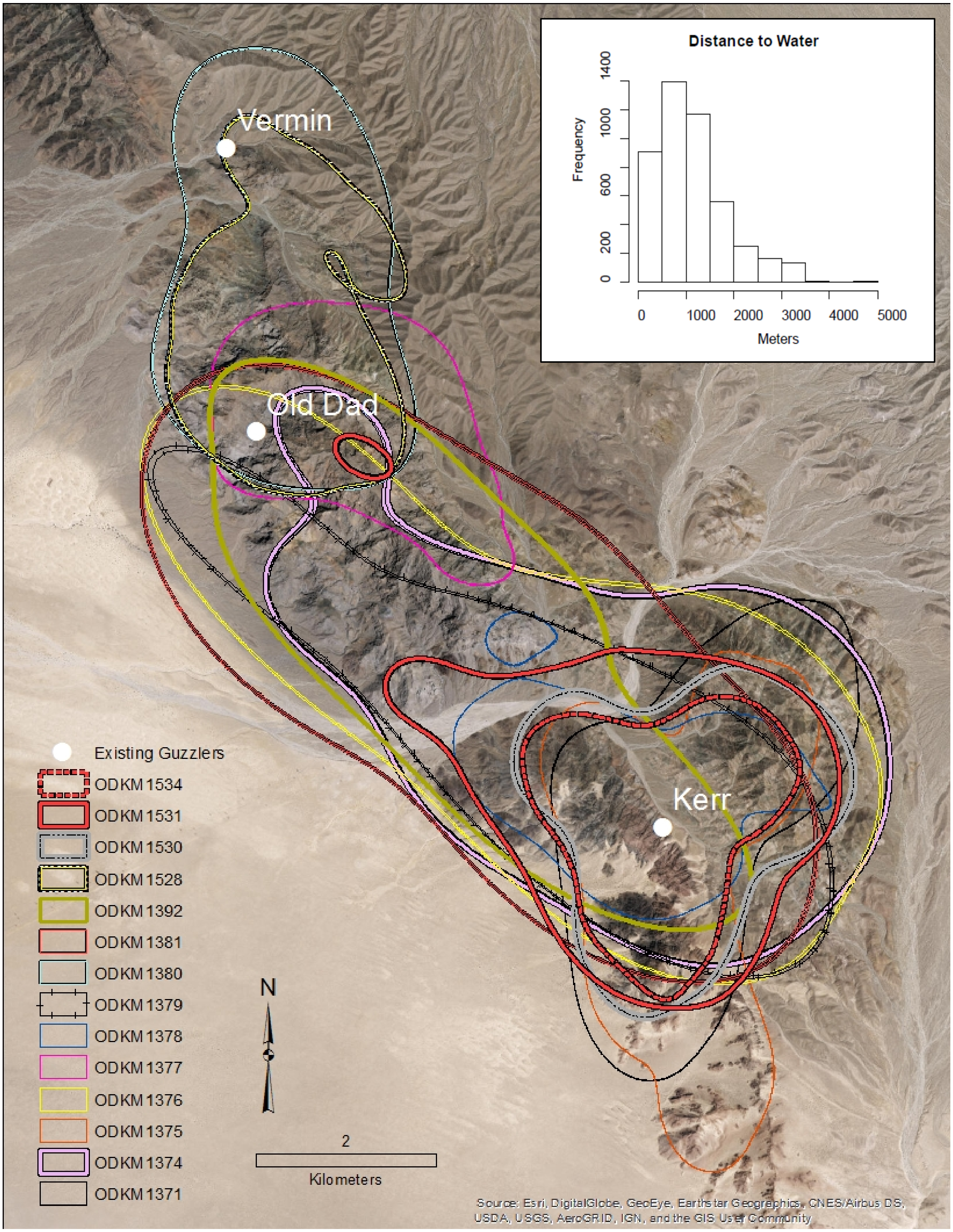
As discussed above, access to a reliable water source during the dry season is an important component of bighorn habitat and survival. This need for surface water to support lamb and ewe survival and bighorn populations in general is the intended purpose of most big game guzzlers that have been constructed in the Preserve. However, many natural or developed springs are also known to be used by bighorn and are considered part of the habitat context. The known water sources for bighorn—including guzzlers and springs—are listed in Table 15, by habitat patch.

For inventory and analysis purposes, it is understood that desert bighorn sheep will congregate in habitat areas that are close to reliable water sources during the dry season. Based on the GPS collar data from the Old Dad/Kelso area, a radius of 2.5 kilometers around waters sources is considered to be the range of suitable dry season habitat (Figure 18).

Table 15. Desert Bighorn Sheep Habitat Patches and Population Estimates

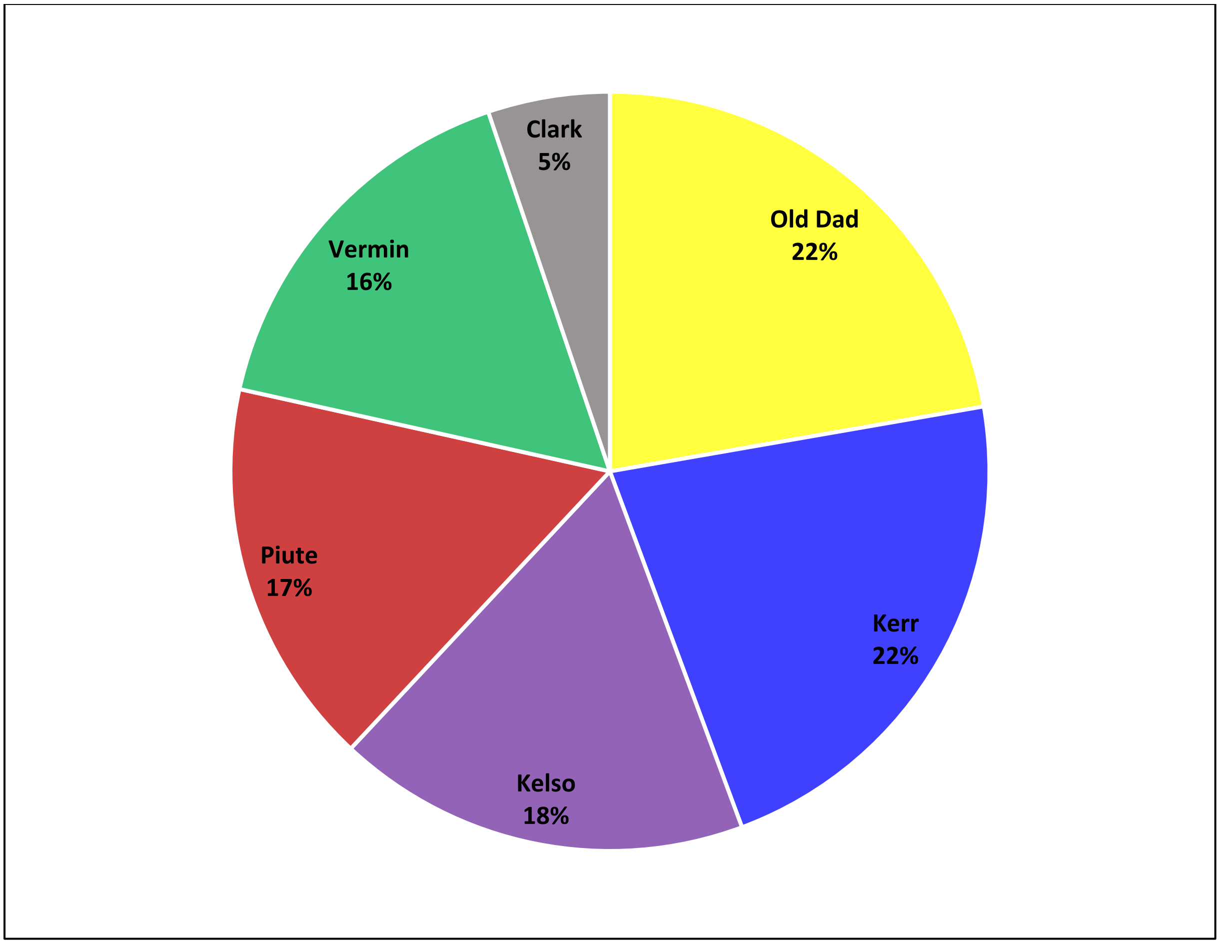
Habitat Patch	Total Habitat (acres)	Estimated Bighorn Population	Water Sources
Clark Mountains	74,134	100–150	Clark guzzler (not used) Black Bird Mine Spring; Pachalka Springs; Colosseum Mine Pit Lake
Old Dad/Kelso	106,987	200–300	Vermin, Old Dad, Kerr, and Kelso guzzlers; Cane, Marl, and Sheep Springs
Granite Mountains	42,262	<25	Budweiser Spring; Bull Canyon Creek; Barnes Spring
Providence Mountains	45,975	25–50	Cornfield, Foshay, and Warm Springs; Vulcan Mine Pit Lake
Mescal/Ivanpah Range	32,357	None	Few known sources, including Morningstar Mine Lake, Ginn Mine, and Mineral Spring on BLM land
Woods/Hackberry Mountains	27,490	50–100	Woods Mountain, Hackberry, Hackberry-South, Lance, and Twin Buttes Springs
Piute/Castle Mountains	75,631	25–50	Piute guzzler; Piute Spring; one additional guzzler and other sources on BLM land

Figure 18. Dispersal of Collared Bighorn Ewe Occurrences in the Old Dad/Kelso Mountain Area (ODKM)



Source: Hughson 2018 (see Appendix B)

Figure 19. Dry Season Habitat Value of Existing Guzzlers



Note: Total habitat value for all guzzlers combined is equal to 100%

The availability and types of water sources vary among the desert bighorn sheep populations and habitat patches in the Preserve. Four guzzlers support the Old Dad/Kelso population, while Cane, Marl, and Sheep Springs also provide limited water sources. One guzzler is present in the Clark Mountain area but is not known to be used by desert bighorn sheep and therefore is not considered to provide dry season habitat for bighorn. Woods Mountain Spring and Hackberry-South Spring are used by bighorn sheep and are within the range of the Woods/Hackberry population. The Piute Guzzler and Piute spring and creek in the Piute/Castle Mountain Range are used by bighorn sheep. In the Mescal/Ivanpah Range, no bighorn sheep have recently been documented despite at least three water sources - Ginn Mine, Morningstar Mine pit lake, and Mineral Spring on adjacent BLM land.

Other Wildlife Species

At least 300 bird species have been confirmed to occur in the Preserve, including 64 species that use the Preserve for breeding, 42 species identified as residents, and 108 species identified as migrants (Johnson and Stuart 2005). Common bird species in desert habitats in the Preserve include raven (*Corvus corax*), cactus wren (*Campylorhynchus brunneicapillus*), and roadrunner (*Geococcyx californianus*). Other notable bird species include prairie falcon (*Falco mexicanus*), Bendire's thrasher (*Toxostoma bendirei*), California thrasher (*Toxostoma redivivum*), gray vireo (*Vireo vicinior*), golden eagle (*Aquila chrysaetos*), Lucy's warbler (*Oreothlypis luciae*), mourning dove, and Gambel's quail. Riparian areas in the Preserve are especially important bird habitat.

In a bird survey focused on Piute Spring, biologists detected 60 total species (PRBO Conservation Science [PRBO] 2005).

Up to 49 mammal species have been documented in the Preserve including desert bighorn sheep (as described above). Other mammal species in the Preserve include coyote, mountain lion (*Puma concolor*), mule deer, and black-tailed jackrabbit. Common small mammals in the Preserve include desert woodrat (*Neotoma lepida*), cactus mouse (*Peromyscus eremicus*), brush mouse (*Peromyscus boylii*), canyon mouse (*Peromyscus crinitus*), and Merriam’s kangaroo rat (*Dipodomys merriami*) (Drost and Hart 2008). Seven bat species have been documented in the Preserve including western pipistrelle (*Pipistrellus hesperus*) and California myotis (*Myotis californicus*).

The Preserve is home to at least 38 species of reptiles and amphibians, including 19 species of snakes, 16 species of lizards, 1 species of tortoise, and 2 species of frogs and toads (Persons and Nowak 2007). The sidewinder (Crotalus cerastes) is the most abundant snake in the Preserve, and many other species are common including gopher snake (*Pituophis catenifer*), speckled rattlesnake (*Crotalus mitchellii*), and Mojave rattlesnake (*Crotalus scutulatus*). The most abundant lizards in the Preserve include zebra-tailed lizard (*Callisaurus draconoides*), desert spiny lizard (*Sceloporus magiste*r), side-blotched lizard (*Uta stansburiana*), desert night lizard (*Phrynosoma platyrhinos*), and western whiptail (*Cnemidophorus tigris*). The desert tortoise (*Gopherus agassizii*) is common in the Preserve and is described in greater detail under “Special Status Species” below. The only naturally occurring amphibians in the Preserve are the red-spotted toad (*Bufo punctatu*s), which is found throughout the Preserve, and the Pacific tree frog (*Pseudacris regilla*), which is restricted to Soda Springs in the Preserve.

Water features are known to support nonnative invasive wildlife species that have detrimental impacts on invasive species—most notably the nonnative burro and native raven. Feral burros are a persistent nuisance species that damage native habitat and compete with desert bighorn, desert tortoise, and other native species for limited forage (NPS 2002). Common ravens have expanded along with human developments in the desert and can pose a threat to juvenile desert tortoise populations due to predation (McIntyre 2004).

The Mohave[1] tui chub (*Siphateles bicolor mohavensis*) is the only fish native to the Mojave River basin and the Preserve. The Mohave tui chub is described in detail below under “Special Status Species.”

Common Wildlife Use of Water Sources, by Species Group

Photo monitoring of wildlife in the Preserve has documented 65 different species using water features (big game guzzlers, small game guzzlers, and springs). Wildlife observed include bats, insects, many different bird species, reptiles, rodents, carnivores, and ungulates. These observations include both native and nonnative wildlife species (NPS 2016). The following discussion summarizes the use of surface water sources, and potential impacts resulting from the loss of or changes to those water sources, by species group.

Herpetofauna, Small Mammals, and Carnivores

Most literature shows that native desert-adapted terrestrial wildlife species do not rely on artificial water sources. While some individuals and groups may use water sources on an opportunistic basis, sites with developed water sources have not been found to have increased

[1] There are two spellings. Mojave is the Spanish form, but Mohave is the American form used when referring to the Mohave tui chub.

species richness or contribute to population viability (Cutler and Morrison 1998; Burkett and Thompson 1994). In general, the benefits of desert water sources (artificial or natural) are likely to be associated with increased vegetation and cover that is supported by the water or is provided by the water collection and distribution infrastructure itself (Rosenstock et al. 1999).

Herpetofauna are not believed to require free-standing water, though some reptiles have been observed drinking (Mayhew 1968; Rosenstock et al. 1999). They may benefit more from development-related materials and structures (such as tanks) (Burkett and Thompson 1994). Only two amphibians are known in the Preserve, and they have not been observed in guzzlers or developed springs (e.g., troughs and tanks), only at naturally occurring springs and seeps.

It is largely believed that small mammals do not depend on water sources (Mares 1983; Rosenstock et al. 1999). As with herpetofauna, development-related materials and structures may play a more important role in increased abundance around water developments (Burkett and Thompson 1994).

Carnivores are not considered to require free-standing water, though many have been observed drinking from water developments. It is believed carnivores can obtain the water they need through their prey. Thermoregulation balance may be a carnivore’s most pressing need for free-standing water (Schmidt-Nielsen 1964 as cited in Rosenstock et al. 1999). It is possible carnivores are attracted to water developments primarily because of use by prey species (Rosenstock et al. 1999).

Bats

Bats are strongly attracted to water developments with open water, using them for both drinking and foraging (Rosenstock et al. 1999). As a result, bat distribution has likely expanded with water developments. Guzzlers have limited benefits to bats due to most of the water being inside storage tanks and to the small surface area of accessible water (Darby, pers. comm. 2016).

Migratory and Resident Birds

In several studies, migratory bird species have been observed using developed springs as stopover points during migration (Cutler and Morrison 1998; Rosenstock et al. 1999; Burkett and Thompson 1994), though the net population-level effects of water sources on bird species are not well understood (Rosenstock et al. 1999; Bush 2015). Springs with significant ground overflow may be more important if they support sufficient riparian vegetation. Resident birds, such as some passerines like house finches and white-crowned sparrows, are seen to heavily use water developments—primarily developed springs. Guzzlers do not likely benefit most birds because of the lack of open water and riparian vegetation. Raptors seem to benefit most, as they are frequently photographed bathing and drinking, primarily in developed springs with troughs or tanks (Darby, pers. comm. 2016).

Game Birds

Game birds include the native Gambel’s quail, mourning dove, and white-winged dove and the nonnative chukar and Eurasian collared dove. Gambel’s quail, mourning dove, and chukar are the most frequently seen birds at water sources. In a study of chukar, an introduced game bird species, Larsen et al. (2007) found that water developments located in areas with a sufficient threshold of shrub canopy cover received the most use. Mourning and white-winged doves have been shown to require surface water (Mirarchi 1993; Lewis 1993; Rosenstock et al. 1999), so any reduction in surface water could have negative consequences for those birds.

According to the *Western Quail Conservation Plan* (Zornes and Bishop 2009), Gambel's quail and chukar do not require free-standing water if succulent vegetation is available; however, in areas with frequent droughts, free-standing water becomes important. During hot and dry weather in the summer and fall, California quail typically come to water each day. Gambel's quail abundance is linked to winter precipitation and the green vegetation produced during wet years; and mortality and survival rates are primarily driven by annual variations in precipitation (Zornes and Bishop 2009).

Ungulates

Besides desert bighorn sheep (which are discussed separately), ungulates in the Preserve include mule deer and the nonnative burro. Based on literature and professional experience of wildlife managers, it is well understood that larger desert ungulate populations depend on surface water sources for survival (Bladh 2004; Bush 2015; McKee et al. 2015). Like bighorn sheep, mule deer appear to depend on free-standing water (Hervert and Krausman 1986), but this varies temporally with the hot, dry months being most important. There is also good evidence that mule deer have benefited from water developments in Arizona (Rosenstock et al. 1999), and reductions in water developments to below an unknown threshold could have negative consequences. Mule deer cannot use small game guzzlers and are not found where the big game guzzlers are located, except for Clark Mountain (which is used by mule deer) (Darby, pers. comm. 2016).

Overall Findings

Based on the above understanding of the reliance of general wildlife species on artificial water sources, the following assumptions were used in this analysis:

- All wildlife species groups are known to use springs for supplemental water or habitat. Migratory and resident birds, bats, and ungulates are not known to use small game guzzlers due to their inaccessibility or lack of open water.
- The presence of artificial water sources, such as guzzlers and developed springs, may support stopover habitat for migratory birds and localized habitat for small mammals, herpetofauna, and mule deer.
- Changes to or loss of individual water sources could negatively affect individual animals or groups in localized areas, but are less likely to affect regional population stability or species diversity; this is for both terrestrial wildlife and migratory birds.
- Changes to or loss of individual guzzlers or water sources could negatively affect individual and localized groups of introduced game birds (e.g., quail), while others would be less affected.
- Changes to or loss of small groups of water sources in the Preserve are expected to have limited effects on regional wildlife populations, considering the above points and the presence of about 450 known water sources.
- Maintenance or improvement of developed springs would benefit local wildlife, but those benefits would be proportionally small and localized and would not affect regional population stability or species diversity.

Special Status Wildlife Species

Special status species include species listed as threatened, endangered, or candidate under the Endangered Species Act (ESA); and species listed as threatened or endangered by the State of

California. Special status species known to occur or potentially occurring in the Preserve are listed in Table 16.

Table 16. Special Status Wildlife Species Potentially Occurring in the Preserve

Common Name	Scientific Name	Status	Occurrence
Arizona Bell's vireo	Vireo bellii arizonae	SE	Two nesting territories were identified at Piute Spring in 2004; current status is unknown
Bald eagle	Haliaeetus leucocephalus	SE	Have been documented near the Preserve, but presence in Preserve is not confirmed
California condor	Gymnogyps californianus	FE, SE	Historic; not present in the Preserve
Desert tortoise	Gopherus agassizii	FT, ST	Confirmed in the Preserve
Mohave tui chub	Gila bicolor mohavensis	FE, SE	Confirmed in the Preserve; occurs in MC Spring and Morningstar Mine Pit Lake
Southwestern willow flycatcher	Empidonax traillii extimus	FE, SE	Occasionally documented in riparian areas, but breeding behavior in the Preserve has not been verified*
Western yellow-billed cuckoo	Coccyzus americanus occidentalis	FT, SE	Occasionally documented in riparian areas, but breeding behavior in the Preserve has not been verified*
Willow flycatcher	Empidonax traillii	SE	Occasionally documented in riparian areas, but breeding behavior in the Preserve has not been verified*

*The limited riparian habitat in the Preserve may provide important stopover habitat during migration.
Note: FE = federally endangered, FT = federally threatened, SE = state endangered, ST = state threatened.
Sources: Johnson and Stuart 2005; PRBO 2005; Drost and Hart 2008; Persons and Nowak 2007.

The desert tortoise and Mohave tui chub are the only federally or state-listed species confirmed to reside in the Preserve year-round. These two species are discussed in detail below.

Desert Tortoise

Desert tortoises occur in the United States in the Mojave and Sonoran Deserts in Southern California, Arizona, and southern Nevada and in southwestern Utah; and in Mexico in Sonora and northern Sinaloa. Desert tortoises occur in a wide range of desert habitats from flats and slopes dominated by creosote bush to rocky slopes dominated by blackbrush and juniper woodlands and at elevations from below sea level to 7,300 feet (2,225 meters) (USFWS 2011a). In the Mojave Desert, tortoises generally occur on gently sloping sites with sparse cover of low-growing shrubs. Soils in desert tortoise habitat are predominantly sand and gravel that is soft enough for the tortoises to dig burrows, but firm enough so that burrows do not collapse (USFWS 2011a).

Desert tortoises have several adaptations for surviving in an arid environment. They spend much of their time hibernating in underground burrows where they are protected from extreme temperatures and lack of moisture (Nagy and Medica 1986). They emerge from burrows in late winter or early spring and remain active through fall. Desert tortoises are less active during summer months but may emerge after summer rain storms. During periods when they are less active, desert tortoises reduce their metabolism, reduce their water loss, and consume less food. Duda et al. (1999) found that home range size, number of different burrows used, average distance traveled per day, and levels of surface activity were significantly reduced during drought years. Tortoises reduce their surface activity and remain mostly dormant underground during drought, reducing their water loss and energy requirements (Nagy and Medica 1986; Duda et al. 1999).

Threats to desert tortoises include habitat destruction, degradation, and fragmentation from human activities such as urbanization, agriculture, livestock grazing, mining, roads, military operations, off-road vehicles, and predation by ravens and other subsidized predators (Boarman 2002). Predation by common ravens on juvenile tortoises is believed to be one of the most important threats to the desert tortoise (McIntyre 2004). Desert tortoise populations have also been adversely affected by humans collecting them as pets, for use as food, or for use in folk medicine (USFWS 1994). Desert tortoises in the western Mojave Desert also have been affected by a respiratory disease (mycoplasma), which has caused mortality and population decline (USFWS 1994).

Desert Tortoise Listing, Recovery, and Critical Habitat **–** The designated Mojave population of the desert tortoise includes those living north and west of the Colorado River (USFWS 1994). The Mojave population of the desert tortoise was listed as threatened by the USFWS and the State of California in 1990. The Recovery Plan for the Mojave Population of the Desert Tortoise was released by the USFWS in 1994 and revised in 2011 (USFWS 1994, 2011a). The 1994 Recovery Plan described a strategy for recovering the desert tortoise, which included the identification of six recovery units, recommendations for a system of Desert Wildlife Management Areas in the recovery units, and development and implementation of specific recovery actions.

Critical habitat is a term defined by the ESA that refers to areas designated by the USFWS that are essential for the conservation of threatened or endangered species and may require special management and protection. Critical habitat for the Mojave population of the desert tortoise was designated in 1994 (USFWS 1994). Two areas of designated critical habitat are present in the Preserve (see Figure 19). The first area of critical habitat includes 769 square miles in the Ivanpah Valley south of Nipton Road, including areas north, west, and south of Cima Dome in the Eastern Mojave Recovery Unit. The second area of critical habitat in the Preserve includes 438 square miles in the Fenner/Clipper Valley in the Colorado Desert Recovery Unit. Combined, the two critical habitat areas cover about 772,463 acres or 48 percent of the Preserve. Additional critical habitat occurs adjacent to the Preserve to the north on BLM land and to the south and east of the Fenner/Clipper Valley area in California and Nevada. Annual desert tortoise monitoring in 2011 estimated that about 11,000 tortoises occur in the Ivanpah Valley and about 12,000 are in the Fenner Valley (USFWS 2012).

Relationship to Water Resources **–** Adult desert tortoises can survive a year or more without access to water and can tolerate large imbalances in their water and energy budgets (Nagy and Medica 1986; Peterson 1996a, 1996b; Henen et al. 1998—all cited in USFWS 2011a). However, desert tortoises depend on the availability of free-standing water for survival (Nagy and Medica 1986; Henen 1994, 1997; Peterson 1996a, 1996b; Henen et al. 1998). Desert tortoises are reported to drink large amounts of free-standing water during and after rains (Medica et al. 1980; Nagy and Medica 1986; Peterson 1996a, 1996b; Henen et al. 1998), have been found to construct water catchments for drinking (Medica et al. 1980), and have been known to remember locations of natural water sources (Berry 1986). In drought years, access to surface water for drinking may be crucial for desert tortoise survival (Nagy and Medica 1986).

The potential for desert tortoises to drown in guzzlers has been a concern in the California desert. Hoover (1995) examined 89 small game guzzlers and found the remains of 26 desert tortoises and 1 live tortoise. It was not possible to determine whether the tortoises had died when they fell into the tanks or whether the tortoises died elsewhere and remains were washed or blown into the tanks. Most of the tortoise remains were found in tanks constructed from fiberglass rather than concrete (Hoover 1995). Hoover concluded that at least some of the tortoises had drowned in the tanks because he thought it unlikely that a desert tortoise could climb out of the fiberglass tanks. Hoover recommended installation of a roughened matt or abraded surface for tortoises to be able to have traction to escape the tank.

However, additional studies have not found that drowning in water developments or guzzlers is a substantial source of mortality for desert tortoises (Andrew et al. 2001; Rosenstock et al. 2004). Andrew et al. (2001) examined 13 wildlife guzzlers in the Sonoran Desert for signs of drowned tortoises and found no tortoise remains, but did find the remains of at least 30 individual vertebrates consisting of mammals, birds, and reptiles. Most skeletal remains found showed a high degree of breakage, consistent with predation by mammals or birds (Andrew et al. 2001), leading to speculation that many of the remains found were from pellets cast by owls or raptors or from scats deposited near guzzlers by mammalian predators and subsequently blown into the water by the wind.

Rosenstock et al. (2004) conducted more than 600 visits to wildlife water developments in southwestern Arizona from 1999 to 2003 and found 19 individual birds, mammals, and lizards dead in water tanks, presumably from drowning. They did not locate any remains of desert tortoises. They concluded that previous studies counting animal remains in water developments may have overestimated drowning events because many animals visiting guzzlers bring prey or scavenged food with them to the water source (Rosenstock et al. 2004).

Although entrapment in guzzlers may not be a substantial source of mortality for desert tortoises, most guzzlers have a ramp that allows wildlife entering the water to escape (Bleich et al. 2005). It is now standard practice to install a durable roughened (for traction) ramp in small game guzzlers to prevent desert tortoise mortality.

Mohave Tui Chub

The Mohave tui chub is the only fish native to the Mojave River basin in California. Mohave tui chub formerly inhabited deep pools and slough-like areas of the Mojave River and are well adapted to the Mojave River's alkaline and hard water qualities. The arroyo chub was introduced into the Mojave River headwaters in the San Bernardino Mountains and first appeared in the Mojave River in the 1930s. Mohave tui chubs steadily declined following the introduction of the arroyo chub, and genetically pure Mohave tui chubs were eliminated from the Mojave River by 1970. In addition to hybridization with the arroyo chub, factors leading to the decline of the Mohave tui chub included habitat modifications resulting from dam construction, introduction of nonnative fish that prey on Mohave tui chub, and overdrafting groundwater in the Mojave River basin, which reduced the extent of aquatic habitat.

A small population of genetically pure Mohave tui chub persisted in the isolated MC Spring, located at Soda Springs on the west bank of dry Soda Lake in the Preserve. Since its rediscovery, the Mohave tui chub has been reintroduced to constructed ponds at several additional locations. Currently, five genetically pure Mohave tui chub populations exist at Soda Springs, Morningstar Mine, China Lake Naval Air Weapons Station, Camp Cady, and Lewis Center for Educational Research in Apple Valley (USFWS 2011b). All five of these sites are isolated populations in human-made habitats in the Mojave Desert.

Cultural Resources

Introduction

Since the Mojave Desert was first settled by Native Americans 8,000 to 10,000 years ago, water was the primary requirement for the establishment of long-term habitation and industry in the region. Little is known of how water was managed in the Mojave Desert by Native Americans before contact with the Spanish and Euroamericans. Water management requires systems to capture, store, and transport water. In a desert environment where water is critical, those systems have become pervasive and significant elements of the landscape and the historical record.

Legal and Policy Guidance

Cultural resources are protected under broad federal environmental regulations such as NEPA, cultural resource regulations such as the NHPA, and NPS directives and policies. Section 106 of the NHPA (1966, as amended), and its implementing regulations under 36 CFR 800, requires federal agencies to consider the potential effects on historic properties that could occur from the issuance of a permit, funding, or ground-disturbing action or undertaking. Section 106 also requires that the agency provide the Advisory Council on Historic Preservation and the SHPO an opportunity to comment on the potential effects of the undertaking on historic properties (36 CFR 800). Under this plan, historical water systems may be managed in such a way that could alter the character-defining aspects of historic properties. Therefore, the potential effects of water resource management on historic properties must be disclosed under NEPA and further evaluated for effects under Section 106 of the NHPA.

Section 110 of the NHPA requires federal agencies to inventory and evaluate all cultural resources that meet the NPS-defined 50-year age criteria for a potential historic property. Historic properties are those cultural resources that are listed or eligible for listing on the NRHP. NPS guidelines for the management of cultural resources are set forth under DO-28 (NPS 1998), which provides for the protection of cultural resources through research, planning, and stewardship.

Two other pertinent federal regulations govern the protection of cultural resources and are relevant for the current undertaking. The Archaeological Resources Protection Act (1979, as amended) prohibits unlawful excavation or disturbance of archaeological sites and permits authorized excavation. The Native American Graves Protection and Repatriation Act (NAGPRA, 1990, as amended) prohibits the disturbance of Native American unmarked graves and associated funerary items and requires the repatriation of human remains and associated funerary items to descendant groups.

Some of the general policy guidance directs the NPS to provide for the long-term preservation of, public access to, and appreciation of the features, materials, and qualities contributing to the significance of cultural resources. General approaches include:

1. preservation in their existing states;
2. rehabilitation to serve contemporary uses, consistent with their integrity and character; and
3. restoration to earlier appearances by the removal of later additions and replacement of missing elements.

The preservation of cultural resources in their existing states will always receive first consideration (NPS 2006).

Historical Context

Native American Context

The Preserve is in the Mojave Desert where numerous large-scale inventory projects have been conducted, although very little is known specifically about the prehistory of the Preserve itself. In part, these projects have defined a broad cultural chronology for the Mojave Desert that spans the last 12,000 years (Sutton et al. 2007). Between these earliest and latest Native American periods is a rich cultural history.

The many natural water sources in the Preserve are directly related to prehistoric settlement and land use patterns through time, as water was a primary component in settlement and subsistence strategies. Unlike many of their more sedentary agricultural neighbors to the east, such as the Anasazi, people in the Mojave Desert do not appear to have substantially modified their water sources or built water control features (Sutton et al. 2007).

At the time of European contact by the Spanish in 1776, California had the highest Native American population in North America, speaking more than 300 dialects. The Chemehuevi were the primary inhabitants of the eastern Mojave Desert around and in what is now the Preserve. The Chemehuevi practiced a hunter-gatherer economy centered on or tethered to the larger springs in the region. With the bow and arrow, the Chemehuevi hunted large game such as desert bighorn sheep and deer and hunted rabbits with nets (Kroeber 1925). They also gathered plants including agave, mesquite, and prickly pear. The Chemehuevi may have practiced limited horticulture or small-patch farming around springs and may have adopted flood farming along the Colorado River (Stewart 1968). Based on the limited food and water resources in the Preserve during prehistoric times, the area of the Preserve most likely did not sustain more than about 150 people (Nystrom 2003).

The Preserve is named after the Mohave people, agriculturists who farmed in the floodplain of the Colorado River and were able to produce food surpluses, which resulted in a population that numbered in the thousands. They were prolific traders and had an extensive network of trails across the desert from water source to water source. An excellent illustration of the importance of water sources to the Mohave people and other prehistoric peoples in the Mojave Desert is the Mojave Road. This network of trails, portions of which are in the Preserve, was developed by the Mohave people for trade purposes. The trails extended from water source to water source all the way to the Pacific Ocean and were the main communication and travel corridor between the Pacific Coast and the desert. The Mojave Road was eventually adapted by Euroamericans for use as a trail and wagon road, the water sources being critical for human and livestock survival in such a climatically hostile environment (Nystrom 2003).

Based on recent evaluations of springs and water features in the Preserve, 47 documented springs are believed to have prehistoric significance. These include Soda Springs, Piute Spring, Mail Spring, Eagle Well, Deer Spring, Rock Spring, Arrowweed Spring, and Vontrigger Spring.

Exploration

The first Euroamerican incursion into what is now the general area of the Preserve occurred in 1776 when Padre Francisco Garces entered the Mojave Desert. While traveling west through the desert, Garces encountered Chemehuevi people at a spring that he called Ojitos de Santa Angel somewhere around the Whipple or Monument Mountains. On his return trip through the desert, Garces encountered Chemehuevi rancherias near the Mohave Sink and the Providence Mountains (Stewart 1968). He also encountered the Mohave people on his travels. The Mohave were friendly and guided Garces through the desert on their trails. They also guided trapper Jedediah Smith in 1826 on one of his many trips through the area.

As more explorers and settlers began moving through the area, conflict erupted as early as 1827, and the Mohave were branded hostile and were avoided by Euroamerican explorers. The trail system the Mohave had shown to explorers became known as the Mojave Road. It was the basis for routes used by later explorers, settlers, and the military before construction of railroads (Nystrom 2003). The 1854 American expedition led by Lt. A. W. Whipple crossed the Preserve through the Lanfair Valley. Evidence suggests the 1776 Garces Expedition may have traversed the Preserve as well, but it is not known exactly where.

Each expedition noted the abundance of grass and the potential for livestock grazing. By 1864, military drovers were routinely crossing the Mojave Desert with livestock to supply Fort Mojave and other points further west, making routine stops at Marl and Rock Springs for water and pasture. The first motivation to settle and graze livestock over the vast expanse of the eastern Mojave Desert was to supply meat and hides to prospectors, miners, and the military. With the arrival of the Southern Pacific Railroad in 1883, the scale of cattle ranching in the region expanded with a reliable transportation network. The acquisition of water rights and construction of water management and distribution systems developed concurrently to meet the needs of the cattle ranching industry.

Historic Water Use

Historic habitation and land use depended on the same water sources that Native Americans had been using for thousands of years. Many of the natural water sources (springs and seeps) were modified, and new water sources were established to accommodate expanding human habitation and industries such as ranching and mining. Modifications of these seeps and springs include tunneling, hand-dug wells, drilled wells, dams in drainage channels, excavated earthen catchments and reservoirs, and pipelines (NPS 2005b). Development of these features is directly responsible for the proliferation and long-term success of ranching in the Preserve. The relative importance of these ranching operations has been demonstrated by their inclusion in or eligibility for listing on the NRHP as part of various historic districts. Water resources are important contributing components to the ongoing existence of these districts.

Mining. The first successful mining in what would be the Preserve began in the 1860s, after a few earlier attempts by Mexicans in the area and soldiers at Fort Mojave. Perhaps the most well-known mine in the area before the turn of the century was the Bonanza King Mine, established in 1880.

From the turn of the century to World War I, mining developed in the Vanderbilt area, New York Mountains, and Ivanpah Valley. Some of the mines developed in the Preserve during this period include the Copper World, the Von Trigger (later the California) Mine, and the Paymaster Mine. After a lull in mining following World War I, the Great Depression sparked an increase in gold mining, especially in the Mojave Desert. The Colosseum Mine and Telegraph Mine were two of the mines in the Preserve that were actively mined during the Great Depression.

World War II facilitated a shift in mining throughout the country, including in the Mojave Desert. Industrial metals, rather than precious metals, became sought after. The need for wartime materials again sparked an uptick in Mojave Desert mining. Copper, tin, and tungsten were among the materials important to the war effort found within the area that would become the Preserve. The Evening Star Mine produced tin and tungsten. The Vulcan Mine, which operated until 1948, produced iron ore for the Kaiser steel plant in Fontana, California (Life Magazine 1943).

In the decades between World War II and 1994 (when the Preserve was created), mining activities continued in some form. The Aiken and Cima Cinder Mines focused on salable materials and operated from 1948 through the 1990s. Due to advances in gold recovery, the

Colosseum Mine and Morningstar Mine were both reopened, using cyanide leach treatments to recover microscopic amounts of gold from discarded tailings. Other nearby mines continued operating or reopened and were purposefully excluded from the Preserve because of their active status.

The legacy of this mining history with respect to water resources was the creation or development of numerous water features in the Preserve. The development of adits and tunnels for underground mining activities often resulted in the development of water features. Examples of springs associated with mining activities include Adam Anna Ore Mine Spring, Big Hunch Mine Spring, Black Bird Mine Spring, Bronze Mine Spring, Columbia Mine Spring, Howe Spring Mine Shaft, Negro Mine Spring, and Sagamore Mine Spring. Mine pits resulting from the surface excavation of minerals at the Colosseum Mine (located on private land) and Morningstar Mine have since created pit lakes, which are the largest surface water bodies in the Preserve and surrounding area.

Ranching. Ranching in an environment such as the Mojave Desert is especially dependent on and integrally tied to water. Many of the water sources in the Preserve have been used by wildlife, humans, and livestock. Much of the ranching history is associated with these water sources. The significance of water development by ranches such as the Rock Springs Land and Cattle Company, Kessler Springs Ranch, OX Ranch, and Valley View Ranch was acknowledged in the 2007 NPS Rock Springs Land and Cattle Company Cultural Landscape Study (NPS 2007a). The labor-intensive enterprise of ranching required harnessing water resources from every available source using wells, springs, pipelines, and storage tanks and distributing it across a vast area in an efficient manner (NPS 2007b).

Before formal ranching activities around what would later become the Preserve, grazing livestock was common by many who traversed the area (Nystrom 2003). Following the population growth brought by the California and Nevada mining boom of the 1870s–1880s, the first ranches within the boundaries of the Preserve (Blackburn and Briggs) were established about 1875 at Marl Springs and at Government Holes. In the 1880s, additional ranches were established near the Bonanza King Mine near what is now Kessler Springs.

In 1894, Blackburn and Briggs merged their holdings and formed the Rock Springs Land and Cattle Company, which was headquartered at Barnwell, the northern terminus of the Nevada Southern Railway. Grazing occurred on unfenced federally owned public land, and cattle were transported from the railroad terminal at Barnwell to market. Control of water rights was a major component of the ranch's overall strategy to control the area. They made aggressive and strategic moves to trade or buy water rights throughout the entire area, which allowed them to graze as many as 10,000 cattle on their 50-square-mile range. In fact, these ranches used surrounding federal land as their own land and only held genuine title to land around water sources, indicating the relative value of the watering holes (Nystrom 2003). By 1916, water pipelines from sources at Barnwell, Kessler Springs, and Hackberry Springs transported water to tanks and troughs spread across the range. The company built several distinctive permanent circular concrete troughs or placed moveable galvanized metal troughs at dozens of locations. More than 40 springs and 12 wells provided water for the expanding herds (NPS 2007b).

The monopoly on water held by the ranch caused conflict with surrounding homesteaders who were able to stake claims in prime grazing land in places like Lanfair Valley, but did not have access to water except for a few public sources, making it hard to grow crops. Most homesteaders eventually left due to economic and environmental circumstances. Others were driven from the Rock Spring area of influence after a bloody shootout at Government Holes in 1925.

Substantial changes to ranching in the Preserve came in the 1900s. The first change was a massive drought that struck in 1928, resulting in the death of thousands of cattle. Eventually, the Rock Springs Land and Cattle Company buckled under the hardship caused by drought and was sold piecemeal. Much of the former million-acre ranch was absorbed by other surrounding and new ranching interests. Three major ranches resulted from the dissolution, including the OX Ranch (400,000 acres), Kessler Springs Ranch (300,000 acres), and Valley View Ranch (300,000 acres) (BLM 2010). These ranches successfully navigated the second substantial change during this period—the Taylor Grazing Act of 1934, which required clear delineation and fencing of federally owned rangelands, thus enforcing the payment of fees for ranchers to graze livestock on federally owned public lands.

One major consequence of the Taylor Grazing Act was the development of numerous new water sources within the area that is now the Preserve. As ranches downsized, established water sources may have been isolated by new property lines and fences. As a result, individual ranchers had to develop new water sources on federally owned and private lands to support their livestock and minimize stress on the already established sources. Between the 1940s and creation of the Preserve in 1994, the various ranches continued to make improvements including constructing corrals, fences, and pipelines. Many of the ranches changed ownership or passed on operational control to family members or friends as years went by. By 1986, much of the land in the area that would become the Preserve would come under ownership or operational control of the Overson Family.

Maintenance and development of water sources and the accompanying infrastructure has allowed successful long-term ranching, which is important to the history of the Preserve and region. Developed water features and distribution methods allowed historic ranching to succeed and be sustained through modern times. Without such features, ranching operations would have been much more limited and overgrazing around a small number of springs and seeps more severe. An exhaustive list of small-scale water features can be found in the Rock Springs Land and Cattle Company Cultural Landscape Study (NPS 2007a). Many of the water development features are listed as significant contributing features to the NRHP-eligible cultural landscape district.

Documented Cultural Resources

The Preserve has a rich cultural heritage spanning both prehistoric and historic eras. This heritage is reflected in the many listed and potential NRHP sites, districts, and cultural landscapes that make up the cultural fabric of the Preserve. The Preserve’s GMP (NPS 2002), the NRHP Focus database, and the NPS’s Cultural Landscapes website have identified both individual properties and potential districts that have been listed or are eligible for listing on the NRHP.

Sites and districts in the Preserve that are currently listed on or found eligible for listing on the NRHP include:

- Aikens Wash National Register District
- Piute Pass Archaeological District
- Mojave Road
- Kelso Depot
- Rock Springs Land and Cattle Company
- Soda Springs Historic District
- Vulcan Mine Historic District
- Lanfair Butte
- Providence Townsite

Two additional NRHP-listed cultural landscapes fall within the confines of the Preserve or pass through it, but are not managed by the Preserve: the Union Pacific Los Angeles to Salt Lake City Line (landscape) and the Boulder Transmission Line (landscape).

In addition to the sites and districts listed above, the following cultural landscapes/historic districts and sites have been identified by the Preserve as being potentially eligible for listing on the NRHP (NPS 2002):

- Rock House (site)
- Marl Spring (site)
- Rock Spring (site)
- New York Hills Historic District (1890s landscape)
- Death Valley Mine (landscape)
- Vanderbilt Site (component)
- Foshay Pass (feature)
- Macedonia Mining District (landscape)
- Rock Spring/Government Holes (component)
- Ivanpah Historic District (landscape)
- Ivanpah (component)
- Clark Mountain Mining District (landscape)
- General Patton’s Desert Training Center (Camp Essex) (landscape)
- Lanfair Valley (landscape)

A more recent NPS staff review of water features in the Preserve has identified 85 spring developments that are considered historic. Of these 85 developments, 47 were identified to have prehistoric significance. These sites, and the general nature of the development infrastructure at these sites, are described in greater detail in the “Water Resources” section of this chapter.

Wilderness Character

The 1994 CDPA, which established the Preserve, also designated nearly half of the land area in the Preserve (804,949 acres) as wilderness (Figure 20). The NPS manages the “Mojave Wilderness” in accordance with the 1964 Wilderness Act, the CDPA, NPS *Management Policies 2006*, and DO-41 – Wilderness Stewardship. The Mojave Wilderness is bordered by the BLM’s Kelso Dunes Wilderness Area and Bristol Mountains Wilderness Area to the west. The amount and density of public use in the wilderness is low, and there is no permit or registration system for wilderness access or camping in the Preserve. A wilderness stewardship plan has not been completed for the Preserve.

The Wilderness Act PL 88-577 (16 USC 1131-1136) states that “each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its *wilderness character*” and that “wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use.” Wilderness character is defined by four qualities that the NPS uses in wilderness planning, stewardship, and monitoring:

- *Untrammeled* – Wilderness is essentially unhindered and free from modern human control or manipulation. Purposeful actions that manipulate the biophysical environment affect the untrammeled quality of wilderness.
- *Natural* – Ecosystems in wilderness are substantially free from the effects of modern civilization. Impacts on plant and animal species and communities, physical resources, or biophysical processes affect the natural quality of wilderness.
- *Undeveloped* – Wilderness is without permanent improvements or human habitation. The presence of structures, installations, or developments and the use of motor vehicles, motorized equipment, or mechanical transport affect the undeveloped quality of wilderness.
- *Opportunity for Solitude or Primitive and Unconfined Recreation* – Sights and sounds of people inside wilderness, sights and sounds of occupied or modified areas outside

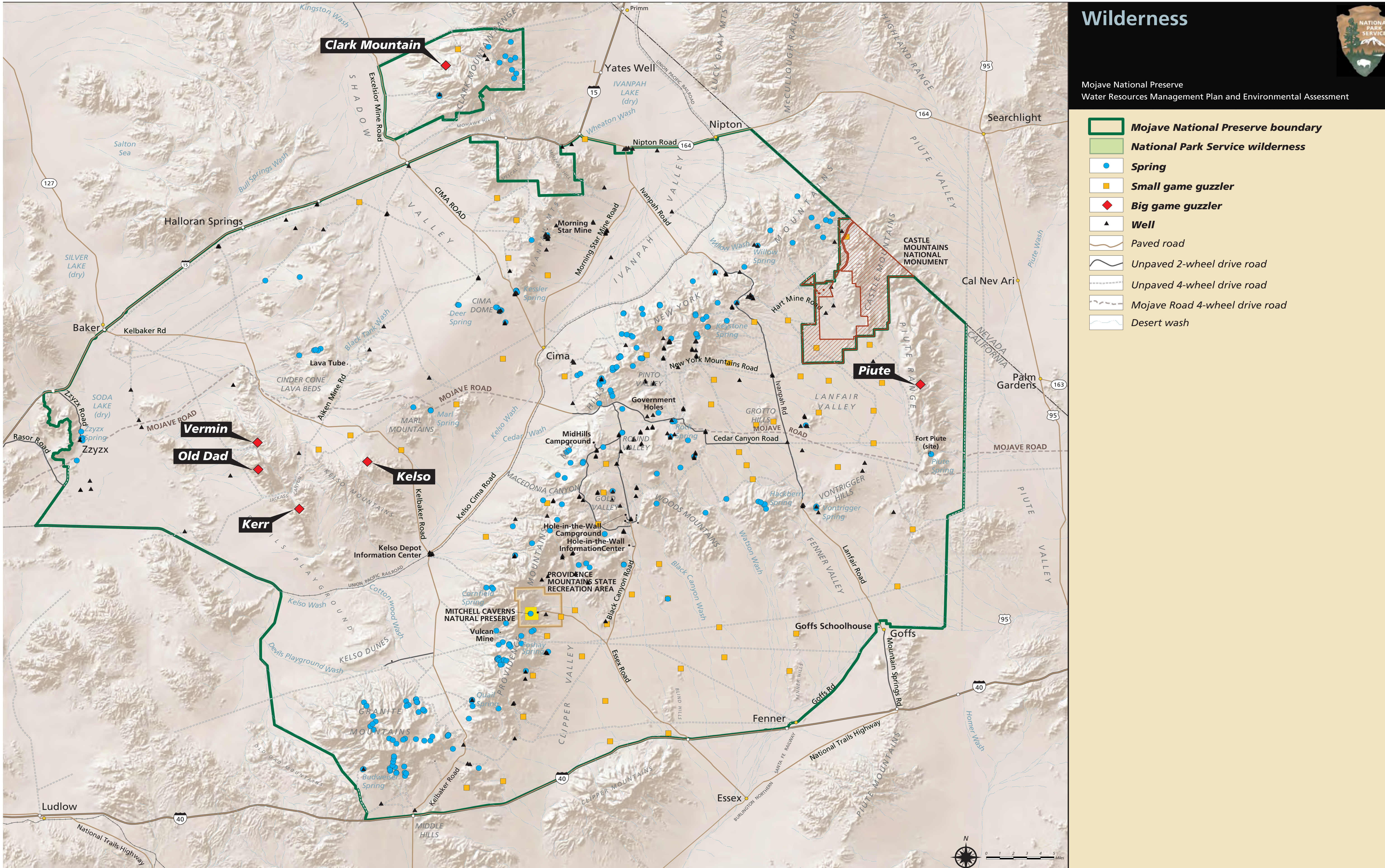
wilderness, facilities that decrease self-reliant recreation, and management restrictions on visitor behavior affect the quality of wilderness as a place with opportunities for solitude or primitive and unconfined recreation.

Water Resources in Wilderness

Most of the water resources that are described in this plan are located in wilderness, including 75 percent of the documented springs, nearly half of the small game guzzlers, and all six of the big game guzzlers. Although the wilderness boundaries were drawn to allow access to some known water sources for ranching (“cherry-stemmed”), many are in designated wilderness. This presents a dilemma for both water resources management and policy compliance, as most of these water sources provide some element of habitat for wildlife, and many require routine maintenance to ensure their effectiveness and safety. However, the existence of developed water features and the mechanized access and tools used for their maintenance are only permitted if they are necessary to meet minimum requirements for the administration of the area for wilderness purposes. While conservation and recreation are purposes of wilderness, and some guzzlers may help preserve some qualities of wilderness character (e.g., the “natural” quality associated with wildlife), the presence of structures and the use of motorized vehicles or equipment to maintain water structures may adversely affect other qualities of wilderness character (e.g., “undeveloped” and “untrammeled” qualities).

Mojave Wilderness Qualities

The NPS has not completed a wilderness character baseline of the Preserve or a wilderness stewardship plan. However, the 2013 Foundation Document includes the following statements about wilderness in the Preserve: “In Mojave Wilderness, natural processes are unrestrained and direct human impacts on the rich biodiversity so critical to the area’s ecological health are minimized” and “part of the Mojave Wilderness contributes to solitude, provides a refuge from urban areas and nearby developments, [and] contributes to scenic viewsheds” (NPS 2013b). Because of a long history of human use and development, the Mojave Wilderness is not devoid of human disturbance.


Wilderness
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
NATIONAL PARK SERVICE
Mojave National Preserve boundary
National Park Service wilderness
Spring
Small game guzzler
Big game guzzler
Well
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
Clark Mountain
Vermin
Old Dad
Kelso
Kerr
Piute
Primm
Yates Well
Nipton
Searchlight
Cal Nev Ari
Palm Gardens
Halloran Springs
Baker
Zzyzx
Cima
Kelbaker Rd
Lava Tube
CINDER CONE LAVA BEDS
MARL MOUNTAINS
Marl Spring
CIMA DOME
Deer Spring
Kessler Spring
Morning Star Mine
Morning Star Mine Road
Nipton Road
Ivanpah Road
IVANPAH LAKE (dry)
SILVER LAKE (dry)
SODA LAKE (dry)
Salton Sea
Zzyzx Spring
Rasor Road
Zzyzx Road
MOJAVE ROAD
Aiken Mine Rd
CIMA ROAD
Excelsior Mine Road
Kingston Wash
Wheaton Wash
Bull Springs Wash
Black Tank Wash
Kelso Wash
Cedar Wash
Kelso Cima Road
Kelbaker Road
Kelso Depot Information Center
UNION PACIFIC RAILROAD
KELSO DUNES
Devils Playground Wash
Cottonwood Wash
GRANITE MOUNTAINS
Budweiser Spring
MITCHELL CAVERNS NATURAL PRESERVE
PROVIDENCE MOUNTAINS STATE RECREATION AREA
Cornfield Spring
Vulcan Mine
Foshay Spring
Quail Spring
CLIPPER VALLEY
CLIPPER MOUNTAINS
Essex Road
Black Canyon Road
Black Canyon Wash
MidHills Campground
Hole-in-the-Wall Campground
Hole-in-the-Wall InformationCenter
MACEDONIA CANYON
GOLD VALLEY
Government Holes
ROUND VALLEY
Rock Spring
Cedar Canyon Road
PINTO VALLEY
NEW YORK MOUNTAINS
New York Mountains Road
Keystone Spring
Willow Spring
Willow Wash
Hart Mine Road
CASTLE MOUNTAINS NATIONAL MONUMENT
LANFAIR VALLEY
GROTTO HILLS
WOODS MOUNTAINS
Watson Wash
Hackberry Spring
VONTRIGGER HILLS
Vontrigger Spring
FENNER VALLEY
Lanfair Road
Fort Piute (site)
Piute Spring
PIUTE VALLEY
Piute Wash
MOJAVE ROAD
NEVADA
CALIFORNIA
Goffs Schoolhouse
Goffs
Goffs Rd
Mountain Springs Rd
Fenner
Essex
National Trails Highway
BURLINGTON NORTHERN SANTA FE RAILWAY
PIUTE MOUNTAINS
Homer Wash
Ludlow
MIDDLE HILLS
15
40
95
127
163
164
N
Miles

For the purposes of this plan, the four qualities of wilderness in the Preserve, and the relationship of those qualities to water resources, are understood to be as follows:

- *Untrammeled* – The Mojave Wilderness is largely free of active human manipulation. However, the use of water developments, ranging from developed springs to wildlife guzzlers, negatively affects the untrammeled quality of wilderness. The presence of historic water development structures that are merely a relic from historical land management, are not actively managed for conservation purposes, and are part of the landscape is not considered an adverse impact on untrammeled qualities.

- *Natural* – The Mojave Wilderness supports a diverse array of native plant and animal species that survive in the desert environment. Part of that natural ecosystem includes desert bighorn sheep and other wide-ranging species that have been negatively affected by modern development both in the Preserve and in the surrounding ecosystem. Wildlife management and conservation activities, including the installation and management of guzzlers or other water developments, are considered an important tool to maintain the natural wildlife qualities of the wilderness (at times at the expense of other qualities).

- *Undeveloped* – Most of the Mojave Wilderness is free of modern land disturbance, structures, or vehicle access that would indicate human improvements or habitation. There are, however, a myriad of abandoned mining and ranching structures located within the wilderness that adversely impact the wilderness character and undeveloped qualities. The presence of guzzlers and other water developments and the use of motorized equipment to access and maintain those developments further adversely impact the undeveloped wilderness quality in the vicinity of those sites.

- *Opportunity for Solitude or Primitive and Unconfined Recreation* – The Mojave Wilderness provides ample opportunities for solitude and primitive recreation. Water features in the wilderness do not affect this quality, nor does the highly infrequent access to water features for the purposes of monitoring or maintenance.

Wilderness Management

Section 4(c) of the Wilderness Act states:

> Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and, except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.

This minimum requirement concept is intended to minimize impacts on wilderness values and resources. Managers may authorize (using a documented process) the generally prohibited activities or uses listed in Section 4(c) of the Wilderness Act if deemed necessary to meet the minimum requirements for the administration of the area as wilderness.

Regarding natural resources management principles, NPS policies direct that the principle of nondegradation be used, and that natural processes be allowed to shape and control wilderness ecosystems. Management intervention in wilderness should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and influences originating outside of wilderness boundaries. Regarding cultural resources, NPS policies direct that cultural resources that have been included in wilderness will be protected and maintained according to the pertinent laws and policies governing cultural resources, using management methods that are consistent with the preservation of wilderness character and values (NPS 2006). These wilderness management principles are important to consider in relation to water resources management in the Mojave Wilderness since many of the existing water developments in wilderness are historic, while others are important for native wildlife conservation.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Introduction

The National Environmental Policy Act (NEPA) requires that environmental documents describe the environmental impacts of a proposed federal action, reasonable alternatives to that action, and any adverse environmental effects that cannot be avoided if a proposed action is implemented. This chapter analyzes both beneficial and adverse impacts that would result from implementing any of the alternatives described in this plan. The No Action Alternative (Alternative 1) is used to compare the effects of current actions and management direction at the Preserve with those proposed in the action alternatives (Alternatives 2, 3, and 4). The resource topics presented in this chapter, and the organization of the topics, correspond to the resource discussions contained in *Chapter 3: Affected Environment*.

This chapter begins with a brief explanation of the resource topics analyzed, followed by a discussion on methods and assumptions for assessing impacts, and finally a description of the projects that make up the cumulative impact scenario. The impacts of each alternative are then analyzed by impact topic. Each impact topic includes a description of the impact of the alternative, a conclusion for each alternative, and a discussion of cumulative effects. The impacts of all alternatives are summarized in Table 22 at the end of the chapter.

Resource Topics Analyzed

The specific resource impact topics to be analyzed were determined during the internal and public scoping process and are based on the dynamics of water resources in the Preserve (this process is described in the “Scoping and Public Participation” section in *Chapter 2: Alternatives*). Resource topics analyzed include the following:

- *Wildlife – Desert Bighorn Sheep* – including the availability of dry season habitat with adequate water to sustain populations
- *Wildlife – General* – including general wildlife species, key water resource–reliant species, unique or important wildlife or wildlife habitat, nonnative and subsidized wildlife species, and threatened, endangered, or sensitive species
- *Cultural Resources* – including historic or archeological resources associated with water sources
- *Wilderness Character* – including the characteristics and qualities of designated wilderness areas

Resources that were not analyzed in depth or were dismissed from further consideration and the rationale for that dismissal are briefly described in *Chapter 1: Purpose of and Need for Action*.

Methods and Assumptions for Assessing Impacts of Alternatives

General Analysis Methods

The analysis of impacts on resources follows CEQ guidelines and DO-12 (NPS 2015). The impact analysis and conclusions are based on quantitative and qualitative assessment of changes to affected resources. The analysis is informed by the best available applicable scientific literature and studies, information and professional judgement provided by experts within the Preserve and NPS and other agency personnel, and public input.

In accordance with CEQ regulations, direct, indirect, and cumulative impacts are described (40 CFR 1502.8 and 1502.16), and the significance of the impact on a resource topic is assessed in terms of context and intensity (40 CFR 1508.27). Where appropriate, measures to mitigate potential adverse impacts are described and are incorporated into the evaluation and description of impacts. More specific methods and assumptions used to assess impacts are described under each resource topic.

Assessing Impacts Using CEQ Criteria

The impacts of the alternatives are assessed using the CEQ definition of "significantly" (1508.27), which requires consideration of both context and intensity:

- *Context* – The significance of an action must be analyzed at multiple scales, such as the specific site, the particular locale, the affected region, and the larger global affected interests. Context can be environmental or social, and may vary based on the resource being analyzed. It includes both resource-specific context and overall context.

- *Intensity* – This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about aspects of a major action. For each resource topic analyzed, the potential significance of the impacts is assessed in the conclusion section that follows the discussion of the impacts for each alternative.

Overall Context

Resource-specific context is presented under each resource topic and applies across all alternatives. The context for impacts may include any of the following scales:

- Site-specific (site of proposed action)
- Local (within the Preserve boundary)
- Regional (within the Mojave Desert, or within about 50 miles of the Preserve boundary)
- Global affected interests (beyond the Mojave Desert region)

Duration and Impact Types

Duration refers to the period over which the effects of an impact persist. Duration of impacts is defined as follows:

- *Short-term* – Impacts last less than two years, often quite less. This would include any temporary impacts, such as construction associated with the alternatives.

- *Long-term* – Impacts last for more than two years, which would include impacts that are permanent. This plan is established to serve the Preserve for the next 15 to 20 years. Therefore, the analysis period used for assessing impacts is up to 20 years.

Impact Type refers to the nature of the impacts of the proposed management actions when compared with the existing conditions (beneficial or adverse), and the relationship between the time and location of the management action and when and where impacts are experienced on resources (direct or indirect) (40 CFR 1508.8). The following definitions of impact types are used for all resource topics:

- *Beneficial* – Impacts that move the resource toward a desired condition or result in a positive change when compared to the existing conditions.

- *Adverse* – Impacts that move the resource away from a desired condition or detract from its appearance and condition when compared to the existing conditions.

- *Direct* – Effects or impacts caused by an action that would occur at the same time and place as the action.
- *Indirect* – Effects or impacts caused by the action that would be reasonably foreseeable but would occur later in time, at another place, or to another resource.

Cumulative Impacts

The CEQ regulations that implement NEPA require the 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 non-federal) or person undertakes such other actions” (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including the No Action Alternative. Table 17 summarizes the actions that could affect the various resources being analyzed. Projects included in the cumulative impact analysis do not affect all resources equally.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects and plans in the Preserve and, if applicable, the surrounding region. These reasonably foreseeable future actions and projects are described in greater detail in the “Regional Context” section of *Chapter 3: Affected Environment*.

For most of the impact topics, the geographic area defined for the analysis was Mojave National Preserve. In some cases, the area of consideration was the greater Mojave Desert region.

Table 17. Cumulative Impact Scenario

Activity	General Wildlife	Desert Bighorn Sheep	Cultural Resources	Wilderness Character
Past and Present Impacts				
Existing Infrastructure: • I-15 and I-40, which border the Preserve to the north and south • UPRR, which crosses through the Preserve • Numerous highways and roads • Transmission lines • Canals and aqueducts • Small towns, settlements, ranches, and population centers	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Loss of local cultural resources at disturbed sites	Impacts on Preserve viewshed and noise levels
Land Management Plans and Actions: • Mojave Trails National Monument • Sand to Snow National Monument • Castle Mountain National Monument	Habitat connectivity and conservation	Habitat connectivity and conservation	Conservation of eligible cultural resources in the Mojave Desert region	Designation of wilderness and protected areas within the Mojave Desert region
Preserve Projects and Plans: • West Pond EA • Translocation of Bighorn Sheep to Eagle Crags Mountains FONSI • Abandoned Mine Safety Installations FONSI • Barber Peak Trail Loop Reroute FONSI • Ivanpah Desert Tortoise Research Facility	Habitat connectivity and conservation	Habitat connectivity and conservation	Conservation of eligible cultural resources in the Mojave Desert region	Restoration of native species habitat and populations (Mohave tui chub and Mojave Desert tortoise)
Land Management Plans and Actions: • Western Solar Plan • Desert Renewable Energy Conservation Plan • West Mojave Plan	Habitat fragmentation and connectivity	Habitat fragmentation and connectivity	Loss of local cultural resources at disturbance sites	Impacts on Preserve viewshed and noise levels
Solar Energy Development: • Bright Source Energy Solar Development • Silver State South Solar Project • Stateline Solar Farm Project	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Loss of local cultural resources at disturbed sites	Impacts on Preserve viewshed and noise levels

Activity	General Wildlife	Desert Bighorn Sheep	Cultural Resources	Wilderness Character
Military, Industrial, Agricultural, and Mining Projects: • Castle Mountain Mine Water Extraction • Calnev Pipeline corrosion control prevention • Mountain Pass Rare Earth Mine (inactive since 2015)	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Loss of local cultural resources at disturbed sites	Impacts on Preserve viewshed and noise levels
Reasonably Foreseeable Impacts				
Proposed Infrastructure: • Ivanpah Regional Airport • California-Nevada Maglev (magnetic levitation) Rail • Xpress West high-speed rail • Proposed regional transmission lines	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Loss of local cultural resources at disturbed sites	Impacts on Preserve viewshed and noise levels
Preserve Projects and Plans: • Livestock Grazing Management Plan	Habitat connectivity and conservation	Habitat connectivity and conservation	Conservation of eligible cultural resources in the Mojave Desert region	Domestic livestock are not generally permitted in wilderness areas
Solar Energy Development: • Soda Mountain Energy Development Project	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Loss of local cultural resources at disturbed sites	Impacts on Preserve viewshed and noise levels
Military, Industrial, Agricultural, and Mining Projects: • Fort Irwin National Training Center expansion • Twentynine Palms Marine Corps Air Ground Combat Center expansion • Cadiz Water Project	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Habitat fragmentation, habitat loss, mortality, reduced reproductive success	Loss of local cultural resources at disturbed sites	Impacts on Preserve viewshed and noise levels

Wildlife – Desert Bighorn Sheep

This analysis describes how the proposed plan alternatives could affect the quality of desert bighorn sheep habitat in the Preserve. As described in detail in *Chapter 3: Affected Environment*, desert bighorn sheep are a State of California fully protected species that use both natural and developed water sources (i.e., big game guzzlers) for survival.

Methods and Assumptions

General bighorn habitat in the Preserve is based on seven habitat patches outlined by Creech et al. (2014) (see Figure 2). The NPS created a model to better understand the relationship between landscape and environmental variables and big horn sheep use during the dry season (see *Chapter 3: Affected Environment* and Appendix B). The model indicates that dry season habitat can be understood as an area that provides suitable habitat for bighorn within 2.5 kilometers of a reliable water source (either a spring or guzzler) during the hot summer months of June, July, and August. This range was selected based on GPS collar data gathered from ewes in the Old Dad Mountain area (see Figure 18 and *Chapter 3: Affected Environment*, "Bighorn Habitat in the Preserve"), and on existing studies (Turner et al. 2004; Valdez and Krausman 1999). Ninety-three percent of the location data points for the collared ewes during dry season occurred within this radius (see Figure 18). Dry season habitat is important for bighorn sheep conservation because the availability of water during the summer months is critical for ewe and lamb survival.

The analysis quantifies and compares the dry season habitat value predicted for the separate guzzlers under each alternative. Habitat value indicates the contribution a guzzler makes to the overall quality of the Preserve's dry season habitat based on a model to infer the habitat preferences of ewes during the dry season using radio collar data and environmental variables (see *Chapter 3: Affected Environment* and Hughson 2018—Appendix B). Proximity to water and relatively high elevations emerged as the two variables that best predicted ewes' dry season habitat preferences, and were used to develop a habitat value index. The dry season habitat value predicted under each action alternative is expressed as a percentage of the existing conditions (No Action), which is equal to 100 percent (see Figure 21). The percent change to dry season habitat under each alternative compared to the existing conditions is summarized in Table 18 and Figure 21.

Table 18. Change to Habitat Value under Each Alternative

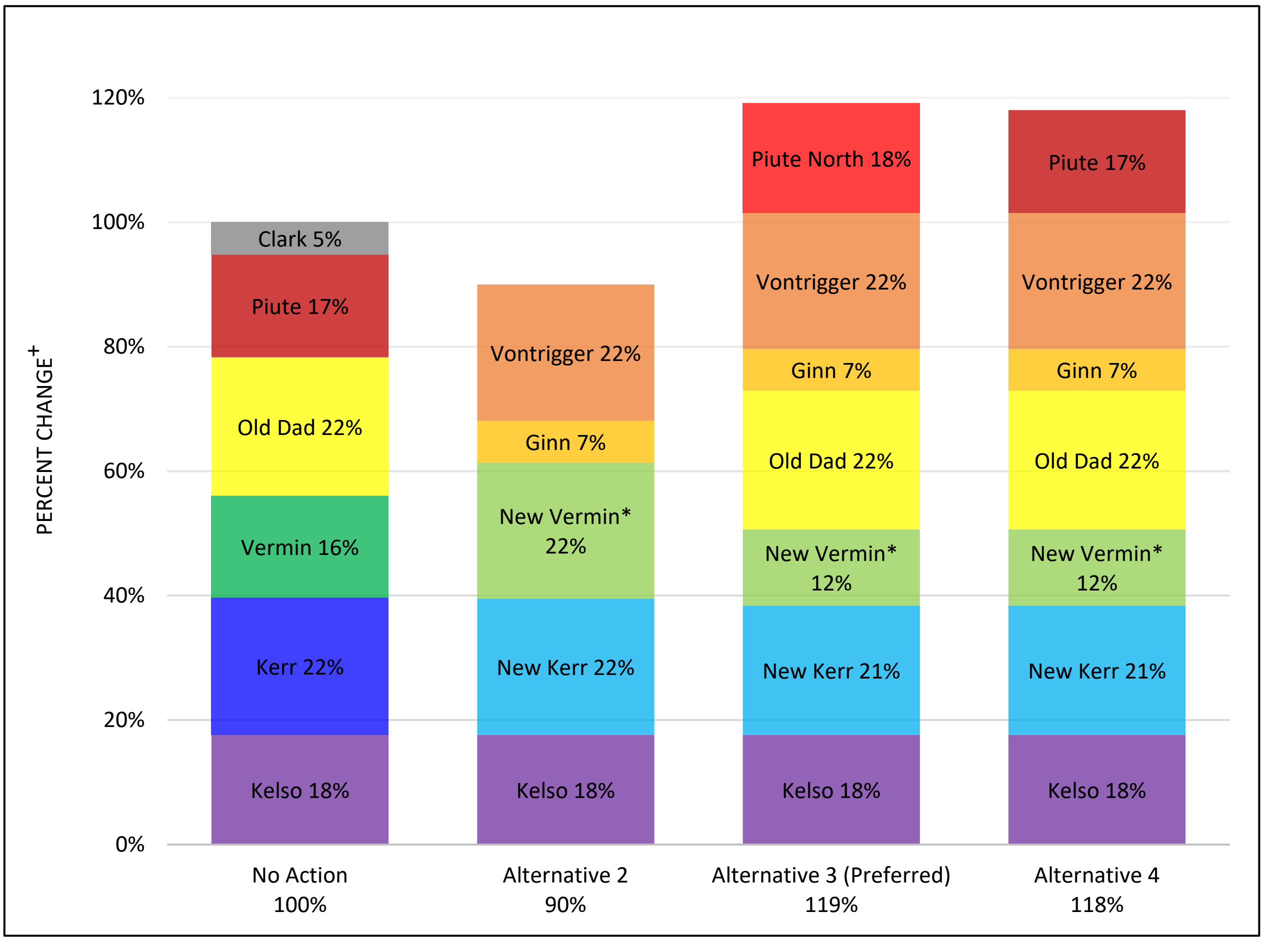
Alternative	Description of Big Game Guzzler Actions	% Change
No Action	Existing guzzler arrangement	no change
Alternative 2	3 removed, 2 relocated, 1 retained, 2 new	-10
Alternative 3 (Preferred Alternative)	2 removed, 2 relocated, 2 retained, 3 new	+19
Alternative 4	1 removed, 2 relocated, 3 retained, 2 new	+18

Context

At least six bighorn populations occur in the Preserve, each associated with rugged mountain ranges where suitable habitat exists ("habitat patches" per Creech et al. 2014; see Figure 2). While several of these habitat patches contain natural water sources, some populations use supplemental water provided by six big game guzzlers. The largest bighorn population in the Preserve—Old Dad/Kelso—uses guzzlers exclusively for water during the dry season, while the Clark Mountain guzzler is in a location that is not known to be used by sheep.

The benefits and effects of artificial water sources on bighorn populations is a debated topic. Several studies, including Longshore et al. (2009) and Bleich et al. (2010), describe the benefits of guzzlers to bighorn populations and their conservation and provide a basis for concerns about the consequences of reduced dry season habitat, such as reduced reproductive success, changes in movement and dispersal patterns, increased mortality, or increased predation. Others, including Cain (2006) and Cain et al. (2007), question the singular importance of developed water sources to bighorn population persistence, suggesting a greater importance of forage availability. This analysis adopts the cautious assumption that the availability of some type of water source during the dry season is a requisite characteristic for long-term habitat occupancy. This assumption is supported by the observations of Preserve staff and by some published literature (see citations in Hughson 2018—Appendix B). If dry season water is less important than assumed in this analysis, actual impacts of the action alternatives would be less than those predicted here.

Figure 21. Dry Season Habitat Value for Each Guzzler under No Action and Action Alternatives



+Percentages are based on the dry season habitat value index, which incorporates distance to water and elevation within 2.5 kilometers of a guzzler or water source (Hughson 2018—Appendix B). The dry season habitat value percentage for each action alternative is the sum of all guzzlers' contributions to habitat value. Action alternative percentages are in reference to existing conditions (No Action), which equals 100 percent.

*Alternative percentages for New Vermin differ due to retention of Old Dad and 2.5 km overlap with Vermin.

Looking more broadly at regional metapopulation implications, several studies, such as Bleich et al. (1996), Epps et al. (2006), Epps et al. (2007, 2010), and Creech et al. (2014), support the importance of regional bighorn connectivity and potential benefits of restoring migration corridors and unoccupied habitat patches. Longshore et al. (2009) and Bleich (2009) describe the importance of artificial water sources as mitigation for the loss of naturally occurring water sources and habitat that has resulted from development and climate change. For this analysis, it is assumed that habitat occupancy or connectivity could be encouraged by the addition of a water source or sources in areas lacking water but featuring other requisite habitat characteristics (e.g., ruggedness).

Each alternative includes a set of actions for the management or disposition of big game guzzlers in a manner that is consistent with the overall objectives of that alternative. The plans for big game guzzlers are described in detail in *Chapter 2: Alternatives* and are summarized in Table 19.

This analysis focuses on the change in modeled dry season habitat under the different alternatives. With this approach, the NPS can quantify changes in the value of available dry season habitat and can draw general conclusions about the effects of those changes on sheep populations. However, this analysis does not attempt to quantify the effects of dry season habitat value changes on the size of bighorn populations, the amount of habitat, the health of bighorn populations, or the number of individual animals that would be affected. That level of analysis would require detailed and complex multiyear studies of each bighorn population to observe and document changes in population size or health. Such studies would require time-intensive or cost-prohibitive monitoring (field observations and GPS data); would be confounded by external variables including precipitation and forage variability, long-term climate change, and disease; and would be limited to only a few population units at a time. Instead, for the purposes of this analysis, the NPS elected to analyze the change in modeled dry season habitat, which can be used as an indicator of change for bighorn populations.

Table 19. Summary of Implementation Actions for Big Game Guzzlers

Guzzler	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Clark	Remove	Remove	Remove
Piute	Remove	Remove	Retain
Old Dad	Remove	Retain	Retain
Kelso	Retain	Retain	Retain
Kerr	Relocate	Relocate	Relocate
Vermin	Relocate	Relocate	Relocate
New Water Sources	Two sites outside wilderness	Three sites outside wilderness	Two sites outside wilderness
Total Guzzlers	5	7	7
Within wilderness	1	2	4
Outside wilderness	4	5	3

Cumulative Impacts Common to All Alternatives

The past, present, and reasonably foreseeable future actions that may result in cumulative impacts on bighorn sheep within the Preserve are listed in Table 17 and are discussed in *Chapter 3: Affected Environment* in the “Regional Context” section. The activities that have affected and would continue to affect desert bighorn sheep resources are human development and disturbance, which include existing and proposed infrastructure, solar energy development, and military, industrial, agricultural, and mining projects; land management plans and actions; and Preserve projects and plans, which include designation of national monuments, resource management plans, and Preserve-sponsored projects.

Human Development and Disturbance

As discussed in *Chapter 3: Affected Environment*, desert bighorn sheep tend to use lower-elevation bajadas and alluvial fans to forage, in addition to the rocky steep mountain slopes, and may move significantly among mountain ranges (Bleich et al. 1990). Human development within the Mojave Desert region poses substantial barriers to sheep migration and the ability of individuals and herds to access adequate forage during dry seasons. Human-wildlife conflict may increase as a result of development, and individuals and herds may be deterred from migration corridors by human presence and development. While these activities taken together would result in local to regional long-term adverse impacts on the species, none of the alternatives would significantly alter the level of impacts on bighorn sheep populations when compared with existing conditions.

Existing and Proposed Infrastructure

The Mojave Desert region is crossed by transmission lines and energy infrastructure that is associated with energy development, highways, railways, canals and aqueducts, and small population centers, in addition to mines, military installations, and industrial solar development (discussed below). These developments have resulted in habitat fragmentation, habitat loss, reduced reproductive success, and potential mortality of individual bighorn sheep by creating barriers for herds and individuals that may cross areas to access water and forage. While these activities taken together would result in local to regional long-term adverse impacts on the species, none of the alternatives would significantly alter the level of impacts on bighorn sheep populations when compared with existing conditions.

Solar Energy Development and Plans

The three existing and one proposed industrial-scale solar energy developments close to the Preserve, including the solar energy development zones (SEZs) identified in the Desert Renewable Energy Conservation Plan (DRECP), are located in valleys below mountain ranges both within and outside of the Preserve (see Figure 1). Solar energy development in the Mojave Desert region poses long-term adverse impacts on bighorn sheep populations similarly to the impacts from infrastructure through habitat fragmentation, habitat loss, reduced reproductive success, and potential mortality of individual bighorn sheep by creating barriers for herds and individuals that may cross areas to access water and forage.

Military, Industrial, Agricultural, and Mining Projects

The presence and development of military installations, mines, and industrial and agricultural facilities in the Mojave Desert region poses long-term adverse impacts on bighorn sheep populations similarly to the impacts from infrastructure and solar development: habitat fragmentation, habitat loss, reduced reproductive success, and potential mortality of individual bighorn sheep by creating barriers for herds and individuals that may cross areas to access water and forage.

Land Management Plans and Actions

The designation of the Mojave Trails, Sand to Snow, and Castle Mountain National Monuments establishes areas within the Mojave Desert region and close to the Preserve where desert bighorn sheep habitat would be left undeveloped, thus providing corridors for sheep to migrate for forage and water if needed. Castle Mountain, located adjacent to the east side of the Preserve, contributes to habitat connectivity between the New York, Castle, and Piute mountain ranges, as well as to the Lanfair Valley. Several water features are in the eastern portion of the Preserve close to Castle Mountain National Monument. The Mojave Trails National Monument would provide potential habitat connectivity among the mountain ranges to the south and west of the Preserve. The Sand to Snow National Monument, located west of the Preserve, would likely have a less notable effect on habitat connectivity due to its distance from the Preserve. All of the alternatives would beneficially, although not significantly, alter the level of impact from these new designations. Nuances to the ways the alternatives would alter the level of impact are discussed under each alternative below.

Impacts of the Alternatives

Alternative 1 – No Action

Under the No Action Alternative, all six big game guzzlers would remain in place. Management and repair of guzzlers, including emergency filling and repairs, would occur on an as-needed basis. Continuation of current management and existing conditions under the No Action Alternative would not affect the amount or availability of dry season habitat available to bighorn sheep populations.

Cumulative Impacts

The cumulative impacts from past, present, and reasonably foreseeable future actions that are caused by human disturbance in the region, and by the implementation of Preserve projects and plans, are the same for all alternatives and are discussed above in the "Cumulative Impacts Common to All Alternatives" section.

While human disturbance and development projects would result in local to regional long-term adverse impacts on bighorn sheep, the No Action Alternative would not alter the level of the impacts in that it would not further inhibit bighorn movement or reduce habitat availability. Likewise, the No Action Alternative, with its passive and ad hoc approach to management, would not alter the regional long-term beneficial impacts from new national monument designations.

Conclusion

Overall, the No Action Alternative would be a continuation of the existing management approach, resulting in no effects on bighorn sheep populations in the Preserve compared with the existing conditions. The No Action Alternative would beneficially but not significantly alter the level of cumulative effects from human disturbance and the implementation of other plans and projects.

Alternative 2

At full implementation, Alternative 2 would include the removal of the Clark, Piute, and Old Dad guzzlers and the relocation of the Kerr and Vermin guzzlers to outside of wilderness (Figure 22). The Kelso guzzler would remain in place. Two new potential guzzlers (Ginn and Vontrigger) would be considered outside of wilderness for native wildlife habitat connectivity, including bighorn sheep. Each of these actions would occur in a deliberate and stepwise fashion, supported by monitoring and evaluation, to ensure that the intended changes in water availability are achieved without resulting in unacceptable impacts on bighorn populations, as outlined above in *Chapter 2: Alternatives* and in Figure 3. To achieve the desired outcome of minimizing wilderness intrusion while maintaining sustainable bighorn populations, Alternative 2 focuses on the strategic relocation of existing guzzlers and establishment of new guzzlers to support bighorn populations.

Preserve-Wide Dry Season Habitat Value

At full implementation of all big game guzzler actions, Alternative 2 would result in a 10 percent decrease in dry season habitat value, compared to existing conditions (see Figure 22 and Table 18). The removal of Clark, Piute, and Old Dad would decrease habitat value by 44 percent, while the relocation of Vermin (to New Vermin) and Kerr (to New Kerr) would increase habitat value by 6 percent. The development of the Ginn and Vontrigger guzzlers would increase habitat value by 29 percent. The 10 percent decrease in the overall dry season habitat value would result in a relatively small loss of dry season habitat value in the Preserve, with more substantial local effects on dry season habitat values.

Old Dad/Kelso Mountains

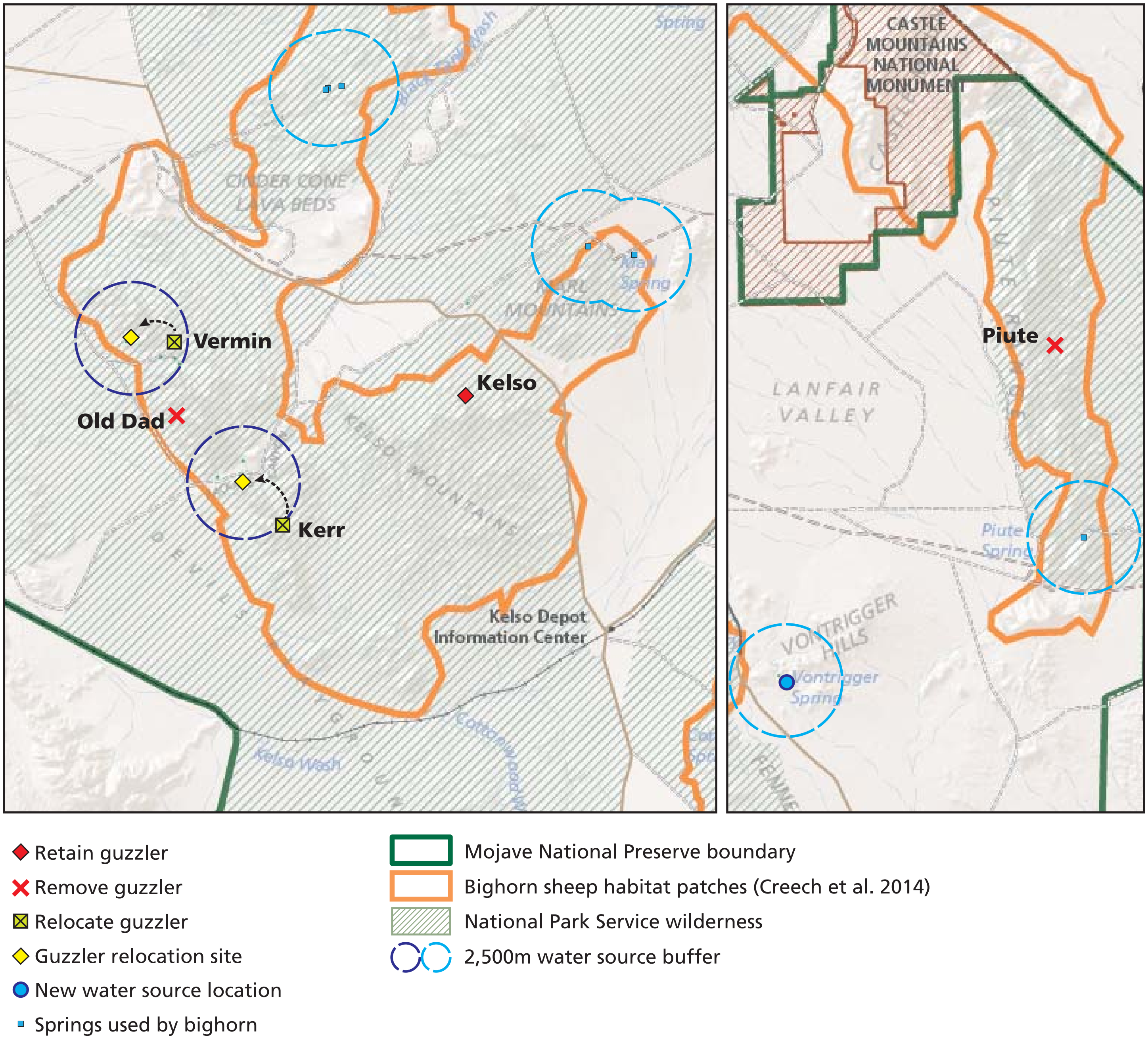
The Old Dad/Kelso Mountain area would experience a decrease of 35 percent in dry season habitat value for the area, mostly from the removal of the Old Dad guzzler. The Old Dad guzzler accounts for about 22 percent of the overall habitat value, but 28 percent of the Old Dad/Kelso Mountains habitat value. The relocation of the Vermin guzzler to New Vermin and Kerr guzzler to New Kerr would result in a combined increase of 6 percent. The Kelso guzzler would continue to support dry season habitat in its present location.

The deactivation of the Old Dad guzzler would result in short-term adverse effects on bighorn individuals and populations accustomed to that particular water source, which would likely result in potential impacts on sheep reproduction and survival of individuals and populations. The NPS expects that most animals and groups of bighorn would use the relocated New Vermin and New Kerr guzzlers, which would be located within or near the 2.5-kilometer radius of the Old Dad guzzler. The removal of the Old Dad guzzler would be completed following the implementation sequence described in *Chapter 2: Alternatives*, only after monitoring has indicated that nearly all bighorn have discovered and are using the New Vermin and New Kerr water sources.

The discovery and use transition from Vermin and Kerr to the relocated New Vermin and New Kerr guzzlers may result in short-term stress to the population, including reduced reproductive success and mortality of some individuals that do not easily adapt to the new location. These changes, however, would be followed by the implementation sequence outlined in Figure 3 and described in *Chapter 2: Alternatives*. The transition to the relocated water sources would take place over an extended period with monitoring of the existing and new guzzler sites to evaluate the discovery and use of the relocated water sources by bighorn. Therefore, while the relocation of two guzzlers would be expected to result in short-term adverse effects on some individuals, the NPS would not allow severe long-term consequences to the overall Old Dad/Kelso population by following the implementation sequence and monitoring. If monitoring indicated that long-term adverse conditions or trends in the population would occur, site-specific mitigation measures, including the reinstatement of existing guzzlers, would be used to avoid significant and adverse long-term effects.

Clark Mountains

The Clark guzzler is not heavily used by bighorn, and additional monitoring of the Clark guzzler would take place before it is deactivated and removed to ensure that bighorn use of the guzzler is rare and adverse impacts would not result. The removal of the Clark guzzler would follow the implementation sequence described in Figure 3 and outlined in *Chapter 2: Alternatives*, and would be subject to site-specific compliance under NEPA and NPS guidance.



CINDER CONE
LAVA BEDS
Vermin
Old Dad
Kerr
Kelso
KELSO MOUNTAINS
Kelso Depot
Information Center
Kelso Wash
CASTLE
MOUNTAINS
NATIONAL
MONUMENT
Piute
LANFAIR
VALLEY
Piute
Spring
Vontrigger
Spring
Retain guzzler
Remove guzzler
Relocate guzzler
Guzzler relocation site
New water source location
Springs used by bighorn
Mojave National Preserve boundary
Bighorn sheep habitat patches (Creech et al. 2014)
National Park Service wilderness
2,500m water source buffer

Mescal/Ivanpah Range

The addition of a water source at Ginn Mine in the Mescal/Ivanpah Range would increase the habitat value in the area. There are no existing guzzlers or developed water sources in this area. The new Ginn water source may support the establishment of a new population in this area, would increase habitat connectivity on the Preserve and the surrounding areas, and would increase the potential for habitat connectivity across I-15 to the north.

Woods/Hackberry Mountains

A new water source at Vontrigger Spring would result in an increase in habitat value in the Woods/Hackberry Mountains. There are no existing guzzlers or developed water sources in this area. The new Vontrigger water source may support the expansion, health, and viability of the area’s existing bighorn population; increase habitat connectivity on the Preserve and the surrounding areas; and increase the potential for habitat connectivity across I-40 to the south.

Piute/Castle Mountains

The removal of the Piute guzzler would result in a decrease in dry season habitat value in the area. The Piute guzzler is the only existing developed water source in the area; however, the Piute Springs are nearby undeveloped water sources that support dry season habitat for bighorn. While the NPS expects that most sheep would successfully shift to Piute Springs, some short-term adverse impacts on sheep would be expected during the transition. Deactivation of the Piute guzzler would take place following the process described in *Chapter 2: Alternatives*, and may require monitoring of bighorn through deployment of GPS collars and additional studies, as well as site-specific compliance. There are currently no collared bighorn in the area. If monitoring indicates long-term adverse impacts on sheep and the overall population, or if nearly all bighorn sheep do not discover and use the spring and creek, the Piute guzzler would be reinstated to mitigate any significant impact.

New Water Sources

As discussed above, the two new potential water sources at Vontrigger Spring and Ginn Mine would increase the dry season habitat value in the Woods/Hackberry Mountains and Mescal/Ivanpah Range, respectively, and in the Preserve overall. These new water sources would contribute 29 percent to the overall value of the Preserve’s dry season habitat (see Figure 20) and would have a greater impact on dry season habitat value in the areas where they are located. The increases in the area’s habitat value would help support regional migration corridors within the Preserve and with other populations to the north and south. In addition, these new non-wilderness water sources could promote the expansion of existing populations in the Woods/Hackberry Mountains and the establishment of a new population in the Mescal/Ivanpah Range. Over the long term, these actions are expected to benefit desert bighorn sheep by expanding populations and improving interpopulation movement and regional metapopulation stability. The timing and magnitude of these benefits are uncertain, but could contribute to long-term bighorn conservation.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions that are considered cumulatively with the effects of Alternative 2 include human disturbance and development and changes to land management plans and actions, particularly the creation of the adjacent Castle Mountains National Monument. Human disturbance and development would continue to have long-term adverse impacts on bighorn sheep by reducing habitat and habitat connectivity in the Mojave

Desert region. Regional impacts on habitat connectivity and migration would be both adversely and beneficially impacted by Alternative 2.

The 10 percent decrease in dry season habitat value would not significantly alter the level of impact from regional human disturbance or Preserve projects and plans, compared with existing conditions. While the dry season habitat value within the Preserve and in the Old Dad/Kelso Mountain, Piute/Castle Mountain, and Clark Mountain areas may result in more pronounced local negative contributions to overall regional impacts, the increase in dry season habitat value from the new water sources at Ginn Mine and Vontrigger Spring would contribute to improved regional habitat connectivity, and to the habitat value in within the Woods/Hackberry Mountains and the Mescal/Ivanpah Range.

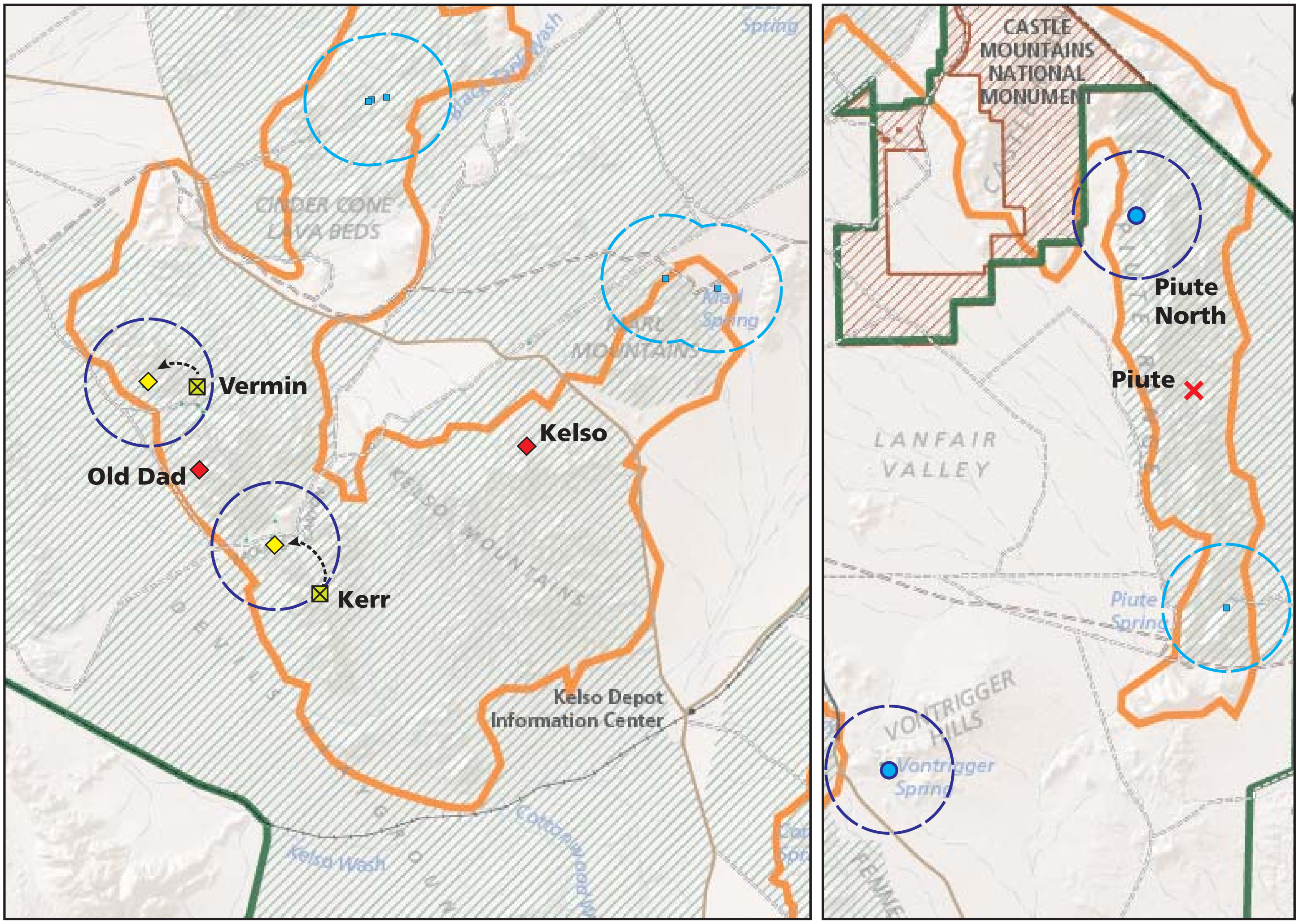
Conclusion

Full implementation of Alternative 2 would result in an overall 10 percent reduction in available dry season habitat across the Preserve. While the Old Dad/Kelso Mountains and Piute/Castle Mountains would experience decreases in dry season habitat value, the long-term improvement of dry season habitat value in the Mescal/Ivanpah Range and Woods/Hackberry Mountains could benefit bighorn populations by improving regional movement and metapopulation stability. The decrease in dry season habitat value would largely be the result of the removal of the Old Dad guzzler and the Piute guzzler. The Clark guzzler is not heavily used by bighorn and would not substantially contribute to the cumulative effects. As a result of implementation and monitoring, the increases in habitat value within the Mescal/Ivanpah Range and Woods/Hackberry Mountains areas, and strategic placement of new water sources, the reduction in dry season habitat would not result in significant adverse effects on bighorn sheep. Overall, no significant adverse cumulative effects are anticipated under Alternative 2.

The NPS expects that the relocation, deactivation, and removal of existing guzzlers could result in short-term adverse effects on some bighorn individuals, including stress, mortality, and reduced lambing rates. Each action would be planned and implemented to avoid the risk of severe impacts on populations. Short-term adverse effects would be balanced and offset by the long-term benefits that would result from relocated guzzlers. The relocation, deactivation, or removal of any guzzler would be subject to site-specific design, implementation, and monitoring, and would be subject to additional compliance under NEPA and NPS guidance (see *Chapter 2: Alternatives*).

Alternative 3 (Preferred Alternative)

Alternative 3 would be similar to Alternative 2 except that the Old Dad guzzler would not be removed, and an additional new water source, the Piute North guzzler, would be implemented in the Piute/Castle Mountains. At full implementation, Alternative 3 would include the removal of the Clark and Piute guzzlers and the relocation of the Kerr and Vermin guzzlers to outside of wilderness (Figure 23). The Old Dad and Kelso guzzlers would remain in place. Three new potential guzzlers (Ginn, Vontrigger, and Piute North) would be considered outside of wilderness for native wildlife habitat connectivity, including bighorn sheep. Each of these actions would occur in a deliberate and stepwise fashion, supported by monitoring and evaluation, to ensure that the intended changes in water availability are achieved without resulting in unacceptable impacts on bighorn populations, as outlined above in *Chapter 2: Alternatives* and Figure 3 and Figure 4. To achieve the desired outcomes of ensuring stable wildlife populations, reducing water developments in wilderness, and improving regional habitat connectivity, Alternative 3 utilizes a blended strategic approach of removals, relocations, retained guzzlers, and new water sources.



◆ Retain guzzler
✕ Remove guzzler
⊠ Relocate guzzler
◇ Guzzler relocation site
● New water source location
▪ Springs used by bighorn

Mojave National Preserve boundary
Bighorn sheep habitat patches (Creech et al. 2014)
National Park Service wilderness
2,500m water source buffer

Preserve-Wide Dry Season Habitat Value

At full implementation of all big game guzzler actions, Alternative 3 would result in a 19 percent increase in dry season habitat value on the Preserve, compared with existing conditions (see Figure 21 and Table 18). The removal of Clark and Piute would decrease habitat value by 23 percent. The relocated New Vermin and New Kerr guzzlers would have slightly less habitat value than the existing Kerr and Vermin guzzlers, due to the continued value of the Old Dad guzzler within proximity to the relocated guzzlers.

The addition of the Piute North, Ginn, and Vontrigger guzzlers would increase habitat value by 47 percent. The increase in the overall dry season habitat value would result in a substantial beneficial overall effect on dry season habitat value on the Preserve, while a variation of effects would occur at smaller scales.

Old Dad/Kelso Mountains

The Old Dad/Kelso Mountain area would experience a decrease of 7 percent in dry season habitat value for the area when compared to the No Action Alternative. This decrease would come from the relocation of the Kerr (to New Kerr) and Vermin (to New Vermin) guzzlers, which would have slightly lower dry season habitat value compared to the existing guzzlers. The Kelso and Old Dad guzzlers would continue to support dry season habitat in their present locations.

As with Alternative 2, the discovery and use transition from Vermin and Kerr to the relocated New Vermin and New Kerr guzzlers may result in short-term stress to the population, including reduced reproductive success and mortality of some individuals that do not easily adapt to the new location. These changes, however, would be followed by the implementation sequence outlined in Figure 3 and Figure 4 and described in *Chapter 2: Alternatives*. The transition to the relocated water sources would take place over an extended period with monitoring of the existing and new guzzler sites to evaluate the discovery and use of the relocated water sources by bighorn. Therefore, while the relocation of two guzzlers would be expected to result in short-term adverse effects on some individuals, the NPS would not allow severe long-term consequences to the overall Old Dad/Kelso population. If monitoring indicated that long-term adverse conditions or trends in the population would occur, mitigation measures, including the reinstatement of existing guzzlers, would be used to avoid significant and adverse long-term effects.

Clark Mountains

The effects on the Clark Mountains would be identical to Alternative 2. The Clark guzzler is not heavily used by bighorn, and additional monitoring of the Clark guzzler would take place before it is deactivated and removed to ensure that bighorn use of the guzzler is rare and adverse impacts would not result. The removal of the Clark guzzler would follow the implementation sequence described in Figure 3 and outlined in *Chapter 2: Alternatives*, and would be subject to site-specific compliance under NEPA and NPS guidance.

Mescal/Ivanpah Range

The effects on the Mescal/Ivanpah Range would be identical to Alternative 2. The addition of a water source at Ginn Mine in the Mescal/Ivanpah Range would increase the habitat value in the area. There are no existing guzzlers or developed water sources in this area. The new Ginn water source may support the establishment of a new population in this area, would increase habitat connectivity on the Preserve and the surrounding areas, and would increase the potential for habitat connectivity across I-15 to the north.

Piute/Castle Mountains

The addition of the Piute North guzzler would increase the habitat value in the Piute/Castle Mountains area by about 7 percent, compared to the habitat value in the area under the No Action Alternative. The loss of habitat value from the removal of the exiting Piute guzzler would be offset by the installation of Piute North, resulting in an increase in dry season habitat value for the area.

As with Alternative 2, the removal of the Piute guzzler would result in a decrease in dry season habitat value in the area. The existing Piute guzzler is the only developed water source in the area; however, the Piute Springs are nearby undeveloped water sources that support dry season habitat for bighorn. The Piute North guzzler would be installed before the Piute guzzler was deactivated and removed, providing an additional water source for bighorn in the area. While the NPS expects that most sheep would successfully shift to Piute Springs and Piute North, some short-term adverse impacts on sheep would be expected during the transition.

Deactivation of the Piute guzzler would take place following the process described in *Chapter 2: Alternatives*, and may require monitoring of bighorn through deployment of GPS collars and additional studies, as well as site-specific compliance. There are currently no collared bighorn in the area. If monitoring indicates long-term adverse impacts on sheep and the overall population, or if nearly all bighorn sheep do not discover and use the spring and creek, the Piute guzzler would be reinstated to mitigate any significant impact.

New Water Sources

As discussed above, the development of three new potential water sources at Vontrigger Spring, Piute North, and Ginn Mine would increase the Preserve's dry season habitat value by 47 percent and could help support regional migration corridors within the Preserve and to other populations to the north and south. In addition, these new non-wilderness water sources could promote the expansion of existing populations in the Piute/Castle Mountains and Woods/Hackberry Mountains, and the establishment of a new population in the Mescal/Ivanpah Range. The Piute North guzzler would offset the loss of habitat value from the deactivation and removal of the existing Piute guzzler. Over the long term, these actions are expected to benefit desert bighorn sheep by expanding populations and improving interpopulation movement and regional metapopulation stability. The timing and magnitude of these benefits are uncertain, but they could contribute to long-term bighorn conservation.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions that are considered cumulatively with the effects of Alternative 3 include human disturbance and development and changes to land management plans and actions, particularly the creation of the adjacent Castle Mountains National Monument. Human disturbance and development would continue to have long-term adverse impacts on bighorn sheep by reducing habitat and habitat connectivity in the Mojave Desert region. Those regional impacts would be reduced by efforts in Alternative 3 to improve regional migration corridors and connectivity.

The 19 percent increase in dry season habitat value under Alternative 3 may benefit regional habitat conditions, potentially offsetting some of the impacts from regional human disturbance or Preserve projects and plans, compared with existing conditions. The decreases in dry season habitat value within the Old Dad/Kelso and Clark areas are not likely to result in substantial contributions to the regional trends. The decrease in habitat value in the Old Dad/Kelso area would be slight, and the Clark guzzler is not heavily used by bighorn. Increases in habitat value in the Piute/Castle, Mescal/Ivanpah, and Woods/Hackberry areas may result in local beneficial contributions to overall regional impacts. The increase in dry season habitat value from the new water sources at Piute North, Ginn Mine, and Vontrigger Spring would contribute to improved regional habitat connectivity, as well as to the habitat value in the Woods/Hackberry Mountains and the Mescal/Ivanpah Range.

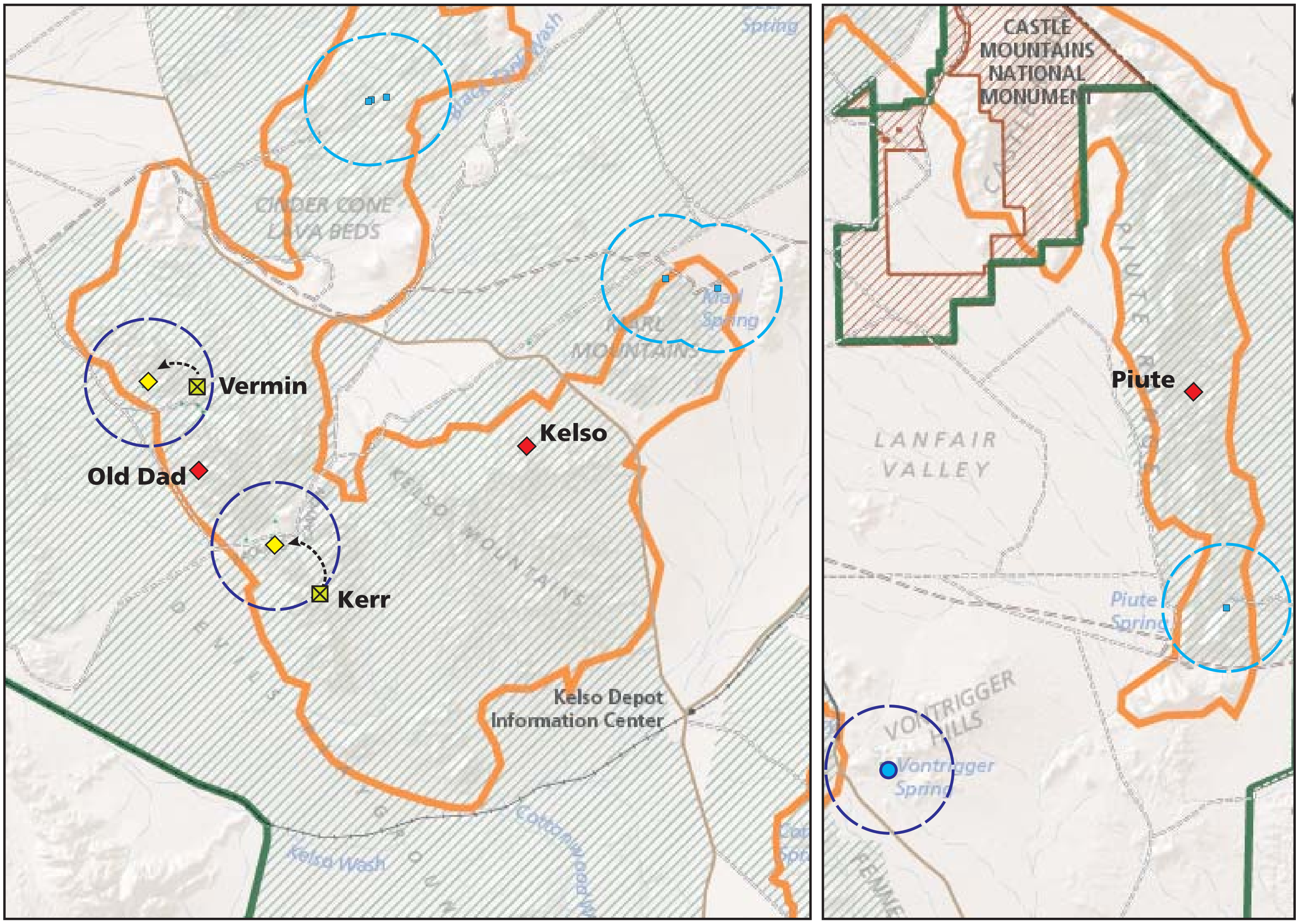
Conclusion

Full implementation of Alternative 3 would result in a 19 percent increase in dry season habitat value across the Preserve. While the Old Dad/Kelso Mountains would experience a slight decrease in dry season habitat value, the long-term improvement of dry season habitat value in the Piute/Castle Mountains, Mescal/Ivanpah Range, and Woods/Hackberry Mountains could benefit bighorn populations by improving regional movement and metapopulation stability. The Clark guzzler is not heavily used by bighorn and would not substantially contribute to the cumulative effects. This expansion in dry season habitat, combined with the implementation and monitoring protocol, would benefit bighorn sheep in the Preserve. As a result of the increases in the Preserve’s overall habitat value through strategic placement of new water sources, Alterative 3 would result in significant beneficial effects on bighorn sheep in the Preserve. The increase in dry season habitat and connectivity in Alternative 3 would potentially offset some of the cumulative effects of regional habitat loss, though the overall cumulative benefit on regional populations would be limited.

The NPS expects that the relocation, deactivation, and removal of existing guzzlers could result in short-term adverse effects on some bighorn individuals, including stress, mortality, and reduced lambing rates. Each action would be planned and implemented to avoid the risk of severe impacts on populations. Short-term adverse effects would be balanced and offset by the long-term benefits that would result from relocated guzzlers. The relocation, deactivation, or removal of any guzzler would be subject to site-specific design, implementation, and monitoring, and would be subject to additional compliance under NEPA and NPS guidance (see *Chapter 2: Alternatives*).

Alternative 4

Alternative 4 would be similar to Alternative 3 except that the Piute guzzler would not be removed, and the Piute North guzzler would not be implemented. At full implementation, Alternative 4 would include the removal of the Clark guzzler and the relocation of the Kerr and Vermin guzzlers to locations outside of wilderness (Figure 24). The Kelso and Old Dad guzzlers would remain in place. Two new potential guzzlers (Ginn and Vontrigger) would be considered outside of wilderness for native wildlife habitat connectivity, including bighorn sheep. Each of these actions would occur in a deliberate and stepwise fashion, supported by monitoring and evaluation, to ensure that the intended changes in water availability are achieved without resulting in unacceptable impacts on bighorn populations, as outlined above in *Chapter 2: Alternatives* and in Figure 3. To achieve the desired outcome of augmenting existing habitat in the Preserve and maintaining or developing connections between the Preserve and surrounding habitat in the larger landscape, Alternative 4 focuses on the strategic relocation and maintenance of existing guzzlers, and establishment of new guzzlers to support bighorn populations.



◆ Retain guzzler
✕ Remove guzzler
☒ Relocate guzzler
◇ Guzzler relocation site
● New water source location
▪ Springs used by bighorn

Mojave National Preserve boundary
Bighorn sheep habitat patches (Creech et al. 2014)
National Park Service wilderness
2,500m water source buffer

Preserve-Wide Dry Season Habitat Value

At full implementation of all big game guzzler actions, Alternative 4 would result in an 18 percent increase in dry season habitat value, compared to existing conditions (see Figure 21 and Table 18). The removal of the Clark guzzler would decrease in habitat value by 5 percent, while the relocation of Vermin (to New Vermin) and Kerr (to New Kerr) would decrease habitat value by 5 percent. The addition of the Ginn and Vontrigger guzzlers would increase habitat value by 29 percent. The increase in the overall dry season habitat value would result in a substantial beneficial overall effect on dry season habitat value on the Preserve, while a variation of effects would occur at smaller scales.

Old Dad/Kelso Mountains

The effects on the Old Dad/Kelso Mountain area would be identical to Alternative 3, with a slight decrease of 7 percent in dry season habitat value for the area when compared to the No Action Alternative. This decrease would come from the relocation of the Kerr (to New Kerr) and Vermin (to New Vermin) guzzlers, which would have slightly lower dry season habitat value compared to the existing guzzlers. The Kelso and Old Dad guzzlers would continue to support dry season habitat in their present locations.

As with Alternative 3, the discovery and use transition from Vermin and Kerr to the relocated New Vermin and New Kerr guzzler sites may result in short-term stress to the population, including reduced reproductive success and mortality of some individuals that do not easily adapt to the new locations. These changes, however, would be followed by the implementation sequence outlined in Figure 3 and Figure 4 and described in *Chapter 2: Alternatives*. The transition to the relocated water sources would take place over an extended period with monitoring of the existing and new guzzler sites to evaluate the discovery and use of the relocated water sources by bighorn. Therefore, while the relocation of two guzzlers would be expected to result in short-term adverse effects on some individuals, the NPS would not allow severe long-term consequences to the overall Old Dad/Kelso population. If monitoring indicates that long-term adverse conditions or trends in the population would occur, mitigation measures, including the reinstatement of existing guzzlers, would be used to avoid significant and adverse long-term effects.

Clark Mountains

The effects on the Clark Mountains would be identical to Alternatives 2 and 3. The Clark guzzler is not heavily used by bighorn, and additional monitoring of the Clark guzzler would take place before it is deactivated and removed to ensure that bighorn use of the guzzler is rare and adverse impacts would not result. The removal of the Clark guzzler would follow the implementation sequence described in Figure 3 and outlined in *Chapter 2: Alternatives*, and would be subject to site-specific compliance under NEPA and NPS guidance.

Mescal/Ivanpah Range

The effects on the Mescal/Ivanpah Range would be identical to Alternatives 2 and 3. The addition of a water source at Ginn Mine in the Mescal/Ivanpah Range would increase the habitat value in the area. There are no existing guzzlers or developed water sources in this area. The new Ginn water source may support the establishment of a new population in this area, would increase habitat connectivity on the Preserve and the surrounding areas, and would increase the potential for habitat connectivity across I-15 to the north.

Woods/Hackberry Mountains

The effects on the Woods/Hackberry Mountains would be identical to Alternatives 2 and 3. A new water source at Vontrigger Spring would result in an increase in habitat value in the Woods/Hackberry Mountains. There are no existing guzzlers or developed water sources in this area. The new Vontrigger water source may support the expansion, health, and viability of the area’s existing bighorn population; increase habitat connectivity on the Preserve and the surrounding areas; and increase the potential for habitat connectivity across I-40 to the south.

Piute/Castle Mountains

There would be no change to dry season habitat value in the Piute/Castle Mountains. The Piute guzzler is the only existing developed water source in the area and would remain in its present location and be maintained as needed. The Piute Springs are nearby undeveloped water sources that also support dry season habitat for bighorn.

New Water Sources

The effects of the new water sources would be identical to Alternative 2. The two potential new water sources at Vontrigger Spring and Ginn Mine would increase the dry season habitat value in the Woods/Hackberry Mountains and Mescal/Ivanpah Range, respectively, and in the Preserve overall. These new water sources would contribute 29 percent to the overall value of the Preserve’s dry season habitat (see Figure 21) and would have a greater impact on dry season habitat value in the areas where they are located. The increases in the areas’ habitat values would help support regional migration corridors within the Preserve and with other populations to the north and south. In addition, these new non-wilderness water sources could promote the expansion of existing populations in the Woods/Hackberry Mountains and the establishment of a new population in the Mescal/Ivanpah Range. Over the long term, these actions are expected to benefit desert bighorn sheep by expanding populations and improving interpopulation movement and regional metapopulation stability. The timing and magnitude of these benefits are uncertain, but they could contribute to long-term bighorn conservation.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions that should be considered cumulatively with the effects of Alternative 4 include ongoing human disturbance and development in the region, creation of the adjacent Castle Mountains National Monument, and implementation of Preserve projects and plans. Human disturbance and development would continue to have long-term adverse impacts on bighorn sheep by reducing habitat and habitat connectivity in the Mojave Desert region. Those regional impacts would be reduced by efforts in Alternative 4 to improve regional migration corridors and connectivity.

The 18 percent increase in the Preserve’s dry season habitat value under Alternative 4 may benefit regional habitat conditions, potentially offsetting some of the impacts from regional human disturbance or Preserve projects and plans, compared with existing conditions. The decreases in dry season habitat value within the Old Dad/Kelso and Clark areas are not likely to result in substantial contributions to the regional trends. Increases in habitat value in the Piute/Castle, Mescal/Ivanpah, and Woods/Hackberry areas may result in local beneficial contributions to overall regional impacts. The increase in dry season habitat value from the new water sources at Ginn Mine and Vontrigger Spring would contribute to improved regional habitat connectivity, as well as to the habitat value in the Woods/Hackberry Mountains and the Mescal/Ivanpah Range.

Conclusion

Full implementation of Alternative 4 would result in an 18 percent increase in dry season habitat value across the Preserve. The Old Dad/Kelso Mountains would experience a slight decrease in dry season habitat value, and the Piute/Castle Mountains would experience no change to dry season habitat value. The long-term improvement of dry season habitat value in the Mescal/Ivanpah Range and Woods/Hackberry Mountains could benefit bighorn populations by improving regional movement and metapopulation stability. The Clark guzzler is not heavily used by bighorn and would not substantially contribute to the cumulative effects. This expansion in dry season habitat, combined with the implementation and monitoring protocol, would benefit bighorn sheep in the Preserve. As a result of the increases in the Preserve's overall habitat value through strategic placement of new water sources, Alterative 4 would result in significant beneficial effects on bighorn sheep. The increase in dry season habitat and connectivity in Alternative 4 would potentially offset some of the cumulative effects of regional habitat loss, though the overall cumulative benefit on regional populations would be limited.

The NPS expects that the relocation, deactivation, and removal of existing guzzlers could result in short-term adverse effects on some bighorn individuals, including stress, mortality, and reduced lambing rates. Each action would be planned and implemented to avoid the risk of severe impacts on populations. Short-term adverse effects would be balanced and offset by the long-term benefits that would result from relocated guzzlers. The relocation, deactivation, or removal of any guzzler would be subject to site-specific design, implementation, and monitoring, and would be subject to additional compliance under NEPA and NPS guidance (see *Chapter 2: Alternatives*).

Wildlife – General

This section describes how the proposed plan alternatives would affect general wildlife species (excluding desert bighorn sheep) in the Preserve. This analysis is focused on native and introduced species that commonly occur in the various habitat types in the Preserve including more than 300 bird, 49 mammal, 38 reptile and amphibian, and 1 native fish species. Special status species, including federally or state-listed threatened and endangered species, are also discussed in this analysis. Desert bighorn sheep are analyzed separately above.

Methods and Assumptions

This analysis discusses the potential effects of proposed changes to water resource management on both general and special status wildlife species. For general wildlife, the primary focus of the analysis is the continued availability of surface water sources and how changes to surface water availability may affect both native and introduced species. Potential changes to water resource management that may affect wildlife include the removal, relocation, or maintenance of big game or small game guzzlers, the maintenance and management of select springs and water developments, and the continued neglect of water features.

The evaluation of potential effects of changes to surface water availability to wildlife is based on assumptions about the reliance of wildlife species on developed or artificial water sources. The specific context of wildlife in the Preserve is described below. Based on the understanding of the reliance of general wildlife species on artificial water sources, the following assumptions were used in this analysis:

- The presence of artificial water sources, such as guzzlers and developed springs, may support stopover habitat for migratory birds and localized habitat for small mammals, herpetofauna, and mule deer.

- Changes to or loss of individual water sources could negatively affect individual animals or groups in localized areas, but are less likely to affect regional population stability or species diversity; this is true for both terrestrial wildlife and migratory birds.
- Changes to or loss of individual guzzlers or water sources could negatively affect individual and localized groups of game birds (e.g., quail), while others would be less affected.
- Changes to or loss of small groups of water sources in the Preserve are expected to have limited effects on regional wildlife populations considering the above points and the presence of about 450 known water sources.
- All of the plan alternatives, including No Action, include continued loss and deterioration of many guzzlers and springs due to long-term neglect. This condition, and its effects, would largely continue under the plan alternatives and would be exacerbated under Alternatives 2 and 3.
- Any impacts on general wildlife that do occur would be indirect, due to alteration of habitat or water availability, and would occur over the long term—no proposed actions would directly impact or take individual animals.
- Maintenance or improvement of developed springs would benefit local wildlife, but those benefits would be proportionally small and localized and would not affect regional population stability or species diversity.

Small game guzzlers would be evaluated for their ecological importance through monitoring and evaluation. The impacts from implementation of non-wilderness small game guzzler actions on resident, migratory, and game birds would include reducing water levels of and blocking access to randomly selected guzzlers, observing the age ratios of Gambel's quail at guzzlers, tracking the locations of GPS-fitted quail in relation to the location of water sources, and conducting point counts of avian species at random locations within 3.2 kilometers of guzzlers during the month of April. Age ratios would help the NPS understand if neglecting small game guzzlers impacts the mortality and survival of Gambel's quail. Location data would help the NPS understand habitat selection in relation to water sources. Recorded call count surveys would help the NPS understand the importance of water sources for the diversity of bird species in the Preserve. Based on the results of the monitoring for ecological importance of 10 to 25 guzzlers (dependent on the alternative), individual guzzlers would be maintained, improved, removed, or neglected (see "Implementation of Alternatives by Water Feature Type" in *Chapter 2: Alternatives*).

Context

The evaluation of potential effects of changes to surface water availability on wildlife is based on assumptions about the reliance of wildlife species on developed or artificial water sources. The general effects that wildlife may experience from the removal of developed water features is discussed in depth in *Chapter 3: Affected Environment* in the "Other Wildlife Species" section and outlined in Table 20. A brief review of potential impacts on general wildlife species groups is discussed below.

Table 20. Effects from Removal of Developed Water Features by Species Group

Species Group	Use Guzzlers?	Use Springs?	Notes
Herpetofauna, small mammals, and carnivores	Yes	Yes	Local impacts on affected sites
Migratory and resident birds	Migratory – No Resident – Yes	Yes	Migratory bird local impacts on riparian habitat and raptors Open water appears to be preferred by resident bird species
Game birds	Yes	Yes	Greater impact on dove species
Bats	No	Yes	Localized—spring sites with open troughs or pools
Ungulates	No*	Yes	Mule deer use springs/free-standing water; *Clark guzzler used by mule deer

Cumulative Impacts Common to All Alternatives

The past, present, and reasonably foreseeable actions that may result in cumulative impacts on wildlife within the Preserve are listed in Table 17 and are discussed in “Regional Context” in *Chapter 3: Affected Environment*. The activities that have affected and would continue to affect general wildlife are human development and disturbance, which include existing and proposed infrastructure, solar energy development, and military, industrial, agricultural, and mining projects; land management plans and actions; and Preserve projects and plans, which include designation of national monuments, resource management plans, and Preserve-sponsored projects.

Human Development and Disturbance

The existing and proposed human development in the region are the same as discussed above in the “Wildlife – Bighorn Sheep” section. Industrial-scale solar projects in particular have resulted in desert tortoise mortality and habitat loss, and tortoise relocation is often a mitigation requirement for these projects. Human-wildlife conflict may increase as a result of development, and individuals from various species may be deterred from migration corridors by human presence. These activities taken together have resulted in long-term adverse impacts on birds, mammals, herpetofauna, and mule deer in both the Preserve and the Mojave Desert region.

Land Management Plans and Actions

The designation of the Mojave Trails, Sand to Snow, and Castle Mountain National Monuments establishes areas within the Mojave Desert region and close to the Preserve where general wildlife habitat would be left undeveloped, thus providing corridors wildlife migration, habitat for displaced wildlife from human disturbance, and refugia for species impacted by climate change. Castle Mountain, located adjacent to the east side of the Preserve, would provide general wildlife habitat connectivity among the New York, Castle, and Piute mountain ranges, as well as to the Lanfair Valley. Several water features are located in the eastern portion of the Preserve. The Mojave Trails National Monument would provide potential habitat connectivity among the mountain ranges to the south and west of the Preserve. The Sand to Snow National Monument, located southwest of the Preserve, would likely have a less notable impact on wildlife habitat connectivity due to its distance from the Preserve.

Impacts of the Alternatives

Common and Distinguishing Features among All Alternatives

Special Status Wildlife Species

As stated in the “Special Status Wildlife Species” section of *Chapter 3: Affected Environment*, two federally listed species are confirmed year-round residents of the Preserve: Mohave tui chub (endangered) and desert tortoise (threatened). The management approach for water resources as they pertain to these species is the same for all alternatives, including No Action.

The Mohave tui chub would be managed at several sites in the Preserve, including MC Spring and Lake Tuendae at Soda Springs and the Morningstar Mine Pit Lake. Under all alternatives, management would be a continuation of current practices and is expected to result in long-term benefits to the species by supporting its conservation.

Small game guzzlers have been considered in the past to be a threat to desert tortoises, which have potential to become trapped and drown in them (Hoover 1995). While some research disputes the threat guzzlers may pose to tortoises (see Rosenstock et al. 2004), it has become common practice to install escape ramps in small game guzzlers to minimize the potential for entrapment. All proposed alternatives, including No Action, include the installation of escape ramps in all retained small game guzzlers that occur in designated desert tortoise habitat to reduce this potential threat.

Discussion of Effect by General Wildlife Species Group

Effects on these somewhat ubiquitous species are difficult to predict under any of the alternatives because the relationship of these species to water sources is not well understood and because the change from current management would be minor. It is assumed, based on existing conditions and management practices, that many constructed water features, primarily in wilderness, would fall into disrepair over time, eventually reaching a point where they would no longer produce water that is accessible to wildlife. It is not known when or where various neglected water structures would reach this failure point, but it is reasonable to assume that it would occur in different locations over a long period and that failure would occur to some fraction of the guzzlers (and developed springs) that are neglected.

In terms of comparing the effects of the alternatives, there are only minor differences between the action alternatives and No Action. The action alternatives assume that all water features would be neglected in wilderness, most small game guzzlers in the front country would function within the 20-year period of this analysis, and developed springs would be managed in the front country on an ad hoc basis, based on ecological selection factors. Only minor distinctions differentiate the alternatives in terms of the number of water features that would be removed, relocated, evaluated, or maintained. Table 21 summarizes the expectations for small game guzzlers that would be likely to function through the lifespan of this plan.

Table 21. Summary of Small Game Guzzler Actions by Alternative

Existing Status of Guzzlers	
Total Small Game Guzzlers	131
Wilderness	60
Non-wilderness	71
Non-wilderness: Rebuilt 2006–2013	64
Non-wilderness: Subject to Rebuild	Up to 8 (2 are near roads; 6 are not vehicle accessible)

Existing Status of Guzzlers				
NPS Actions	No Action	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Neglect – Wilderness	60	60	60	60
Neglect – Non-wilderness	0	8	6	0
Non-wilderness: Rebuild (+)	Up to 8	Up to 2	Up to 2	Up to 8
Non-wilderness: Remove (-)	0	Up to 16	Up to 16	Up to 8
Maximum Change from NPS Actions	+8	-16	-14	0
Total Functional Non-wilderness Guzzlers at Full Implementation	72	40	42	64

Herpetofauna, Small Mammals, and Carnivores

Terrestrial wildlife species are known to use developed water sources for drinking, cover, forage, and predation; therefore, these sites function as congregation sites for a variety of wildlife species. Many species will drink free-standing water when available, even if they are adapted to obtain their moisture from forage or prey. Smaller animals may use the water structure itself as cover or use vegetation supported by the water source as cover. Predators are attracted to water sources both for drinking and to take advantage of the higher density of prey. As a result, the gradual long-term loss of some of these water sources from neglect—which would occur at less than half of these water sources under all alternatives—would result in a site-specific impact in terms of reduced wildlife presence at these sites. Each alternative also includes a subset of water sources that would be maintained; these water sources would be expected to remain congregation sites for a variety of wildlife species.

While many species use these water sources, they are not believed to depend on them for hydration or other uses. As a result, there is little basis to conclude that neglecting (or in rare cases, removing) guzzlers or modified springs would have a substantial effect on terrestrial wildlife at the population level. Nonetheless, the question of population-level effects cannot be answered conclusively based on the existing research.

Migratory and Resident Birds

Developed springs that support riparian vegetation are used by migratory bird species as stopovers during migration. Migratory birds are not associated with small game guzzlers or developed springs that lack this riparian vegetation. Over time, in the absence of maintenance, some developed springs would deteriorate to a point where water flows sufficient to support riparian vegetation would fail. These sites would then cease to function as stopover locations for migratory birds. While this would impact site-specific migratory bird presence, it is not clear if migratory birds would be affected more broadly. All alternatives involve the potential that some developed springs with riparian vegetation would be maintained; these would continue to function as stopover sites.

Resident bird behavior more closely resembles that of small mammals and herpetofauna, although the most heavily used sites are developed springs with riparian vegetation and open water; guzzlers are less commonly used. All alternatives could affect resident bird presence at sites that fail to produce surface water due to long-term neglect. Broader effects at the population level are not well understood. Where sites are in good condition, higher densities of resident birds are anticipated.

Game Birds

Game birds, such as Gambel's quail and chukar, primarily rely on succulent vegetation for their hydration requirements. The abundance of this vegetation is a function of winter precipitation as opposed to dry season surface water, but these species are nonetheless known to use and congregate near small game guzzlers and springs, particularly during dry periods. It appears that free-standing water may be important for these species during droughts when vegetation is scarce. Other species, such as mourning and white-winged doves, require some limited surface water throughout the year.

Under all action alternatives, many small game guzzlers and springs would continue to be neglected, as they are now, and would deteriorate over time, leading to failure of some fraction of them over the life of this plan. As with migratory and resident birds, this pattern of neglect, primarily in wilderness, would have an adverse effect on game bird presence at sites that fail to produce surface water. The effects on game bird populations beyond the site-specific scale are more speculative, but adverse effects are possible as time passes and functional supplemental water sources become less common at the scale of the Preserve. Where non-wilderness sites are rebuilt, there would be corresponding benefits to game bird presence at those sites. (However, only a small fraction of guzzlers—up to, but likely fewer than eight—are likely to be rebuilt under any alternative.) Impacts on species that require surface water may be greater than for species adapted to hydrate from vegetation. In the latter case, the impact of reduced availability of surface water may take the form of increased drought risk.

Bats

Bats are known to use water developments with open tanks and troughs. It is unknown whether bats use guzzlers with enclosed tanks or springs that lack open pools. The latter represents a subset of the various types of developed springs in the Preserve. The impacts of the alternatives on bats would be similar to those described for birds: site-specific impacts would occur under all alternatives due to neglect of spring sites that are used by bats. Those impacts would be similar under all alternatives, including No Action, and would occur over time as individual spring sites deteriorate and fail to produce water. These site-specific and periodic impacts on springs are not anticipated to affect regional bat populations.

Ungulates

Like desert bighorn sheep, ungulate species (primarily mule deer and nonnative burro) appear to depend on free-standing water during hot summer months. Since the impact of failing springs would occur in disparate locations over a very long period, the long-term impact of those changes on mobile species like mule deer and burro populations is speculative. However, it is possible that the loss of springs due to long-term neglect could have negative impacts on ungulate populations. At the Clark guzzler site, which would be removed under all action alternatives, mule deer presence would decline. Maintenance of select springs would benefit ungulates in the area of the maintained spring, but the consequences to populations over longer periods are less clear. In any case, the long-term effects of the action alternatives would be similar to those of No Action.

Cumulative Impacts to Wildlife

The cumulative impacts from past, present, and reasonably foreseeable future actions that are caused by human disturbance in the region and by implementation of Preserve projects and plans would be the same for all alternatives and are discussed above in the "Cumulative Impacts Common to All Alternatives" section and outlined in Table 17.

Conclusion

The effects on special status species and general wildlife species under the No Action Alternative and the action alternatives are anticipated to be very similar, of limited scale, and of low magnitude. The primary impact would be reduced wildlife presence at sites that cease to produce surface water or riparian vegetation. However, many other managed sites that have these properties of surface water, cover, and vegetation would still be available in the Preserve. While significant impacts do not appear likely, population-scale effects are uncertain.

Cultural Resources

This analysis identifies how the proposed plan alternatives would affect historic water features associated with managed springs and small game guzzlers in the Preserve. Big game guzzlers are not considered historic and are not discussed in this section. Most of the managed springs are located in designated historic ranching districts or cultural landscapes in the Preserve, including the Rock Springs Land and Cattle Company Cultural Landscape (NPS 2007a), the 7IL Ranch Cultural Landscape (Livingston 2005), and those springs documented under an ethnographic report prepared for the BLM (Bengston Consulting 2010).

Methods and Assumptions

The analysis of potential impacts on historic springs and small game guzzlers assumes that each meets the NPS's 50-year age criterion for a potential historic property and is furthermore potentially eligible for listing on the NRHP, either individually or as a contributing element of a National Register District or Cultural Landscape. Since very few of these water features have been evaluated for NRHP significance, they are all treated as unevaluated and therefore are potentially eligible for listing on the NRHP. In order for the NPS to meet its Section 106 obligations and resolve anticipated adverse effects on historic properties, the NPS intends to enter into consultation with the SHPO, American Indian tribes, and other potentially interested parties.

This analysis assumes that NPS consultation with the SHPO would result in stipulations for continued Section 106 compliance regardless of the selected alternative. The SHPO would stipulate procedures for the documentation and significance evaluation of water features currently unevaluated for listing on the NRHP and the identification, documentation, and evaluation of other potential historic properties, including known and unknown prehistoric archeological sites that have been preliminarily identified at natural springs.

Most of water development features within managed springs have not been formally documented and evaluated for NRHP significance. For purposes of this plan, all unevaluated water development features that meet the NPS 50-year age criterion are considered potential historic properties. The NPS understands that all managed springs and some of the small game guzzlers meet the age criterion. This analysis assumes that, before implementation of activities that have the potential to affect historic properties—whether through neglect, removal, or disabling—all affected potential historic properties will be documented, evaluated for NRHP significance, and assessed for effects in consultation between the NPS and SHPO.

For this analysis, any activity that results in the alteration, removal, or deterioration of potentially eligible water features is considered an adverse effect. This includes the ongoing neglect and deterioration of water features. Activities that maintain, improve, or stabilize potentially eligible water features are considered beneficial effects, provided that those activities are undertaken in a manner that preserves or replaces in kind elements of the water features (e.g., design and materials) that contribute to the significance of those features and does not diminish character-defining elements.

Cumulative Impacts Common to All Alternatives

Cumulative impacts on cultural resources were determined by combining the No Action Alternative with other past, present, and reasonably foreseeable future actions as described in Table 17. Actions that could affect cultural resources are human development and disturbance, which include solar energy development and military, industrial, agricultural, and mining projects; and Preserve projects and plans, which include designation of national monuments, resource management plans, and Preserve-sponsored projects. These activities are described above and in *Chapter 3: Affected Environment*.

None of the alternatives would significantly alter the level of impact on cultural resources or result in long-term adverse cumulative effects on cultural resources when combined with the other development projects throughout the Mojave Desert region. Under all alternatives, including No Action, cultural resources would be evaluated for eligibility under NHPA Section 106 and in accordance with NPS policy and SHPO guidance to avoid, mitigate, and reduce adverse impacts on cultural resources.

The cumulative impacts from past, present, and reasonably foreseeable future actions that are caused by human disturbance in the region, and by implementation of Preserve projects and plans, are the same for all alternatives and are discussed above in the "Cumulative Impacts Common to All Alternatives" section and outlined in Table 17.

Impacts of the Alternatives

Alternative 1 – No Action

Under the No Action Alternative, current management practices, including the management of water features, would continue on a case-by-case basis. Proposed projects that would affect water features would be reviewed by the NPS as individual undertakings with the potential to affect historic properties as defined under Section 106 of the NHPA (36 CFR 800.3). The NPS would review the undertaking for potential effects on water features, consult with the SHPO regarding project effects on potential historic properties, and implement measures to resolve anticipated adverse effects.

Small Game Guzzlers

Ad hoc maintenance of small game guzzlers outside of wilderness would continue under the No Action Alternative. Small game guzzlers would continue to be maintained, as needed, by the NPS and authorized volunteers. No new guzzlers would be constructed. The small game guzzlers in wilderness would be left to naturally deteriorate, resulting in a long-term adverse effect on those features, as it would ultimately result in the loss of potentially eligible features.

Springs and Water Developments

Under the No Action Alternative, management or maintenance of springs and related water features would be limited to infrequent efforts as needed to prevent resource damage and to protect visitor safety. Most springs and water developments would be neglected and would be allowed to continue to deteriorate over time, resulting in long-term adverse effects on those features.

Cumulative Impacts

The No Action Alternative would be a continuation of current management practices and would not result in a significant alteration of the level of impact from any of the activities identified above (see "Cumulative Impacts Common to All Alternatives").

Conclusion

The No Action Alternative, which represents a continuation of existing conditions, would result in long-term adverse effects on small game guzzlers and developed water features left to naturally deteriorate in wilderness because potentially eligible features would not be preserved. Ad hoc maintenance of guzzlers and select springs outside of wilderness would result in benefits to the few sites that are maintained. Maintenance activities would preserve but not alter characteristics of guzzlers or water features that potentially contribute to their historic significance.

Alternative 2

Under Alternative 2, water development features would be managed to reduce human interference within a desert ecosystem. The overall number of water features in the Preserve would be reduced through natural deterioration and neglect and through the select disabling of noncritical water features; repair and maintenance of remaining water features would be undertaken on an as-needed basis to support native wildlife populations.

Small Game Guzzlers

In Alternative 2, all small game guzzlers in wilderness would be neglected and left to naturally deteriorate over time, actively disabled or removed. This would result in an adverse effect on those features, similar to the No Action Alternative. Select non-wilderness guzzlers would be maintained to support native wildlife populations, and up to two may be rebuilt. The neglect, disabling, or removal of small game guzzlers in wilderness would result in the loss of those features and long-term adverse effects on potential historic properties, while the rebuilds outside of wilderness would result in benefits to potential historic properties, as potentially eligible features would be preserved.

Springs and Water Developments

Under Alternative 2, up to about 10 water development features at managed springs would be considered for maintenance and stabilization to help support native wildlife populations. Stabilized or maintained water development features would result in beneficial effects on historic properties from long-term preservation. Stabilization or maintenance activities would be undertaken in a manner that preserves or replaces in kind those characteristics or elements that contribute to significance, including design and materials. The remaining water development features would continue to deteriorate over time, resulting in long-term adverse effects on historic properties from the ultimate loss of those potentially eligible features.

Cumulative Impacts

The impacts of Alternative 2 on cultural resources would alter the level of long-term adverse cumulative effects, although not significantly (see “Cumulative Impacts Common to All Alternatives” above).

Conclusion

The actions under Alternative 2 would result in long-term adverse effects on water development features in the Preserve from neglect, natural deterioration, or active disabling. Adverse effects on historic properties would be resolved under consultations between the NPS and SHPO. The neglect and removal of cultural resources under Alternative 2 would alter the level of adverse cumulative impacts, although not significantly.

Alternative 3 (Preferred Alternative)

Under Alternative 3, water development features would be managed to support native wildlife conservation through maintenance and stabilization.

Small Game Guzzlers

Under Alternative 3, management of small game guzzlers in wilderness would be the same as under Alternative 2—all guzzlers would be neglected, some would be actively disabled or removed. Select non-wilderness guzzlers would be maintained to support native wildlife populations, and up to two may be rebuilt. The neglect, disabling, or removal of small game guzzlers in wilderness would result in the loss of those features and long-term adverse effects on potential historic properties, while the rebuilds would result in benefits to potential historic properties, as potentially eligible features would be preserved.

Springs and Water Developments

Under Alternative 3, management of springs and water development would be the same as under Alternative 2—up to about 10 water development features at managed springs would be considered for maintenance and stabilization to help support native wildlife populations. Stabilized or maintained water development features would result in beneficial effects on historic properties from long-term preservation. Stabilization or maintenance activities would be undertaken in a manner that preserves or replaces in kind those characteristics or elements that contribute to significance, including design and materials. The remaining water development features would continue to deteriorate over time, resulting in long-term adverse effects on historic properties from the ultimate loss of those potentially eligible features.

Cumulative Impacts

The impacts of Alternative 3 on cultural resources would alter the level of long-term adverse cumulative effects, although not significantly (see “Cumulative Impacts Common to All Alternatives” above).

Conclusion

Under Alternative 3, the maintenance and stabilization of about 17 developed water features and select small game guzzlers would benefit those historic properties. The continued neglect and deterioration of remaining water features would result in adverse effects on historic properties from the loss of those features. These effects would be similar to Alternative 2 and would be resolved through consultations between the NPS and SHPO.

Alternative 4

Under Alternative 4, water development features would be managed to expand native wildlife habitat.

Small Game Guzzlers

Management of small game guzzlers in wilderness in Alternative 4 would be the same as Alternatives 2 and 3—all would be neglected, while some would be actively disabled or removed. Non-wilderness guzzlers would be maintained to support native wildlife populations. The removal and neglect of small game guzzlers in wilderness would result in long-term adverse effects on potential historic properties from the ultimate loss of those features. Active maintenance of guzzlers outside wilderness, and the potential rebuilds of up to eight guzzlers, would result in beneficial effects on potential historic properties, as potentially eligible features would be preserved.

Springs and Water Developments

Under Alternative 4, up to about 15 water development features at managed springs would be maintained and restored to support wildlife habitat. Maintained water development features would result in beneficial effects on historic properties from long-term preservation. Restoration activities would be undertaken in a manner that preserves or replaces in kind those characteristics or elements that contribute to their significance, including design and materials. The remaining water development features would continue to deteriorate over time, resulting in long-term adverse effects on historic properties from the ultimate loss of those potentially eligible features.

Cumulative Impacts

The impacts of Alternative 4 on cultural resources would alter the level of long-term adverse cumulative effects, although not significantly (see “Cumulative Impacts Common to All Alternatives” above).

Conclusion

Similar to Alternative 3, the maintenance and stabilization of several developed water features and select small game guzzlers in Alternative 4 would benefit historic properties, while the continued neglect and deterioration of other water features would result in adverse effects from the loss of potentially eligible features. As described for Alternatives 2 and 3, these effects would be resolved through consultations between the NPS and SHPO.

Wilderness Character

This analysis identifies how the proposed plan alternatives would affect wilderness character in the Preserve. As described in *Chapter 3: Affected Environment*, the 1994 CDPA designated nearly half of the Preserve (804,949 acres) as wilderness. Many of the water features addressed in this plan are located in wilderness, including all of the big game guzzlers, most of the small game guzzlers (60 percent), and most of the springs (70 percent).

Methods and Assumptions

This analysis describes the potential effects of the proposed alternatives on the five qualities of wilderness character that are to be protected under the Wilderness Act. Since the NPS has not completed a wilderness character baseline or stewardship plan for the Preserve, the wilderness qualities as they pertain to water resources are described in *Chapter 3: Affected Environment* and are summarized as follows:

- *Untrammeled* – Water developments, including developed springs and guzzlers, negatively affect the untrammeled quality of wilderness. These effects stem from the presence of the water developments themselves, in addition to the influence of water features on the management of wildlife.
- *Natural* – Native wildlife conservation activities, including the management of guzzlers or other water developments, support the natural quality of wilderness. These beneficial effects are the result of the contribution of water developments to wildlife conservation, particularly desert bighorn sheep.

- *Undeveloped* – The presence of guzzlers and water developments, and motorized access to maintain those developments, negatively affects the undeveloped quality of wilderness. The effects are limited to the immediate footprint of the water developments.
- *Opportunity for Solitude or Primitive and Unconfined Recreation* – Water features in wilderness do not affect this quality.
- *Other Features and Values* – No other features or values related to water resources have been identified.

For analysis purposes, each water feature (e.g., guzzler or developed spring) is assumed to have an impact footprint of about 0.1 acre. This includes the developed features themselves, along with associated ground disturbance surrounding the feature. The area in which water features are immediately visible to visitors is assumed to be about 4 acres.

Minimum Requirement Analysis

Section 4(c) of the Wilderness Act prohibits certain activities in designated wilderness, including motor vehicles, motorized equipment, landing of aircraft, other forms of mechanical transport, and structures or installations, except as necessary to meet minimum requirements for the administration of the area for the purposes of the act. The National Park Service conducts a Minimum Requirement Analysis (MRA) to determine if a proposed 4(c) prohibited use is necessary.

For the proposal contemplated in this plan, the NPS will complete an MRA that addresses the necessity to retain one or more big game guzzlers in designated wilderness, as these guzzlers qualify as structures or installations under the meaning of the Wilderness Act (a draft MRA is provided in Appendix A). The plan also acknowledges that in the past, maintenance of these structures has involved the use of motor vehicles, motorized equipment, and landing of aircraft, and it is possible that a future maintenance need will necessitate one of these prohibited uses. However, it is not possible to address the question of necessity for a prohibited use in the absence of information about specific maintenance needs, and it is assumed that a variety of maintenance needs could be resolved without resort to a 4(c) prohibited use. For these cases, future maintenance projects would be addressed with appropriate site-specific NEPA compliance and, if a 4(c) prohibited use is contemplated, with a site-specific MRA. The proposal contemplated also examines a number of other structures in wilderness that predate designation. In many cases, the proposed course of action is to neglect these structures and take no action to use or maintain them. Neglect of existing structures in wilderness would not be addressed in an MRA.

Cumulative Impacts Common to All Alternatives

The past, present, and reasonably foreseeable actions that may result in cumulative impacts on wilderness character within the Preserve are listed in Table 17 and are discussed in the "Regional Context" section of *Chapter 3: Affected Environment*. The activities that have affected and would continue to affect wilderness character are human development and disturbance, which include existing and proposed infrastructure, solar energy development, and military, industrial, agricultural, and mining projects; land management plans and actions; and Preserve projects and plans, which include designation of national monuments, resource management plans, and Preserve-sponsored projects.

The cumulative impacts from past, present, and reasonably foreseeable future actions that are caused by human disturbance in the region and by the implementation of Preserve projects and plans are the same for all action alternatives and are outlined in Table 17. All action alternatives would beneficially, although not significantly, alter cumulative impacts on the local wilderness character in that guzzlers located within wilderness would be neglected, removed, or relocated outside of wilderness.

Human Disturbance and Development

Cumulative impacts from human development and disturbance in the Mojave Desert region may result in visual and noise impacts within the Preserve. The existing solar energy developments and mining projects are visible from areas within the Preserve, including the Clark, New York, and Piute Mountains. Noise from existing and proposed highways and railways may be audible within the Preserve, as well as noise from construction and use of existing and proposed infrastructure. The proposed Ivanpah Regional Airport would likely result in an increase in airplane traffic over the Preserve, while existing and proposed transmission lines may impact the viewshed from wilderness areas within the Preserve.

Land Management Plans and Actions

The designation of the Mojave Trails, Sand to Snow, and Castle Mountain National Monuments would have a long-term beneficial impact on the wilderness character within the Mojave Desert region. Under these designations, areas of the Mojave Desert close to the Preserve would be protected as wilderness or as national monuments and therefore would be excluded from development.

Impacts of the Alternatives

Alternative 1 – No Action

Under the No Action Alternative, current management practices, including the management of water features, would continue on a case-by-case basis. Projects involving water resources in wilderness would be reviewed in a MRA and would be allowed to proceed only if it is determined that the minimum level of activity and disruption of wilderness qualities would be used.

Big Game Guzzlers

Under the No Action Alternative, access to and maintenance of big game guzzlers would continue. The presence of guzzlers at six sites in wilderness would adversely affect the untrammeled and undeveloped qualities of wilderness in their immediate location and from nearby areas where they are visible. The impact on undeveloped qualities would be limited to the footprint of the guzzlers (up to about 0.6 acre) and the areas of wilderness in which they are potentially visible to wilderness visitors (up to about 24 acres), as well as the access routes used to maintain the guzzlers. By either measure, the magnitude of effect is small (24 acres, or 0.00086 percent) when compared with the size of the total wilderness area (804,949 acres). In addition, these water developments in wilderness are generally inaccessible to visitors.

The presence of the guzzlers and their importance to the support and conservation of desert bighorn sheep populations would have conflicting effects on wilderness qualities. Because the guzzlers are important to the survival and persistence of some existing herds and therefore influence their behavior and distribution, they could be considered an adverse effect on the untrammeled quality of wilderness in the Preserve. Conversely, the importance of the guzzlers for the conservation of sheep populations may also be considered a benefit to the natural quality of wilderness.

The adverse effect would be substantial in the immediate area of the guzzlers, but would be small on a Preserve-wide scale. Big game guzzlers have a relatively small footprint within the Preserve’s vastly larger wilderness landscape. The continued ability to conserve and sustain desert bighorn sheep populations that depend on guzzlers, as well as other native wildlife species that use these guzzlers, would benefit the natural quality of wilderness. This direct benefit to natural qualities would be relatively large as it pertains to desert bighorn sheep populations, but would be inconsequential for other wildlife and natural qualities.

Small Game Guzzlers

Under the No Action Alternative, approximately 60 existing small game guzzlers would remain in wilderness but would not be managed or maintained. Their presence would have ongoing adverse impacts on the undeveloped quality of wilderness, but those effects would be limited to about six total acres or about 0.1 acre each, which is equivalent to about 0.00086 percent of the designated wilderness in the Preserve. Their presence, as long as they function without maintenance, would also have the potential to affect a variety of smaller wildlife species. This can be viewed as an adverse effect in terms of the untrammeled quality, by influencing animal behavior, or as a beneficial effect in terms of the natural quality, by improving hydration, but the effects are speculative.

Springs and Water Developments

Management or maintenance of springs or other water developments in wilderness would be limited to infrequent efforts (as needed) to prevent resource damage or protect visitor safety. These activities would not affect the wilderness character (undeveloped, untrammeled, and natural) in the Preserve.

Wells

Wells that are not needed would be destroyed according to state regulations, both within and outside of wilderness. This would have a slight beneficial impact on the untrammeled wilderness character of the area.

Cumulative Impacts

Under the No Action Alternative, guzzlers and developed water features located within wilderness would continue to be maintained on an ad hoc basis using a MRA. The impacts on wilderness character under the No Action Alternative would not affect the regional long-term benefits of other management designations and Preserve projects and plans (see “Cumulative Impacts Common to All Alternatives” above).

Conclusion

The No Action Alternative would result in the continuation of current water resource management and the associated impacts on the untrammeled and undeveloped qualities of wilderness resulting from the presence of and access to up to 6 big game and about 60 small game guzzlers. These impacts would be detectable in the immediate vicinity of the guzzlers, but would represent a very small portion of the total wilderness area. The big game guzzlers would continue to benefit the natural quality of wilderness character, while the limited management of springs and water developments in this alternative would not affect wilderness qualities. Overall, the No Action Alternative would result in adverse effects on wilderness character in the Preserve due to the continued management of guzzlers within wilderness.

Alternative 2

Under Alternative 2, water resources would be managed to minimize intrusion into wilderness while supporting native wildlife populations.

Big Game Guzzlers

At full implementation, five of the six big game guzzlers would be removed or relocated from wilderness. This would benefit the untrammeled and undeveloped qualities of wilderness, in the vicinity of the five guzzlers, by removing the guzzlers (with a total footprint of about 0.5 acre) and eliminating the need for motorized access for maintenance. As described above in the "Wildlife – Desert Bighorn Sheep" section, the reduction in dry season habitat value for desert bighorn sheep (-10 percent) would have a negative impact on the natural quality of wilderness in the Preserve, since the support for bighorn habitat that is provided by the guzzlers is considered to benefit the natural quality of native wildlife.

Small Game Guzzlers

Under Alternative 2, most small game guzzlers in wilderness would be neglected, while some would be actively removed, and a few outside of wilderness would be maintained based on wildlife use. The continued neglect of most guzzlers would result in no change to wilderness qualities when compared with the No Action Alternative. The active removal of select small game guzzlers would benefit the untrammeled and undeveloped qualities in localized areas by reducing the presence and visibility of these structures in wilderness. The natural qualities of wilderness, including the value to habitat for native wildlife, could be adversely affected by the neglect and removal of guzzlers, but those effects would be of a limited scale and at a low magnitude.

Springs and Water Developments

Under Alternative 2, several springs in wilderness would be considered for ongoing maintenance and management of water delivery structures to support wildlife habitat. A MRA would be conducted before implementation to ensure that any methods or treatments used would minimize potential adverse impacts on wilderness qualities.

Wells

The actions and effects would be the same as under the No Action Alternative.

Cumulative Impacts

Alternative 2 would beneficially, although not significantly, alter cumulative impacts on the local wilderness character in that guzzlers located within wilderness would be neglected, removed, or relocated outside of wilderness (see "Cumulative Impacts Common to All Alternatives" and Table 17).

Conclusion

The removal of five big game guzzlers and select small game guzzlers from wilderness would contribute to the untrammeled and undeveloped wilderness qualities in the Preserve. These benefits would be considerable in the immediate vicinity of guzzler sites (covering about 0.5 acre of wilderness), but would still be inconsequential at a Preserve-wide scale. The natural qualities associated with bighorn conservation would be negatively affected due to a reduction in available dry season habitat. The continued neglect of springs and water developments in wilderness would not affect wilderness character in the Preserve. Overall, implementation of Alternative 2 would have beneficial effects on the undeveloped and untrammeled aspects of wilderness character in the Preserve from the reduction of human development in wilderness, but at a consequence to the natural character provided by wildlife habitat.

Alternative 3 (Preferred Alternative)

Under Alternative 3, water resources would be managed to support native species populations while reducing the number of water developments within wilderness.

Big Game Guzzlers

At full implementation, four big game guzzlers would be removed or relocated from wilderness, and two would be retained in place. The removal or relocation of four guzzlers would substantially benefit the untrammeled and undeveloped qualities of wilderness in the vicinity of those sites (affecting up to about 0.4 acre). The continued presence and maintenance of the Old Dad and Kelso guzzlers would adversely affect untrammeled and undeveloped qualities of wilderness in the Preserve. However, the impact would be limited to the footprint of the guzzlers (about 0.2 acre) and the areas of wilderness in which they are visible (up to about 8 acres). Additionally, the adverse effect on untrammeled qualities would likely be offset by the beneficial effects on the natural quality of wilderness that would result from continued bighorn sheep conservation.

Small Game Guzzlers

Under Alternative 3, management of small game guzzlers in wilderness would be the same as Alternative 2—all small game guzzlers would be neglected, while some would be actively disabled or removed. Likewise, the effects on wilderness qualities would be the same as described for Alternative 2: no change resulting from neglect and localized benefits from limited disabling or removal.

Springs and Water Developments

Under Alternative 3, management of springs and water developments in wilderness would be the same as Alternative 2—the several springs in wilderness would be considered for ongoing maintenance and management of water delivery structures to support wildlife habitat. A MRA would be conducted before implementation to ensure that any methods or treatments used would minimize potential adverse impacts on wilderness qualities.

Wells

The actions and effects would be the same as under the No Action Alternative.

Cumulative Impacts

Alternative 3 would beneficially, although not significantly, alter cumulative impacts on the local wilderness character in that guzzlers located within wilderness would be neglected, removed, or relocated outside of wilderness (see “Cumulative Impacts Common to All Alternatives” and Table 17).

Conclusion

The removal or relocation outside wilderness of four big game guzzlers would benefit the untrammeled and undeveloped qualities of wilderness in the Preserve, with considerable benefits in the immediate vicinity of affected guzzler sites. The benefits of select removal of small game guzzlers from wilderness would be the same as for Alternative 2. The potential maintenance of springs and water developments to support wildlife could result in small adverse impacts on wilderness qualities at those sites, but those impacts would be minimized through a MRA. Implementation of Alternative 3 would have minimal adverse effects on the untrammeled wilderness qualities in the Preserve from benefits of big game guzzler removal. There would also be a slight adverse local effect on the untrammeled quality from spring maintenance.

Alternative 4

Under Alternative 4, water resources would be managed to augment native wildlife habitat and connectivity.

Big Game Guzzlers

Under Alternative 4, three big game guzzlers would be removed or relocated from wilderness, while the remaining three would be retained in place. This would benefit the untrammeled and undeveloped qualities of wilderness in the vicinity of the removed and relocated guzzlers, while the adverse impacts on those qualities would persist in the vicinity of the other three sites (up to about 0.3 acre of wilderness). The adverse effect on untrammeled qualities would likely be offset by the beneficial effects on the natural quality of wilderness that would result from continued bighorn sheep conservation.

Small Game Guzzlers

Under Alternative 4, management of small game guzzlers in wilderness would be the same as Alternatives 2 and 3—all small game guzzlers would be neglected, while some would be actively disabled or removed. Likewise, the effects on wilderness qualities would be the same as described for Alternative 2: no change resulting from neglect and localized benefits from limited disabling or removal.

Springs and Water Developments

Under Alternative 4, 5 to 7 springs in wilderness per year would be considered for maintenance and management to support wildlife habitat. In each case, a MRA would be conducted to ensure that any methods or treatments used would minimize potential impacts on wilderness qualities. While the number of sites that would be considered for maintenance is almost double the number in Alternative 3, the impact on wilderness qualities would remain small due to the dispersed nature of the sites and the fact that the sites are already disturbed, and the MRA process would minimize additional impacts resulting from maintenance activities.

Wells

The actions and effects would be the same as under the No Action Alternative.

Cumulative Impacts

Alternative 4 would beneficially, although not significantly, alter cumulative impacts on the local wilderness character in that guzzlers located within wilderness would be neglected, removed, or relocated outside of wilderness (see “Cumulative Impacts Common to All Alternatives” and Table 17).

Alternative 4 would adversely, but not significantly, alter the level of impact from human disturbance on the wilderness character in that three big game guzzlers and all small game guzzlers located within wilderness would be removed, relocated, or neglected, potentially leading native wildlife populations to shift outside of wilderness areas in the Preserve. However, the remaining three guzzlers and most of the other water developments within wilderness would remain in place for native wildlife to use, thus supporting the natural characteristic of wilderness.

Conclusion

The removal and relocation of three big game guzzlers outside wilderness would benefit wilderness character. The ongoing neglect of small game guzzlers in wilderness would not affect wilderness character in the Preserve, while the maintenance of up to 15 springs and water developments to improve wildlife habitat may result in localized small adverse impacts on the untrammeled and undeveloped qualities of wilderness. Overall, implementation of Alternative 4 would result in localized small adverse effects on wilderness character due to the continued presence and maintenance of developed water structures. However, Alternative 4 would also result in localized benefits on the natural qualities of wilderness in the Preserve from the continued presence of water developments to support native wildlife populations.

Table 22. Summary of Water Resource Management Alternatives Environmental Consequences

Resource	No Action (Existing Conditions)	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Wildlife – Desert Bighorn Sheep	• No effects • No strategy for long-term management	• Guzzler removal, relocation, and new guzzler implementation would result in a potential 10% decrease in the Preserve's dry season habitat value • Decreased habitat value would occur in the Old Dad/Kelso Mountains and Piute/Castle Mountains. A slight decrease would occur in the Clark Mountains • Increased habitat value in the Mescal/Ivanpah Range and Woods/Hackberry Mountains • Two new water sources would increase dry season habitat value, support migration corridors, and support the expansion and establishment of populations • Guzzler removal/relocation would result in short-term adverse effects on individual sheep • Implementation sequencing to reduce adverse effects, site-specific planning, and monitoring would guard against significant adverse impacts (see Figure 3). • Overall, potential for long-term adverse effects on bighorn sheep is low, due to careful implementation, monitoring, and increased habitat connectivity	• Guzzler removal, relocation, and new guzzler implementation would result in a potential 19% increase in the Preserve's dry season habitat value • Slight decrease in habitat value would result in the Old Dad/Kelso Mountains and Clark Mountains • Increased habitat value in the Piute/Castle Mountains, Mescal/Ivanpah Range, and Woods/Hackberry Mountains • Three new water sources would increase dry season habitat value, support migration corridors, and support the expansion and establishment of populations • Guzzler removal/relocation would result in short-term adverse effects on individual sheep • Implementation sequencing to reduce adverse effects, site-specific planning, and monitoring would guard against significant adverse impacts (see Figure 3). • Overall, some short-term adverse impacts on sheep with the potential for long-term benefits	• Guzzler removal, relocation, and new guzzler implementation would result in a potential 18% increase in the Preserve's dry season habitat value • Slight decrease in habitat value would result in the Old Dad/Kelso Mountains and Clark Mountains • No change to habitat value in the Piute/Castle Mountains • Increased habitat value in the Mescal/Ivanpah Range and Woods/Hackberry Mountains • Two new water sources would increase dry season habitat value, support migration corridors, and support the expansion and establishment of populations • Guzzler removal/relocation would result in short-term adverse effects on individual sheep • Implementation sequencing to reduce adverse effects, site-specific planning, and monitoring would guard against significant adverse impacts (see Figure 3). • Overall, some short-term adverse impacts on sheep with the potential for long-term benefits

Resource	No Action (Existing Conditions)	Alternative 2	Alternative 3 (Preferred Alternative)	Alternative 4
Wildlife –General	• Benefits to Mohave tui chub and desert tortoise • Localized benefit from ad hoc maintenance • Localized and low-magnitude impacts from long-term deterioration of water sources • Uncertain wildlife population effects	*Common to All Action Alternatives:* • Benefits to Mohave tui chub and desert tortoise • Localized and small impacts from long-term deterioration of water sources and limited removal of water sources • Localized and small benefits from limited maintenance of non-wilderness water sources • Uncertain wildlife population effects		
Cultural Resources	• Adverse effects on features that are left to deteriorate • Benefits from ad hoc maintenance of historic water features • No comprehensive strategy or compliance approach for treatment of historic water features	*Common to All Action Alternatives:* • Adverse long-term effects from neglect, deterioration, and disabling of other historic water features • Benefits to non-wilderness water features that are maintained and stabilized • Effects would be resolved through a consultation with the State Historic Preservation Office (SHPO)		
Wilderness Character	• Adverse impacts on untrammeled and undeveloped qualities due to the presence of developed guzzlers in wilderness • Benefits to natural qualities from the conservation value of guzzlers to desert bighorn sheep • Overall, small adverse effect on wilderness character	• Benefits to untrammeled and undeveloped qualities from the removal of five big game guzzlers from wilderness • No impacts on natural qualities associated with bighorn conservation • Some adverse impacts associated with spring maintenance in wilderness • Overall benefit to wilderness from the reduction of active guzzler development and maintenance in wilderness	• Benefits to untrammeled and undeveloped qualities from the removal of four big game guzzlers from wilderness • No impacts on natural qualities associated with bighorn conservation • Some adverse impacts associated with spring maintenance in wilderness • Overall benefit to wilderness from the reduction of active guzzler development and maintenance in wilderness	• Benefits to untrammeled and undeveloped qualities from the removal of three big game guzzlers from wilderness; but adverse effects from three guzzlers that would remain • Benefits to natural qualities associated with bighorn conservation • Overall, small adverse effects on wilderness character due to retention of big game guzzlers and maintenance of select springs in wilderness

CHAPTER 5: CONSULTATION AND COORDINATION

The intent of NEPA is to encourage the participation of federal and state involved agencies and affected citizens in the assessment procedure, as appropriate. This section describes the consultation that occurred during development of this plan, including consultation with scientific experts and other agencies. This chapter also includes a description of the public involvement process and a list of the recipients of the draft and final plan and EA.

History of Public Involvement

The public involvement activities for this plan and EA fulfill the requirements of NEPA and NPS DO-12 (NPS 2015).

The Scoping Process

The NPS divides the scoping process into two parts: internal scoping and external or public scoping. Internal scoping involved discussions among NPS personnel regarding the purpose of and need for management actions, issues, management alternatives, mitigation measures, the analysis boundary, appropriate level of documentation, available references and guidance, and other related topics.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process. The public scoping process helps ensure that people have an opportunity to comment and contribute early in the decision-making process. For this planning document and environmental impact statement, project information was distributed to individuals, agencies, and organizations early in the scoping process, and people were given opportunities to express concerns or views and identify important issues or even other alternatives.

Taken together, internal and public scoping are essential elements of the NEPA planning process. The following sections describe the various ways scoping was conducted for this plan.

Internal Scoping

An internal scoping meeting was held November 3 and 4, 2010, and included a full-day site visit and a full-day meeting. The purpose of the meeting was to identify the purpose, need, and objectives for the action; identify issues related to the action; determine the proper NEPA path; discuss a range of preliminary alternatives; and identify data needs. Representatives from the Preserve, the NPS Environmental Quality Division (EQD), the NPS Biological Resources Division (BRD), the NPS Water Resources Division (WRD), and ERO Resources Corporation (ERO; contractor) were in attendance. The results of the meetings were captured in detailed notes now on file as part of the administrative record.

Public Scoping

Public scoping efforts for this planning process focused on the means or processes to be used to include the public, the major interest groups, and local public entities. Based on past experience, park staff place a high priority on meeting the intent of public involvement in the NEPA process and giving the public an opportunity to comment on proposed actions.

Public Notification

The public scoping process began on May 11, 2011, with the publication of a Notice of Intent in the Federal Register (FR) (FR, Volume 76, Issue 27344). A 60-day public scoping comment period was announced and began on May 11, 2011; this date was extended an additional 30 days. Public scoping ended on August 12, 2011.

A newsletter was mailed in early May 2011 to the project's preliminary mailing list of government agencies, organizations, businesses, and individuals. The newsletter announced the public scoping meetings and provided background on the project. It also summarized the plan's objectives, purpose and need. The newsletter included information about the project and alternatives and invited the public to comment and attend the public scoping meetings. Public service announcements were provided to local television and radio news agencies and local newspapers, and an announcement was posted on the NPS Planning, Environment and Public Comment (PEPC) site to notify the public of these meetings.

The NPS hosted four public scoping meetings in the vicinity of the Preserve to present the preliminary alternative concepts and potential management tools and solicit feedback on a range of questions developed specifically on these topics. Public scoping meetings were held in 2011 on June 27 (Henderson, Nevada), June 28 (Needles, California), June 29 (San Bernardino, California), and June 30 (Barstow, California).

Public Meetings and Comments

Meetings were organized in an open-house format, allowing the public to browse informational posters, interact with park staff, and listen to a brief presentation at their own pace. Meetings were available to the public between 6:00 p.m. and 10:00 p.m. A series of full-color display boards was presented to help illustrate the project vicinity and background and an overview of water resources in the Preserve. These display boards also provided an overview of the NEPA process. Preserve staff, NPS staff, and contractors were located at the display boards to answer questions, facilitate discussions, and record thoughts, ideas, and concerns raised by the public.

During each open house, the NPS offered brief slideshow presentations defining the proposed timeline of the project; background of the Preserve; current wildlife and water resources management strategies; the purpose, need, and objectives of the plan and EA; and the preliminary range of alternatives. The public was offered a variety of opportunities to provide feedback or submit questions, including flip charts, comment forms (and drop box), and preaddressed comment forms for postal delivery. Participants were given information regarding accessing PEPC and were encouraged to submit their comments electronically using this system. The addresses for submitting comments were printed on all news releases and the project newsletter for the benefit of people who could not attend the open houses but still wanted to provide comments. During the scoping period, 67 pieces of correspondence were received.

Comments and input received during the public scoping period were compiled for review and evaluation by the planning team. This analysis process assisted the team in organizing, clarifying, and addressing technical information pursuant to NEPA regulations and identifying the topics and issues to be evaluated and considered throughout the planning process.

The process included seven steps:

1. Entering correspondence into the database that was not input directly into PEPC;
2. Reviewing all correspondence;
3. Developing a coding structure;
4. Identifying and coding comments pulled from correspondence;
5. Analyzing the comments to identify issues and themes;

6. Creating concern statements; and
7. Preparing the Public Scoping Analysis Report.

A coding structure was developed to help sort comments into logical groups by topic and issue. The coding structure was derived from an analysis of the range of comments received based on the “Questions to Consider” that were provided in the distributed newsletter and presented at the meetings. The coding structure was designed to capture all comments and content, rather than restrict or exclude any content.

Analysis of the public comments involved the assignment of codes to statements made by the public in their letters, email messages, and written comment forms. Codes were assigned in the PEPC database for each individual comment in a correspondence. All comments were read and analyzed including those of a technical nature; opinions, feelings, and preferences of one element or one potential alternative over another; and comments of a personal or philosophical nature. All comments were considered, whether they were presented by several people saying the same thing or by a single person expressing a unique viewpoint. After reviewing and categorizing all of the comments within each correspondence received during the public review process, 518 comments were identified and coded appropriately for scoping and 76 for the preliminary draft alternatives review.

The 518 comments received during the scoping period were organized into 51 codes. Of the 51 codes assigned, 7 were related to the alternatives, 29 were concerned with the issues the NPS should consider when evaluating the possible management actions for water resources, 10 were concerned with impact topics, and 5 were related to the NEPA and regulatory process. Of the 29 codes related to issues the NPS should consider, eight were directly related to water resources, seven were related to wildlife management, three were related to cultural resources, four were related to recreation and access, one was related to wilderness, two were related to Preserve management, and four were related to the regional context including land development, ecosystem function, and climate change. Of the 10 codes concerning impact topics, one was related to water resources, five were related to wildlife, one was related to cultural resources, and three were related to visitor use.

Administrative Draft Plan and NEPA Pathway Change

This project was initially scoped as an Environmental Impact Statement (EIS) due to uncertainty regarding the significance of impacts to desert bighorn sheep. In February 2017, an Administrative Draft Plan and EIS was submitted to NPS and CDFW reviewers. Comments on the Administrative Draft Plan/EIS resulted in a revised and updated analytical model of bighorn habitat and change to the action alternatives. Based on updates to the habitat model and action alternatives, as well as the application of an adaptive implementation sequence, the uncertainty regarding impacts to desert bighorn sheep is resolved.

Because there is no potential for significant adverse impacts, the NEPA pathway was changed from an EIS to an EA in late 2017. Preparing an EA rather than an EIS will allow for a more timely and efficient approach to the NEPA process that provides a streamlined path to a decision document and project implementation. This pathway change is consistent with agency efforts to streamline the NEPA process by employing the most efficient approach to NEPA review that is possible under current policy.

Agency Consultation

California Department of Fish and Wildlife

Consultation with the CDFW, a cooperating agency, has been ongoing throughout this planning process. In 2017, CDFW provided detailed comments and feedback on an internal review version of the plan and NEPA analysis, resulting in substantial changes and improvements to the alternatives and analysis.

California State Historic Preservation Officer

Consultation with the California SHPO also occurred in 2017, as the NPS determined the appropriate framework for compliance with Section 106 of the National Historic Preservation Act.

U.S. Fish and Wildlife Service

A biological assessment of this plan/EA has been provided to the U.S. Fish and Wildlife Service for review and comment.

Tribal Consultation

The NPS has initiated tribal consultation with the following tribes: Colorado River Indian Reservation, Fort Mojave Indian Tribe, Chemehuevi Indian Tribe, and Twentynine Palms Band of Mission Indians. Tribal consultation is ongoing and copies of this EA will be forwarded to the tribes for review or comment.

Technical Contributors

The following individuals with specific knowledge of the resources and issues addressed in this plan/EA provided technical feedback during the plan development process:

Table 23. Technical Contributors

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APPENDICES

Appendix A

Minimum Requirements Analysis

Draft Minimum Requirements Analysis for Mojave National Preserve Management Plan for Developed Water Sources

Background

Mojave National Preserve is preparing an Environmental Assessment in support of a Management Plan for Developed Water Sources in Mojave National Preserve. Among the issues being addressed in the plan is the disposition of six big game guzzlers, which are systems of catchments, tanks, and drinker boxes that were built and maintained to provide desert bighorn sheep with access to drinking water. While the guzzlers that are now present in Mojave National Preserve were constructed prior to wilderness designation in 1994, they have remained in use since then as part of the Preserve's bighorn sheep management efforts. The guzzlers have been repaired periodically, often by volunteers, to keep them operational. They have also been manually refilled on occasion when water levels became low during dry periods.

Whether to use some number of guzzlers to support bighorn sheep populations is one of the decisions to be made in the Developed Water Sources Plan. The Wilderness Act prohibits structures and installations in wilderness except as necessary to meet the minimum requirements for the administration of the area as wilderness. It also prohibits the use of motorized equipment unless necessary to meet the minimum requirements for the administration of wilderness. The National Park Service's Management Policies require the completion of a Minimum Requirements Analysis for any management decision that affects wilderness. (Management Policies 6.3.5) This Minimum Requirements Analysis has been prepared to assist NPS decision makers in determining whether continued use of guzzlers is necessary for administration of the area as wilderness, and if so, how to minimize impacts on wilderness character. "Use" in this context is understood as the decision to retain the structure or installation for a particular purpose, maintain the structure through both routine and urgent repairs, and actively monitor and operate the structure or installation, for example, by refilling empty tanks when necessary.[1]

Analytical Framework

The following questions have been developed to assess whether the use of some number of guzzlers to further bighorn sheep conservation is consistent with the Wilderness Act.:

1) Is the project's purpose, conservation of bighorn sheep, consistent with the Wilderness Act?

2) Are there other conservation strategies, alone or in combination, that could achieve bighorn sheep conservation objectives without the need to use guzzlers?

3) If using guzzlers is necessary, what number (or range) of guzzlers and what maintenance and operating activities are the minimum necessary to administer the area for the purpose of the Act?

4) How would use of guzzlers impact the recreational, scenic, scientific, educational, historical, and other public purposes of wilderness, including other conservation purposes? Are impacts to these other purposes outweighed by the need to conserve bighorn sheep?

[1] This contrasts with the case in which a structure or installation is present at the time of wilderness designation, but is not actively used or maintained for an administrative purpose, and therefore does not require a Minimum Requirements Analysis. As an example, Mojave National Preserve Wilderness contains a number of small game guzzlers, but these are neither maintained nor used for conservation purposes, and no Minimum Requirements Analysis has been developed.

5) Is using guzzlers consistent with the Wilderness Act requirement to preserve wilderness character and avoid impairment to the same?

Analysis

1) Is the project's purpose, conservation of bighorn sheep, consistent with the Wilderness Act?

The Wilderness Act directs agencies to administer wilderness areas to preserve their wilderness character and to devote wilderness areas to six identified public purposes, namely, recreational, scenic, scientific, educational, conservation, and historical use." One of the objectives of the Water Resources Management Plan is to "conserve desert bighorn sheep populations in a manner that complements regional sheep conservation goals and is consistent with wilderness values."

Desert bighorn sheep are an emblematic species in the Mojave Desert region. Conservation of this iconic species is a purpose rooted in law and policy regarding the Mojave National Preserve and is consistent with the administration of Mojave National Preserve wilderness under the Act.

The National Park Service Organic Act (1916) identifies wildlife conservation as a primary aspect of the NPS mission, stating that the "fundamental purpose" of national parks is "to conserve the scenery, natural and historic objects, and wild life [therein] and to provide for the enjoyment of the scenery, natural and historic objects, and wild life in such manner and by such means as will leave unimpaired for the enjoyment of future generation" 54 U.S.C. § 100101(a).

National Park Service Management Policies (2006) reinforce this mandate and provide specific direction regarding the conservation of native species. Section 4.4.1 General Principles for Managing Biological Resources states, "The National Park Service will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems." The Management Policies identify several approaches to achieving this purpose, namely by "preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur; restoring native plant and animal populations in parks when they have been extirpated by past human-caused actions; and minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them." The Water Resources Management Plan proposes to conserve desert bighorn sheep by preserving dry season habitat, which will help offset impacts from habitat fragmentation and climate change.

This minimum requirements analysis, and the impacts analysis in the EA, focuses on changes in sheep habitat, and specifically functional dry season habitat, as opposed to changes to sheep populations, for several reasons:

- **Biological Importance:** All wildlife population require habitat, and loss of habitat is a common threat to many species. Sheep are particularly vulnerable to habitat loss (Epps et al. 2005; Longshore et al. 2009; Creech et al. 2014). Also, for sheep, we know that water availability is a key habitat variable that affects lambing rates, which is crucial for herd persistence (Wehausen 2005).

- **Management Efficacy:** Water is a habitat component that is subject to direct management by the National Park Service. Other habitat elements, such as topography and forage, are not, and other population factors, such as disease, are similarly difficult to control or predict. Section 2), below, discusses the limitations of a variety of other management approaches.
- **Accessibility for Analysis:** Habitat analysis is far easier than analysis of changes to sheep populations, which are naturally variable, occur over long time periods, and are costly to measure. Using the analysis completed for the EA, the National Park Service can make strong predictions about the effects of changing water supply location on functional dry season habitat. In contrast, predictions about changes to sheep populations are confounded by many other variables that influence population dynamics, such as disease events, and are dependent on data that must be collected over impractically long time frames at great cost. These data generally involve sheep collaring and tracking, including aircraft use. The proposed approach is to use these types of methods on a more limited basis as a monitoring tool to observe sheep responses to new guzzler locations.

The California Desert Protection Act added public lands in the California desert to the National Park System and the National Wilderness Preservation System in order to "preserve unrivaled scenic, geologic, and wildlife values associated with these unique natural landscapes." Specifically, Mojave National Preserve was created to protect "the particular ecosystems and transitional desert type found in the Mojave Desert area" lying between Death Valley and Joshua Tree National Parks. Congress further directed that "the wilderness within the Mojave Desert should receive maximum statutory protection by designation pursuant to the Wilderness Act."

The Mojave National Preserve General Management Plan (2002) elaborates the Preserve's role in protecting resource values related to wildlife generally and desert bighorn sheep in particular, stating:

> Native populations of Nelson's bighorn sheep (Ovis canadensis nelsonii) are found in most of the mountainous terrain of the park, with population estimates as of 1994 at between 400 and 675 or more animals (Torres, S. G. et al. 1994). The population is listed as "fully protected" by the state, primarily due to the fragmentation of habitat throughout its range. It is not a federally listed species. Mojave National Preserve provides substantial protected habitat for desert bighorn sheep and is also one of the few places in California where bighorn sheep hunting is allowed.

The Foundation Document for Mojave National Preserve (2013) reinforces the importance of native wildlife and the need to preserve wildlife by addressing habitat fragmentation with measures to improve habitat connectivity.[2] In describing the resources that merited the Preserve's designation as a unit of the national park system and that are a focus of management action, the Foundation Document explains that, "Mojave National Preserve protects a large, relatively intact ecosystem of the eastern Mojave Desert from continuing threats associated with expanding development and provides connectivity between other protected natural areas within the larger Mojave Desert ecoregion." The Foundation Documents identifies the "full range of biological diversity of native species representative of the eastern Mojave Desert ecosystem, minimally disturbed by humans" as one of the Preserve's fundamental values and indicates

[2] A Foundation Document for a unit of the National Park System identifies the purposes for which the park area was established, the fundamental resources and values that it protects, and the significant features that make the park worthy of inclusion in the National Park System.

that protecting this “fundamental resource will help sustain a relatively intact desert ecosystem, maintain the connectivity of the preserve to the larger ecoregion, and uphold the intent of the enabling legislation (the California Desert Protection Act).” Threats to NPS’s ability to protect this fundamental value emanate from, “habitat fragmentation and edge effects from through-roads, renewable energy developments, and power lines have adverse effects on the biodiversity (e.g., blocked sheep movement, birds injured in flight, tortoise translocation) and cause direct habitat loss outside the preserve boundaries.”

As discussed above, Congress established the Preserve and designated large portions of it as wilderness in order to preserve “unrivaled … wildlife values” and the area’s unique and transitional ecosystem. Desert bighorn sheep are an iconic wildlife species in the Preserve, and the habitat that sustains them is an integral component of the Mojave Desert ecosystem. For these reasons, plans and policies that direct NPS management efforts for the Preserve identify bighorn sheep and their habitat as fundamental resources and values to be protected. Conservation efforts directed at bighorn and their habitat are therefore consistent with the purposes for which Congress established wilderness in Mojave National Preserve.

Desert bighorn sheep are also the subject of a draft California Department of Fish and Wildlife (CDFW) Conservation Plan (2012) that addresses the herds found in the preserve. Particular emphasis is placed on the importance of free surface water as a habitat component, and for the Old Dad/Kelso herd, the plan states that, in order to keep a stable population of desert bighorn sheep, “[m]anagement needs in this herd unit are limited to enhancing the reliability of existing water developments.” The special status of desert bighorn sheep is not straightforward. They are neither listed as threatened or endangered on federal or state lists, although a peninsular subpopulation, once considered a distinct species, is listed as federally endangered and state threatened. As mentioned in the Mojave GMP, the official status according to CDFW is “fully protected,” despite being legally hunted under state law. In addition, the United States Forest Service and Bureau of Land Management identify desert bighorn as a sensitive species in California, which is defined as a species that could easily become endangered or extinct in the state in the absence of special management.

2) Are there other conservation strategies, alone or in combination, that could achieve bighorn sheep conservation objectives without the need to use guzzlers?

This analysis examines whether there are means to achieve big horn sheep conservation without resorting to actions that are identified as a prohibited use in Section 4(c) of the Wilderness Act, namely, the use and maintenance of water provisioning structures in wilderness.

<u>Predator (mountain lion) control</u>

Predation by even a small number of mountain lions, where they have established this hunting behavior, can be a significant source of adult sheep mortality. This predation pattern is most common where bighorn sheep habitat overlaps with that of mule deer or other cervids, mountain lions’ main prey.

Predator control has also long been considered repugnant in national park units. For example, as early as 1963, in *Wildlife Management in the National Parks,* Aldo Leopold wrote about the destructive past practice of predator control, its contribution to unnatural conditions in parks, and the need for NPS to intensify predator conservation as opposed to control. National Park Service Management Policies (2006) generally rejects predator control as a management practice in Section 4.4.3, Harvest of Plants and Animals by the Public: “The Service does not engage in activities to reduce the numbers of native species for the purpose of increasing the numbers of harvested species (i.e., predator control), nor does the Service permit others to do so on lands managed by the National Park Service.” Mountain lions are a native species at Mojave Preserve, and desert bighorn sheep are both a harvested species and native species. In the view of NPS Management Policies, the appropriate approach in national park units is to manage prey species such that predation by other native species is sustainable. This is also consistent with the Wilderness Act duty to preserve the natural quality of wilderness character.

Section 4.4.2, Management of Native Plants and Animals, does contemplate certain circumstances in which the Service may intervene to manage a native species. Among the circumstances are when a “population occurs in an unnaturally high or low concentration as a result of human influences (such as loss of seasonal habitat, the extirpation of predators, the creation of highly productive habitat through agriculture or urban landscapes) and it is not possible to mitigate the effects of the human influences”. Desert bighorn sheep, at the regional scale, do exist in unnaturally low concentrations as a result of habitat fragmentation and a drier, hotter climate. Indeed, addressing this condition is a central purpose in providing ample free water during the dry season by using and maintaining guzzlers. Conceivably, the service could intervene by controlling predator conservation if this addressed the root cause of the native species’ unnaturally low concentration.

However, in Mojave Preserve, mountain lion predation is considered an important source of mortality *only* in the Granite Mountain area (in the far southern part of the Preserve). It is not considered an important source of mortality in the habitat areas where guzzlers currently exist or are being contemplated. Predator control would therefore not achieve the desired conservation objectives for the populations of bighorn sheep in designated wilderness where maintenance of water provisioning structures is proposed.

Controlling mountain lion predation therefore runs counter to the general direction of NPS policy regarding predator control, and if pursued as an exceptional case in which intervention is warranted for the sake of a native species occurring in unnaturally low concentrations, would fail to improve conservation of that species. It is not considered an effective alternative to dry season water provisioning.

<u>Reducing or eliminating translocations</u>

Translocations have occurred only once, when Mojave National Preserve allowed one translocation of 13 ewes to China Lake Naval Air Weapons Station in 2006. In the future, the preserve would consider proposals that would increase resiliency of the Mojave desert bighorn sheep metapopulation, provided that did not jeopardize the preserve’s source population, but these would at most be uncommon cases involving a small number of animals. Currently, no translocations are planned. Thus, reducing or eliminating translocation practices is unlikely to have a detectable effect on sheep populations over the life of this plan, and does not obviate the need for habitat conservation to maintain a stable population of bighorn sheep.

Reducing or eliminating hunting of bighorn sheep in the Preserve

The California Desert Protection Act directs the Secretary to permit hunting within the Preserve in accordance with applicable state and federal law. It further allows the Secretary, acting through the NPS, to limit the periods and locations where hunting can occur.

> The Secretary shall permit hunting, fishing, and trapping on lands and waters within the preserve designated by this Act in accordance with applicable Federal and State laws except that the Secretary may designate areas where, and establish periods when, no hunting, fishing, or trapping will be permitted for reasons of public safety, administration, or compliance with provisions of applicable law.

Because state law permits bighorn sheep hunting, the NPS does not have the authority to prohibit hunting of bighorns within the Preserve, although NPS could further regulate hunting in terms of location and season. However, NPS has not done so, and hunting, as currently practiced pursuant to state regulations is extremely limited in scope. Additional regulation of this limited activity is not considered to be warranted at this time.

Currently, state law allows the hunting of bighorns only in the Kelso Peak area and the Old Dad Mountains. The hunting season is short, usually two to three months during the winter, and a limited number of tags are available for mature rams only. In some years, such as the 2017-2018 seasons, no tags are available for hunting within the Preserve.[3] Over the last ten years, the state has authorized between 3 and 5 tags annually.

The removal of 3-5 rams annually has a negligible impact on lambing rates and population stability. CDFW develops tag limits based on the concept of "compensatory mortality", in which "hunting mortality will be substituted for, rather than added to, natural mortality" (CDFW 2011). CDFW conducts annual aerial surveys to ensure that hunting mortality does not have a depressing effect on bighorn sheep populations. Moreover, protecting this small numbers of rams would not address the important conservation purpose of preserving functional dry season bighorn sheep habitat.

Reducing or eliminating human disturbance

The Mojave National Preserve is the third largest national park unit in the contiguous United States, after Yellowstone National Park and Death Valley National Park. For comparison, Yellowstone receives more than 4 million visitor annually, Death Valley almost 1.3 million, and Mojave National Preserve less than 600,000. As with other large parks, the majority of visitor use is confined to developed areas and backcountry locations with maintained trails. In Mojave, visitor use of these remote sheep habitat areas is known to be very infrequent, and data is not collected regarding the number and destination of foot travelers in these areas. There is no data to suggest that bighorn sheep are affected by human disturbance. In general, sheep habitat areas do not contain maintained trails. The Kelso guzzler is located on an old road stem that could provide access to walkers. The Old Dad guzzler is located in an extremely rugged and remote terrain.

[3] California Code of Regulations, 14 C.C.R. Section 362 and https://www.wildlife.ca.gov/Hunting/Bighorn-Sheep..

Reducing or eliminating disease mortality

Disease transmission from domestic sheep or goats to bighorn is believed to be a major cause of bighorn population declines in the late nineteenth and early twentieth centuries, and remains a major concern for bighorn sheep populations. Preventing contact between domestic animals and wild sheep has been and remains the primary management approach recommended by CDFW and NPS (CDFW 2012, NPS 2017). In Mojave Preserve, domestic sheep and goats are not permitted, and occasional stray or feral animals are removed when detected.

In 2013, a respiratory disease outbreak (Mycoplasma ovipneumoniae) occurred in the Old Dad area. Ewe estimates at the Kerr and Old Dad guzzlers before (2012) and after (2014) the outbreak suggest declines of greater than 50% at Kerr and 40% at Old Dad (Wehausen, conference presentation, April, December 2017). This is the only known episode since the Preserve was established in 1994. While the specific source of this transmission is not known, the disease is not native to wild sheep, and it is widely understood that all cases of this disease originate through domestic animal contact. Once contracted by wild sheep, the disease can be transmitted rapidly between animals. It has been speculated that the scarcity of water sources in the southern Mojave Desert may exacerbate disease transmission by causing infected animals to congregate at water sources (Epps 2016). This is a concern with both guzzlers and natural water sources. However, because the guzzlers increase the number of water sources, and the distribution of the guzzlers increases functioning habitat, this issue of congregation would be worse if guzzlers were to be eliminated. In addition, ewe to lamb transmission is both common and of special importance in terms of population impacts because it suppresses lamb recruitment. This form of transmission does not depend on congregation points. Finally, it is possible to explore guzzler designs that would limit the nose-to-nose contact that is most likely to result in transmission of this disease.

The proposed use of guzzlers, therefore, is not believed to be a contributor to future disease outbreaks, and may mitigate them. Efforts to reduce wild sheep contact with domestic sheep will continue to be the primary mechanism for avoiding disease transmission, but does not function as an alternative means of conserving sufficient desert bighorn habitat.

Reducing or eliminating burro competition

Burros, a nonnative species in the Preserve, occupy similar habitat as bighorn sheep and compete for forage and water resources where populations overlap. This competition is understood to be a significant threat to bighorn sheep populations, and increasing burro populations have been correlated with declining sheep populations. Burros are known to damage spring sites with manure, urine, and trampling, and monopolize springs sites by hazing sheep.

Wildlife management agencies including NPS and CDFW have identified burro removal as a strategy for many areas in the Mojave region. The 2002 GMP contained a detailed program for burro removal as a means to protect resources; similar proposals are contained in the CDFW draft conservation plan for many areas in the Mojave region. In Mojave Preserve, NPS funded burro removal from 1998 to 2003, and held an additional round up in 2005. In subsequent years, burro populations reached a low point in the Preserve.

More recently, burros have again become an issue in the Wood Mountain area, where they have damaged and monopolized a spring formerly used by bighorn sheep. The preserve is considering removal options for burros in the Wood Mountain area, and is working on an agreement with a non-profit to manage a round-up and adoption program. If successful, this could help with sheep conservation efforts in that area.

Burro competition is not, however, currently a problem in the areas where guzzlers are present. The NPS would remove burros from areas where guzzlers are present if they are detected, but this is not a substitute for water provisioning in areas where developed water sources are necessary for maintaining dry season habitat.

Use of the previously discussed measures in combination

Because sheep translocation, hunting, and disturbance by humans are not believed to be important factors in sheep population dynamics or sheep habitat function, combining these measures would at most have a marginal impact on conserving and maintaining bighorn sheep populations. Burros and domestic sheep and goats pose real risks to sheep, but removal is already the preserve's management response. Mountain lion predation can be a significant pressure on sheep populations, but in Mojave it does not appear to be a factor for the sheep populations that use guzzlers. Moreover, other policy considerations would make this form of predator control an action of last resort even if it was believed to be potentially effective as a conservation measure. It is therefore not believed that addressing any of these factors in combination represents a meaningful alternative to ensuring conservation of bighorn sheep populations, on the same level that maintenance of dry season habitat would, which requires dry season water sources.

Relocating guzzlers outside wilderness

Several of the existing guzzlers do have potential relocation sites outside of wilderness, primarily along "cherry-stemmed" road corridors. Therefore, each of the action alternatives contemplates relocation of some number of the existing guzzlers, consistent with the habitat objectives on which the alternatives are founded. The process of relocating water sources is described in detail in the EA (see page 41). In all cases, the process would involve some experimentation to ensure that sheep begin to use the new sites before the old sites are decommissioned. The conclusion of the impact analysis in the EA is that removal of all guzzlers from wilderness would result in potentially significant adverse effects. This alternative was therefore considered but dismissed from full analysis in the EA.

Conclusion

Based on this review of alternative (non-prohibited) conservation approaches, the conclusion of this analysis is that none of these alternative conservation approaches represents a viable alternative to water provisioning as a means of conserving functioning dry season desert bighorn sheep habitat. As discussed in the Management Plan for Developed Water Sources/EA, this is understood to be an important factor in lambing success and therefore population stability. Water provisioning at some level is considered necessary to maintain habitat during dry seasons, and particularly during dry seasons of drought years.

However, there are believed to be alternatives in terms of non-Wilderness locations for guzzlers that would provide the habitat component currently provided by a guzzler location. Additional discussion of guzzler relocation is provided below.

3) If using guzzlers is necessary, what number (or range) of guzzlers and what maintenance and operating activities are the minimum necessary to administer the area for the purpose of the Act?

Number of guzzlers

Water provisioning, by the retention of some number of tank and drinker guzzlers, is considered necessary for desert bighorn sheep conservation in the Mojave National Preserve. The Management Plan for Developed Water Sources/EA explores three alternatives, each of which contains a different proposal in terms of the number and location of guzzlers that would be retained in wilderness and outside wilderness.

The development of these alternatives was based on a number of factors that inform the feasibility of achieving the Plan's bighorn sheep conservation goals. These factors include:

- The importance of dry season water access in terms of lambing rates and lamb survival
- The regionally fragmented state of desert bighorn sheep habitat, which reduces species resiliency
- The prediction that climate will continue to change in the Mojave Desert region, and that these changes are likely to involve longer, drier, and more frequent droughts
- The need to consider impacts to wilderness character, including the impact from the presence of guzzlers on the undeveloped quality of wilderness, and the impact of active water provisioning for desert bighorn sheep on the untrammeled quality
- The availability of alternative, non-wilderness locations for guzzlers that provide for sufficient functional dry season desert bighorn sheep habitat

These factors lead to three alternatives in terms of the trade-off between the amount of dry season habitat that is conserved and the manner in which wilderness values are protected. In the EA preferred alternative (Figure 1), the preserve would adopt a no-net-loss-of-functional-dry-season-habitat objective, and would take actions to reduce wilderness impacts given this habitat objective. Based on this objective for bighorn sheep habitat, the preserve determined:

- One guzzler does not does not appear to be used by sheep, and can most likely be eliminated without consequence to sheep habitat function (Clark Guzzler)
- Two guzzlers have potential relocation sites outside of wilderness near to the existing guzzler sites (Vermin and Kerr Guzzlers).
- One guzzler does not have alternative, non-wilderness relocation sites, but is located in an area where other water sources provide coverage for that habitat, allowing removal without jeopardizing the no-net loss of habitat objective (Piute Guzzler)
- Two guzzlers in wilderness cannot be eliminated without jeopardizing the no-net-loss-of-functional-habitat objective (Kelso and Old Dad Guzzlers)
- In addition, three new guzzler/developed spring sites outside of wilderness will be considered to provide habitat connectivity between habitat areas (New Piute Guzzler, Ginn Spring, Vontrigger Spring)

Chapter 2 of the Management Plan for Developed Water Sources/EA contains additional detail about the re-location sites, processes, and monitoring approach for the Preferred Alternative (see page 41).

Based on that impact analysis, the NPS has identified Alternative 3, which would allow for the redesign and maintenance of two guzzlers in wilderness, as the minimum necessary for administering the area for conservation purposes.

Maintenance and Operating Activities

Guzzlers that are retained and used in wilderness will require occasional inspection and repair when damage is detected, both to keep them working and to protect the animals that use them. The majority of repairs will be performed on an as-needed basis, and it is therefore not possible to identify the case-specific factors that would be used to determine if a particular prohibited use is necessary to accomplish a particular repair.

However, past experience provides some insight into the types of repairs and operations that are probable in the future, and several projects have been recently approved through separate NEPA processes. In 2015, Mojave National Preserve completed a Categorical Exclusion (CE) and Minimum Requirements Decision Guide (MRDG) for various repair and maintenance work at all six existing guzzlers, including repairing and replacing float valves, repairing and replacing damaged pipe, replenishing water tanks, cleaning debris out of check dams, cleaning out blocked pipes, and adjusting water level instrumentation. Some of these tasks require the use of motorized vehicles or power tools. Another proposed project is to mitigate the risk to sheep from a cracked tank at the Old Dad Guzzler by building a wooden platform that can support the weight of sheep. In the past, an incident occurred in which a bighorn fell through the top of the Old Dad Guzzler and drowned, causing a botulism outbreak that killed a number of other sheep. This project will require pickup truck access and power tools, and is documented with a CE and MRDG.

In addition to as-needed repairs, the Kelso Guzzler has limited water capacity relative to its heavy use by sheep, and it is typically necessary to refill the storage tanks at that site once or twice during the dry summer season. This is accomplished by making a trip with five to seven light 4wd pickup trucks with water tanks secured in the pickup beds. These trucks traverse an unmaintained jeep road about 2 miles beyond the wilderness boundary. They then run hoses from the truck tanks to the guzzler tanks and pump the water with generator power. At present there is no alternative means to refill these tanks that does not involve another prohibited use, such as aircraft landing. In the future, additional storage tanks could be added to increase the storage capacity, and this could reduce or eliminate the need to refill tanks at Kelso Guzzler. However, this potential project would also require minimum requirements analysis, and the impacts of such a project on wilderness character would need to be compared to the impact of the current practice.

For each as-needed repair, a minimum requirements analysis using the MRDG form will be completed to review the necessity for any proposed 4(c) prohibited use. For refilling the Kelso Guzzler, a programmatic CE and MRA will be completed and reviewed every 3 years.

4) How would use of guzzlers impact the recreational, scenic, scientific, educational, historical, and other public purposes of wilderness, including other conservation purposes? Are impacts to these other purposes outweighed by the need to conserve bighorn sheep?

As disclosed in the Mojave National Preserve Water Resources Plan Environmental Assessment, under the current preferred alternative, four big game guzzlers (Clark, Kerr, Vermin, and Piute) would be removed from wilderness at full implementation. Two (Kelso and Old Dad) would be used and maintained in their current location.

In terms of the agency's balancing of multiple purposes, this proposal is intended to ensure that the conservation purpose of wilderness continues to be fulfilled by taking a cautious approach to reducing the number of installations in wilderness that native bighorn sheep have come use for dry season water needs. This is expressed both by the adoption, in the EA Preferred Alternative, of a no-net-loss-of-functional-dry-season-habitat objective, and by cautiously phasing the removal and relocation of guzzlers to ensure that unacceptable impacts do not occur. While the proposal would serve the scenic purpose of wilderness by removing, in the long term, a number of visible installations, it balances this purpose with the desire to avoid potentially unacceptable impacts to bighorn sheep from loss of dry season water sources. Guzzlers do not have a direct recreational purpose, but they do support sheep, which are subject to very limited hunting. Chapter 1 of the EA considered but dismissed impacts on "Recreation and Hunting". The conclusion is that due to the very small number of tags issued each year, which typically result in 100% success rate, in combination with the overall expansion of desert bighorn sheep habitat under the Preferred Alternative, no adverse impact on hunting would result. No changes to the location or timing of hunting are proposed. Insofar as desert bighorn sheep in the preserve remain available for study by wildlife biologists, the project also serves the scientific purpose of wilderness. The monitoring proposals that accompany guzzler relocation would probably result in improved understanding of bighorn sheep distribution and response to changing water availability. The big game guzzlers do not have an educational or historical component. There are no impacts to other wilderness purposes that outweigh the need to conserve desert bighorn sheep.

5) Is using guzzlers consistent with the Wilderness Act requirement to preserve wilderness character and avoid impairment to the same?

The removal, deactivation, or relocation of four guzzlers from wilderness would improve wilderness character in terms of the untrammeled and undeveloped qualities, removing longstanding impacts that have existed since the Preserve was established and the area designated as wilderness. Because the overall changes associated with the proposal lead to improvement in wilderness character, by reducing impacts from current levels, the proposal meets the Wilderness Act mandate to preserve wilderness character, as expressed in the Wilderness Act Section 4(b), and leaves the area unimpaired for future use and enjoyment as wilderness, as required by Sections 2(a) and (c).

Some of the impacts to wilderness character that are occurring now as a result of guzzler use would continue in order to avoid adverse impacts to desert bighorn sheep habitat and the natural quality of wilderness, and in order to meet the Wilderness Act's conservation purpose. The use and maintenance of the Kelso and Old Dad guzzlers would continue to adversely affect the untrammeled and undeveloped qualities of wilderness. However, this ongoing impact would be limited to the footprint of the two guzzlers (about 0.2 acres, or .00000025% of the Preserve's 804,949 wilderness acres) and the areas of wilderness in which they are visible (up to about 8 acres, or .00001% of the Preserve's 804,949 wilderness acres). Notwithstanding these ongoing impacts, the Preserve's enormous wilderness area will continue to have scant evidence of human development and management control.

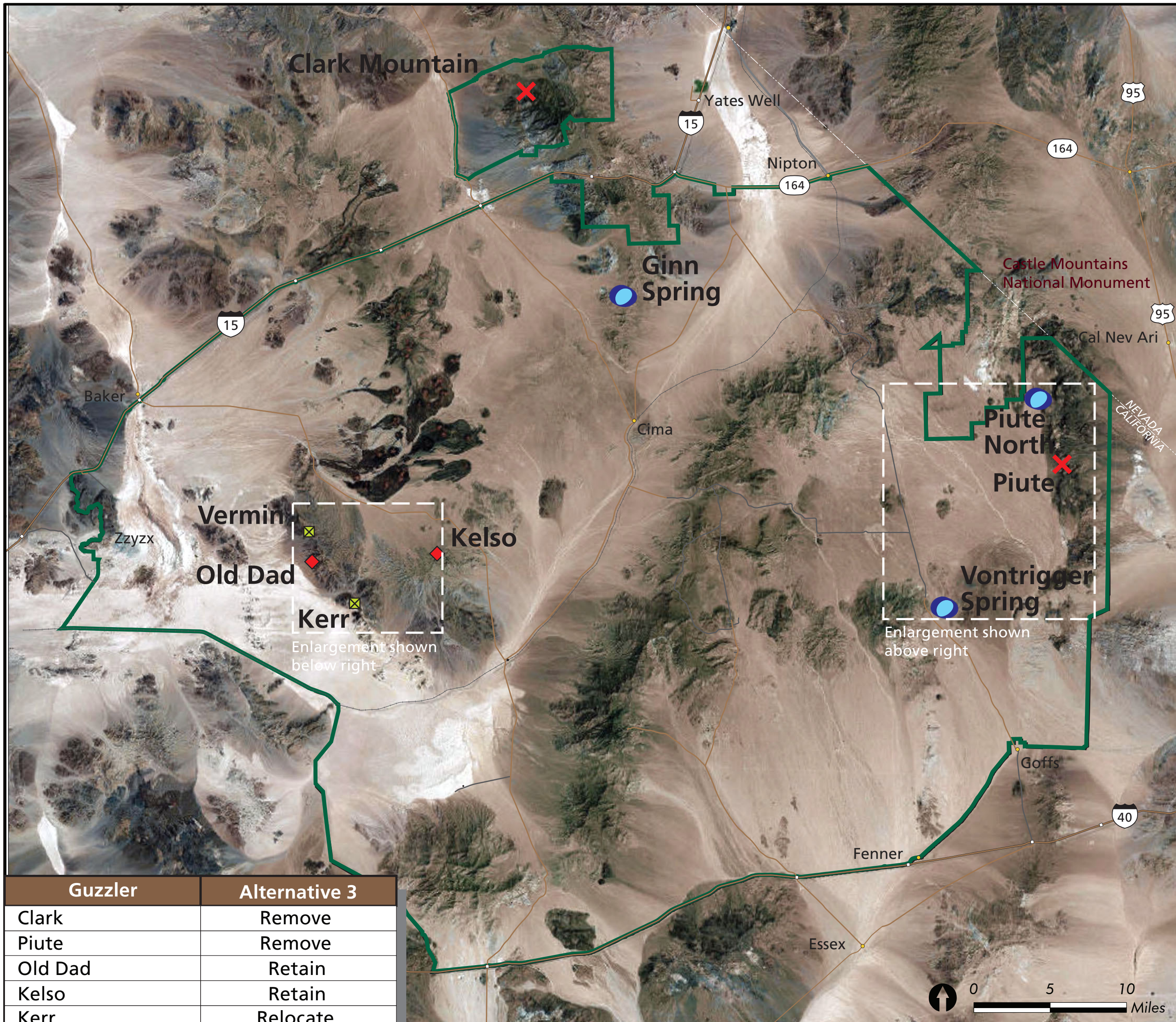
These limited ongoing adverse impacts on the untrammeled and undeveloped qualities must be weighed against the need to preserve the natural quality of wilderness by avoiding net loss of bighorn sheep habitat. These animals are of great importance to conservation in the Preserve and in the Mojave region, their presence enriches the wilderness character of the area, and the large area of undeveloped habitat that these animals depend on is a deliberate consequence of wilderness designation. In the agency's view the proposal to maintain the Kelso and Old Dad guzzlers represents the optimum balance in terms of preserving multiple wilderness character qualities and fulfilling the public purpose of managing this wilderness area for conservation use. A complete discussion of environmental effects of the proposal, including effects on the four qualities of wilderness character, can be found in Chapter 4 of the EA for the Management Plan for Developed Water Sources.

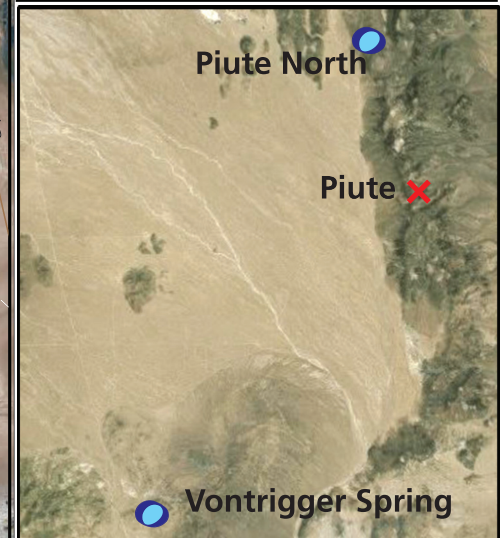
Conclusion

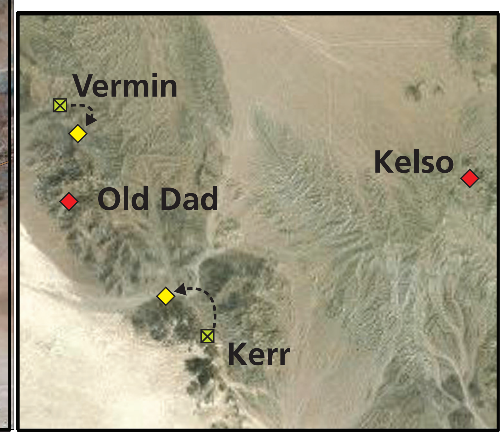
The conclusion of this analysis is that the NPS Preferred Alternative, Alternative 3, as described in detail in the Environmental Assessment, represents the minimum requirement for guzzlers to be used and maintained in wilderness in order to administer the area for the purposes of the Wilderness Act, and specifically for the purpose of preserving sufficient dry season habitat for desert bighorn sheep. This approach will reduce the total number of guzzlers in wilderness from six to two. In arriving at this conclusion, the agency considered the consistency of the project with wilderness purposes, other approaches to desert bighorn sheep that do not involve prohibited uses, ways to minimize the number of guzzlers and associated maintenance and operating activities, the balancing of the project's conservation purpose with other wilderness purposes, and potential adverse effects on wilderness character.

Alternative 3
Big Game Guzzlers

Mojave National Preserve
Water Resources Management Plan and
Environmental Assessment







Guzzler	Alternative 3
Clark	Remove
Piute	Remove
Old Dad	Retain
Kelso	Retain
Kerr	Relocate
Vermin	Relocate
New Water Sources	Yes – Three sites outside wilderness
Total Guzzlers	7
Within wilderness	2
Outside wilderness	5

Alternative Actions

Retain guzzler
Remove guzzler
Relocate guzzler
Guzzler relocation site
New water source location
Mojave National Preserve boundary
Wilderness*

*Vermin relocation site is within a non-wilderness area associated with an existing road

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Appendix B

Desert Bighorn Sheep Habitat Analysis

DESERT BIGHORN SHEEP HABITAT ANALYSIS

Management Plan for Developed Water Sources in Mojave National Preserve (Debra Hughson, Feb. 8, 2018)

The purpose of this analysis is to quantitatively compare bighorn sheep habitat in Mojave National Preserve in relation to provisioned water, i.e. guzzlers. Its objective is to minimize wilderness intrusions while precluding net loss of habitat. Various new guzzler locations are proposed outside of wilderness as compensation for moving other guzzlers out of wilderness.

METHODS

I used Resource Utilization Functions (RUF, Long et al. 2009) to relate animal locations to variable components of habitat (Marzluff et al. 2004, Hoglander et al. 2015). A utilization distribution (UD) can be created from a set of animal relocation points by a kernel density function that weights neighboring relocation points within some area described by a bandwidth smoothing parameter (Calenge 2015, Worton 1989), the correct selection of which has been a subject of discussion (Walter et al. 2011). Nonetheless, the UD is a spatial probability density that represents a probabilistic measure of animal use of a given location (Marzluff et al. 2004) and can be related to habitat variables such as slope and elevation through techniques of multiple linear regression (Marzluff et al. 2004) or mixed linear effects models (Hoglander et al. 2015).

The kernel density estimator assumes animal relocations are independent and identically distributed (*iid*), which is a condition seldom met in nature and especially with frequent GPS data. I used the continuous time movement model (Calabrese et al. 2016) to account for temporal correlation of GPS locations in an auto-correlated kernel density estimator (*akde*). Bandwidth in the *akde* is the minimum mean integrated squared error of the estimate (Flemming et al. 2015). Spatial auto-correlation of the UD can be included in a linear mixed effects model as implemented in the R package *nlme* (Pinheiro and Bates 2000, R Core Team 2017).

AVAILABLE DATA

This analysis has been made possible by a cooperative effort between California Department of Fish and Wildlife and the National Park Service, Mojave National Preserve that initiated May 20, 2013 in response to an outbreak of pneumonia caused by the bacteria, *Mycoplasma ovipneumoniae.* Collars were in place on at least 11 bighorn ewes the following November with 4 added in 2015. A summary of those data is presented in Table 1.

Additional data included:

- USGS digital elevation model at 10-m pixel resolution. Variables derived from the DEM included ruggedness, slope, aspect, and hillshade.
- Vegetation alliance polygons with 5 ha resolution (Thomas et al. 2004).
- Geology (Theodore 2007).

- A complete inventory of perennial water sources. No naturally occurring perennial water sources exist in the Old Dad Mountain area. The only water sources there are the Kerr, Old Dad, and Vermin guzzlers.

Data omitted from the model included precipitation and forage quality. An exploratory study of remotely sensed bighorn nutrition is in a preliminary phase of the NASA PROJECT program. Inclusion of this and reviewer recommended precipitation data is left to pending future efforts. As another reviewer noted, hillshade represents a particular angle (time) of the sun and collars were reporting periodically throughout the day. The absence of any relationship between hillshade and utilization was confirmed by modeling. Quadratic forms of the variables were not included.

The collar data from 15 ewes in the Kerr/ Old Dad area were filtered to include only locations during the summer months of June, July, and August. Euclidean distance to the nearest water was calculated from each location. A utilization distribution (UD) for each ewe was calculated by the auto-correlated kernel density estimate using the *ctmm* package for R (Calabrese et al. 2016, R Core Team 2017) clipped at the 95% volumetric isocline. Ruggedness index was calculated using the vector ruggedness measure (VRM) method (Sappington et al. 2007) from a USGS Digital Elevation Model (DEM) with a 10-m pixel resolution. Slope and aspect were obtained from the DEM using algorithms in ArcGIS 10.2.

Values of each UD within its 95% volumetric isocline as well as elevation, ruggedness (VRM), slope, and aspect were selected at 500 spatially random locations generated using the Generalized Random Tessellation Stratified (GRTS) method (Stevens et al. 2004) as implemented in the *spsurvey* package for R (Kincaid and Olsen 2011, Kincaid 2012, R Core Team 2017). Values of the dependent variable (UD) and covariate candidates (elevation, ruggedness, slope, aspect, geology, and vegetation) were picked from the data layers at these random points. Distance to water was calculated as the Euclidean distance from the center of the 10-m square DEM pixel to the known guzzler location. The dependent variable UD was log-transformed. A highly skewed distribution and the possibility of predicting negative probabilities otherwise motivated this decision. VRM was log-transformed (with a few sparse zeros replaced by the mean) and arcsine square root transforms were applied to slope and aspect after normalizing by 90 and 360 respectively. All of the explanatory variables were standardized by the z-transform. Plotted histograms indicated that the transforms greatly improved the central tendency of the data. The linear mixed effects modeling function *lme()* in R (R Core Team 2017) was used for parameterizing models. Information theory model selection techniques were used to compare models (Symonds and Moussalli 2010). The *predict.lme()* function in R was used to obtain estimates of log(UD) within a 2.5 km radius of each water source given covariates from the DEM raster and distance to a proposed new water source. The UD was assumed to be zero within vegetation polygons of woodland areas (pinyon, juniper, fir, and Joshua tree). Overlap between guzzlers closer than 5 km was assigned to the older guzzler. Habitat at each water source was compared by summing the estimated UD, after back transforming, to give an index of habitat. Validity of the underlying distributional assumptions was checked using methods in the *nlme* library (Pinheiro and Bates 2000, R Core Team 2017), namely plots of the residuals, fitted values, and estimated random effects. Although some minor deviations from normality were observed, overall the assumptions of normality and independence in the model seemed plausible.

RESULTS

DISTANCE TO WATER

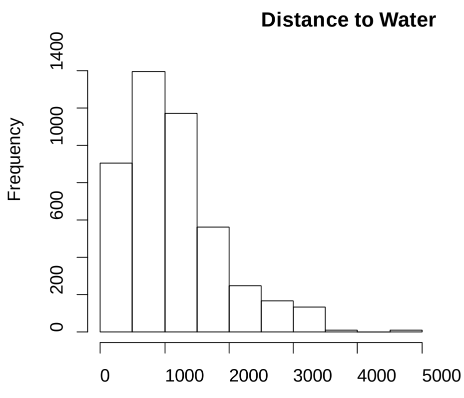

Figure 1

The collared bighorn ewes were likely to be located within a few km of Kerr, Old Dad, and Vermin during the months of June, July, and August. Figure 1 shows the empirical distribution of the distance to the nearest water source for 4613 collar locations from 15 ewes that are temporally correlated on day to monthly scales. Table 1 shows the beginning and end of the period of record for each ewe, total number of locations, and number of locations associated with the nearest water source. The maximum distance was 4.85 km with a median of 1001 m. 93% of the locations were within 2.5 km of a water source. A radius of 2.5 km from water sources was used in this analysis as representing summer habitat for bighorn ewes.

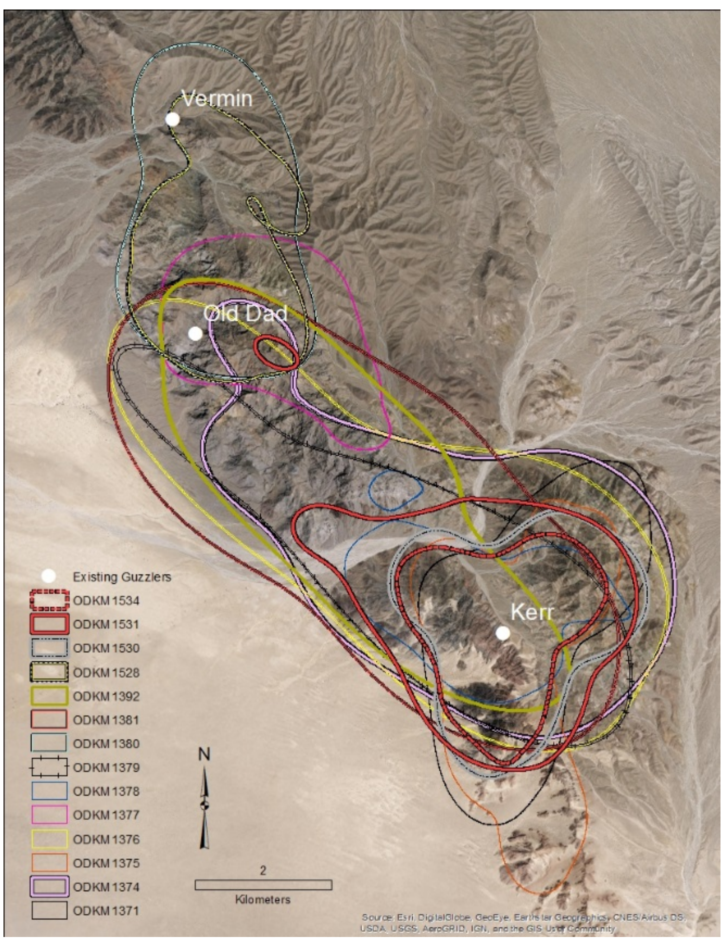

Figure 2. 95% volumetric isoclines individually for 15 ewes in the Old Dad Mountain area are shown for the months of June, July, and August. Casual observation suggests the ewes tend to stay together in groups.

Temporal association of individuals and ram-ewe interactions might be a topic of future research using these and data from collared rams.

Interestingly, the 95% volumetric isoclines also include sand dunes on the southwest side and alluvial fans on the northwest side in addition to the rugged, rocky terrain. Although most of the collar locations occur in the rocky outcrops, a few points in the sandy areas suggest occasional use or crossing.

Table 1. Collared ewes (15) are identified by collar number with beginning and ending dates of available record and total number of relocations. The number of relocations in the summer months of June, July, and August are indicated according to the closest water source.

Collar #	Guzzler	Begin	End	N total	N summer	Summer/Total
1371	Kerr	11/15/2013	10/31/2014	2008	518	0.2580
1373	Kerr	5/01/2014	5/13/2016	232	58	0.2500
1374	Kerr	4/30/2014	6/15/2016	235	58	0.2809
	OldDad				8	
1375	Kerr	11/06/2013	07/31/2016	5755	1361	0.2365
1376	Kerr	4/30/2014	4/23/2016	215	48	0.3116
	OldDad				19	
1377	OldDad	4/30/2014	5/31/2016	273	64	0.2344
1378	Kerr	4/30/2014	6/05/2016	282	62	0.2199
1379	Kerr	4/30/2014	5/17/2016	148	25	0.1959
	OldDad				4	
1380	Old Dad	11/15/2013	8/31/2014	1642	301	0.3076
	Vermin				204	
1381	Kerr	11/15/2013	10/31/2014	1861	208	0.1940
	Old Dad				153	
1392	Kerr	11/15/2013	12/9/2015	2131	253	0.2379
	Old Dad				254	
1528	Old Dad	11/12/2015	7/19/2017	1097	178	0.1923
	Vermin				33	
1530	Kerr	11/12/2015	7/19/2017	1163	264	0.2270
1531	Kerr	11/12/2015	7/19/2017	1168	256	0.2192
1534	Kerr	11/13/2015	7/19/2017	1141	257	0.2270
	Old Dad				2	

Variogram analysis of the residuals showed a spatial correlation structure with range of approximately 500 m and a sill of 1.13 that I modeled as exponential.

The Pearson correlation matrix for continuous covariates within models, and calculated directly from the data selected at random locations, showed a correlation between elevation and elevation squared and between distance to water and its square of close to one. Elevation squared and distance to water squared were not included in the model. All other variable correlations were less than |0.5|.

Candidate models ranked by increasing Akaike information criterion (AIC) are listed in Table 2. I included uninformative models to illustrate their relative ranking and AIC step size.

Table 2. Comparison of candidate models where D is distance to water, E is elevation, S is slope, V is VRM, G is geology, Vg is vegetation, and A is aspect, transformed and normalized. The plus (+) symbol combines covariates and the asterisk (*) includes covariate interactions.

#	Model	AIC	ΔAIC	Relative Likelihood
1	D * S + E * V + G + Vg	-14408.19	0.00	1.0000
2	D * S + E * V + G	-14405.73	2.46	0.2923
3	D * S + E * V	-14399.41	8.78	0.0124
4	D * S + E * V + Vg	-14399.37	8.82	0.0122
5	D * S + E * V * A	-14393.13	15.06	0.0005
6	D * S + E + V	-14387.09	21.10	0.0000

7	D * S + E	-14383.52	24.67	0.0000
8	D + E + S	-14377.63	30.56	0.0000
9	D + E	-14371.37	36.82	0.0000
10	D * E	-14370.63	37.56	0.0000
11	D + G	-14279.00	129.19	0.0000
12	Distance to water (D)	-14248.57	159.62	0.0000
13	Elevation E	-12655.41	1752.78	0.0000
14	Geology (G)	-12583.10	1825.09	0.0000
15	Slope (S)	-12571.28	1836.91	0.0000
16	Ruggedness VRM (V)	-12562.92	1845.27	0.0000
17	Intercept only, with spatial correlation range = 500 m	-12552.99	1855.20	0.0000
18	Aspect (A)	-12552.08	1856.11	0.0000
19	Hillshade (H)	-12551.39	1856.80	0.0000
20	Vegetation (Vg)	-12547.09	1861.10	0.0000
21	Intercept only, no spatial correlation	19590.98	33999.17	0.0000

Models attempting a random slope of distance to water (i.e. the formula for random effects with the form ~ D|Ewe in *lme()*), thereby allowing both the slope and intercept of distance to water to vary by ewe, did not converge.

Model parameters for the best approximating model (model #1), lower and upper 95% confidence intervals, and probabilities are shown in Table 3.

Table 3. Estimated model coefficients for environmental variables from the best approximating model (#1) with lower and upper 95% confidence intervals. Prob. is the probability of the t-statistic, which is the estimated coefficient divided by the standard error. The colon symbol (:) indicates interaction between variables. Letters in braces following the geological description are the map unit symbols in Theodore (2007).

Variable	Coefficient	Lower	Upper	Prob.
Distance to water	-0.76965	-0.80395	-0.73535	0.0000
Slope	0.00277	-0.00015	0.00570	0.0637
Elevation	0.05461	0.04442	0.06479	0.0000
VRM	0.00198	-0.00037	0.00432	0.0989
Jurasic Sands granite (Js)	-0.03947	-0.11760	0.03867	0.3228
Mesozoic volcanic and sedimentary rocks (Mzv)	0.01031	-0.00734	0.02796	0.2528
Quaternary alluvium (Qaf)	0.02408	0.01021	0.02408	0.0007
Tertiary gravel (Tg)	-0.00619	-0.01801	0.00563	0.3056
Triassic Moenkopi limestone and shale (TRm)	-0.01573	-0.03457	0.00311	0.1021
Late Miocene vents and flows (Tv1)	0.00478	-0.03318	0.04274	0.8053
Early Proterozoic gneiss and granitoids (Xg)	-0.01754	-0.04362	0.00854	0.1881
Late Proterozoic and Cambrian silici-clastic rocks (€Zs)	-0.00974	-0.02456	0.00507	0.1981
Jurasic sandstone (Ja)	0.02044	0.00084	0.04005	0.0414
Permian to Devonian limestone (PDl)	0.01499	-0.02230	0.05229	0.4313

Cambrian dolomite (Cd)	0.01406	-0.00156	0.02968	0.0782
Creosote	-0.07004	-0.15805	0.01798	0.1194
Galleta-Creosote	0.00235	-0.02956	0.03425	0.8856
Low Elevation Wash System	0.00581	-0.11862	0.13025	0.9272
Creosote-Brittlebush	0.01723	-0.01600	0.05045	0.3101
Creosote-Mojave Yucca	0.04410	-0.00336	0.09156	0.0690
Galleta	0.00055	-0.05368	0.05478	0.9842
D2water:Slope	0.00331	0.00051	0.00612	0.0209
Elev:VRM	-0.00403	-0.00630	-0.00176	0.0005

Even though the geology of Theodore (2007) provides some information regarding utilization it cannot be used in predictive models unless the geology of the target area consists of the same, or at least a subset of the geological units of the modeled area. Likewise vegetation alliances in the predicted area must be the same, or a subset of the vegetation in the modeled area. The modeled area includes 11 geological units and 7 vegetation alliances. Predictions were made at the 13 locations shown in Figure 3 and listed in Table 4, five of which were a subset of both geology and vegetation in the model, six were a subset of just geology, and six were just a subset of vegetation, Predictions using models 1, 2, 3, and 4 are shown in Table 4.

The predicted response variable (log-transformed UD) was exponentiated and summed over the modeled area (2.5 km radius with woodland areas omitted) to create an index (H=$\sum UD(x,y)\Delta x\Delta y$) where $\Delta x = \Delta y = 10$ m is the pixel area. Existing and potential guzzlers were then ranked and compared based on this index.

Table 4. Index H by location for the top four models.

Location	Model 1	Model 2	Model 3	Model 4
Kerr	0.1202621	0.1199739	0.11986445	0.1200822
Old Dad		0.1209407	0.12013399	
Vermin			0.08798352	0.08815095
Kelso			0.09480965	
Piute			0.08859304	
Clark			0.02824119	
New Kerr no Old Dad	0.1193032	0.1189963	0.11814993	0.1184363
New Kerr with Old Dad	0.1134609	0.1131627	0.11237880	0.1126573
New Vermin no Old Dad	0.1180774	0.1177946	0.11882654	0.1190182
New Vermin with Old Dad	0.06553302	0.06532478	0.06629790	0.06641454
New Piute			0.09531018	
Vontrigger			0.11874796	
Ginn			0.03633760	

Comparison of all existing and potential guzzler locations can only done using the same model. Since the geology and vegetation at eight locations included units and alliances not found in the modeled area, only data consistently available across all locations derived from the DEM can be used for comparison. Even though the model based only on DEM data (model 3) is one percent of the relative likelihood of model 1, the differences in H between all models where geology and vegetation data are available is small.

Various arrangements of existing and potential guzzler locations were compared to the current arrangement (Alternative 1, No Action) that consists of the existing guzzlers named Kerr, Old Dad, Vermin, Kelso, Piute, and Clark. These and the locations of potentially new guzzlers are shown in Figure 3. Various arrangements of guzzlers (Table 5) were compared to the existing arrangement by summing index H over the guzzler lists and calculating percent change as compared to Alternative 1.

Table 5. Various arrangements of guzzlers from the Administrative Draft Water Plan Alternatives are shown in the first row indicated by numbers 1 – 4. Other arrangements compared in this analysis are given in the second row of Table 5, labeled arbitrarily W – Z. The locations of existing and proposed guzzlers are shown in Figure 3.

Alternative 1	***Alternative 2***	***Alternative 3***	***Alternative 4***
Old Dad	New Kerr no Old Dad	New Kerr no Old Dad	New Kerr with Old Dad
Kerr	New Vermin no Old Dad	New Vermin no Old Dad	Old Dad
Vermin		Kelso	New Vermin with Old Dad
Kelso		Vontrigger	Kelso
Piute		Ginn	Piute
Clark			Vontrigger
			Ginn
Alternative W	***Alternative X***	***Alternative Y***	***Alternative Z***
New Kerr no Old Dad	New Kerr with Old Dad	New Kerr with Old Dad	Kerr
New Vermin no Old Dad	Old Dad	Old Dad	Old Dad
Kelso	New Vermin with Old Dad	New Vermin with Old Dad	New Vermin with Old Dad
	Kelso	Kelso	Kelso
	Vontrigger	New Piute	New Piute
	Ginn	Vontrigger	Vontrigger
		Ginn	

Table 6. Percent change in H, summed over the guzzlers considered in each alternative, as compared to Alternative 1.

Alternative	**Description**	**% change in summed H**
Alternative 1, No Action	Existing arrangement	0
Alternative 2	2 moved, 4 removed	-56
Alternative 3	2 moved, 3 removed, 2 new, 1 in place	-10
Alternative 4	2 moved, 1 removed, 2 new, 3 in place	+18
Alternative W	2 moved, 3 removed, 0 new, 1 in place	-39
Alternative X	2 moved, 2 removed, 2 new, 2 in place	+2
Alternative Y	2 moved, 2 removed, 3 new, 2 in place	+19
Alternative Z	1 moved, 2 removed, 2 new, 3 in place	+14

Discussion

Linear mixed effects models (Pinheiro and Bates 2000) can be used to infer the relative importance of various environmental covariates (Hoglander et al. 2015). In the case of these 15 ewes in the Old Dad Mountain area during the months of July, August, and September, distance to water was the dominant factor (Table 3). Elevation appears to be the most important covariate after distance to water. The model is apparently telling us that, during the summer, the ewes prefer to be in high places near water. Slope and VRM both showed weak effects.

Surprisingly, Quaternary alluvium (Qaf), showed the strongest positive relationship of all the geological units (Table 5). If this relationship is reproduced in future analyses, further investigations might look for a forage interaction since alluvial soils tend to support more vegetation than rocky slopes. Vegetation alliances overall; however, seemed to generally be uninformative except perhaps a weak effect of Creosote-Mojave Yucca.

The model with the lowest AIC could not be used for predictions and comparisons given the geological units and vegetation alliances that were unknown to the model at some of the prediction locations. One approach could be to group geological units into two categories: alluvium and hard rocks. Grouping vegetation alliances could be more challenging, however, given that bighorn tend to avoid wooded areas (CDWF personal communication) and the modeled area is mostly barren of vegetation. I decided to set modeled UD to zero in woodland polygons to address this concern. If bighorn do in fact utilized wooded areas as one reviewer indicated, H for Clark, Kelso, Ginn, and New Piute would be higher. This assumption is conservative for potential new guzzler locations since it does not take credit for questionable habitat.

According to model 3, based solely on the DEM and distance to water, Old Dad and Kerr are the two best guzzlers with Kelso third. Clark ranks last (Table 5). Kelso and Piute are approximately equivalent. Moving Vermin to the south would improve its score except for the overlap with Old Dad. Moving Kerr north to Jackass Canyon would reduce its score and any overlap with Old Dad would make that reduction even greater. Regarding the proposed locations; it's no surprise that Ginn scores low. A water development at Ginn could encounter a low probability of success, but one could argue that it should be attempted given the potential for improved habitat connectivity. It is a surprise, at least to me, that New Piute appears to be as good as, or perhaps better than, Piute. The New Piute site is perhaps worthy of more attention. I'm puzzled by the relatively high H at Vontrigger but note that I located the guzzler at an existing spring (where water is inaccessible) that emerges in a steep-walled canyon with excellent escape terrain nearby. This potential should be explored.

Alternatives

Alternative 2

The ultimate configuration in Alternative 2 has only two guzzlers remaining, New Kerr and New Vermin, both of which are outside designated wilderness. The model indicates that this would result in a 56% reduction from the existing state, which is unacceptable. Alternative 2 is not the agency's preferred alternative.

Alternative 3

The NPS preferred alternative in the administrative draft plan assumed additional habitat would result from new water sources at Ginn and Vontrigger. This model indicates that even if both were fully successful there would still be a 10% loss.

Alternative 4

Alternative 4 of the administrative draft plan left three guzzlers in wilderness (Old Dad, Kelso, and Piute) and assumed success at both Vontrigger and Ginn. The model indicates an 18% improvement with this arrangement.

Alternative W

Alternative 3 in the administrative draft plan assumed that new water sources at Ginn and Vontrigger would contribute substantial new habitat. Alternative W looks at the consequences if that assumption turns out to be wrong. If both proposed sites, Ginn and Vontrigger failed, and with only Kelso, New Kerr, and New Vermin in place, the result would be a 39% loss.

Alternative X

CDFW recognizes the importance of Old Dad and this model supports that view. The model indicates that leaving two guzzlers inside wilderness, Old Dad and Kelso, and assuming success at both Ginn and Vontrigger, would result in a 2% increase. However, should Ginn and Vontrigger both fail, there could be a loss of 27% (not shown in Table 6).

Alternative Y

A more cautious alternative for bighorn conservation might be found that still leaves only two guzzlers in wilderness (Old Dad and Kelso) but could have a better chance of not losing habitat. If New Piute and Vontrigger could replace Piute, habitat could increase by 13% (not shown in Table 6). Should Ginn be successful as well, habitat could increase by 19%. Collaring bighorn in the Piute area and monitoring for a period of at least 3 years should be a prerequisite. In the event that all three new locations (New Piute, Vontrigger, and Ginn) were to fail and Piute were to remain as one of three guzzlers in wilderness (Old Dad, Kelso, and Piute), the net loss would be 11% (not shown in Table 6).

Alternative Z

Kerr is in a poor location for hydrology but an excellent location for ewes. Alternative Z looks at an arrangement of three guzzlers in wilderness (Old Dad, Kerr, and Kelso) with the assumption of success at both New Piute and Vontrigger but failure at Ginn. The net change would be a 14% improvement.

Many other combinations of habitat improvements could be envisioned if existing guzzlers are to be left in wilderness and additional new water sources created. One alternative could be to move Vermin to New Vermin (or not) and leave the rest in place except for Clark, which receives no use by bighorn that we have been able to detect. Then adding both New Piute and Vontrigger could result in an improvement of 31%. If Ginn were successful, and it probably should be tried, the improvement could be 39% (not shown in Table 6).

RECOMMENDATION

The objective of this analysis was to minimize the number of guzzlers in wilderness subject to the constraint of no net loss of habitat, but not necessarily to limit the total number of guzzlers. Even though alternatives X and Y meet this objective, Y provides more flexibility to maintain habitat in the face of changing conditions and is thus preferable. The +19% in alternative Y could mean maintaining important movement corridors to offset anthropogenic fragmentation. The following sequence might be considered:

1. Rebuild Old Dad.
2. Move Clark to the Vontrigger location.
3. Build New Piute
4. Build Ginn
5. Relocate Kerr and Vermin
6. Remove Piute

Each step should be accomplished within an experimental design, with adequate monitoring, and to the highest engineering design standards. Methods to increase storage capacity, such as buried tanks, will be explored as this will be a means of reducing or eliminating water hauling.

New data could, and should, change these conclusions if, after analysis, the change appears warranted.

Topics of interest for plan implementation include (not a complete list):

- The role of sandy areas in nutrition and their relationship to guzzler placement,
- Optimal guzzler location for connectivity. This is most relevant for Piute, New Piute, Ginn, and perhaps Vontrigger. The model indicates that New Piute ranks higher than Piute, but the latter could be in a better location for connectivity. This model does not account for habitat connectivity.
- The pace of implementation should be set by the bighorn. Discovery and adoption of new and relocated guzzlers are key. Conversely fealty to an existing guzzler location to be moved or removed should motivate consideration of a reverse action.
- Adequacy of the modeling approach is uncertain. Many avenues were left unexplored in this analysis. For example, I followed the lead of Hoglander et al. (2015) in using 500 randomly selected locations, but this might not be enough. I didn't treat year as a random effect thinking it would become more relevant with temporal data, such as precipitation and remotely sensed forage data. Model evolution and improvement should, of course, follow the data.

Figure 3. Existing guzzlers are indicated in the top map and proposed guzzler locations are indicated in the bottom map.

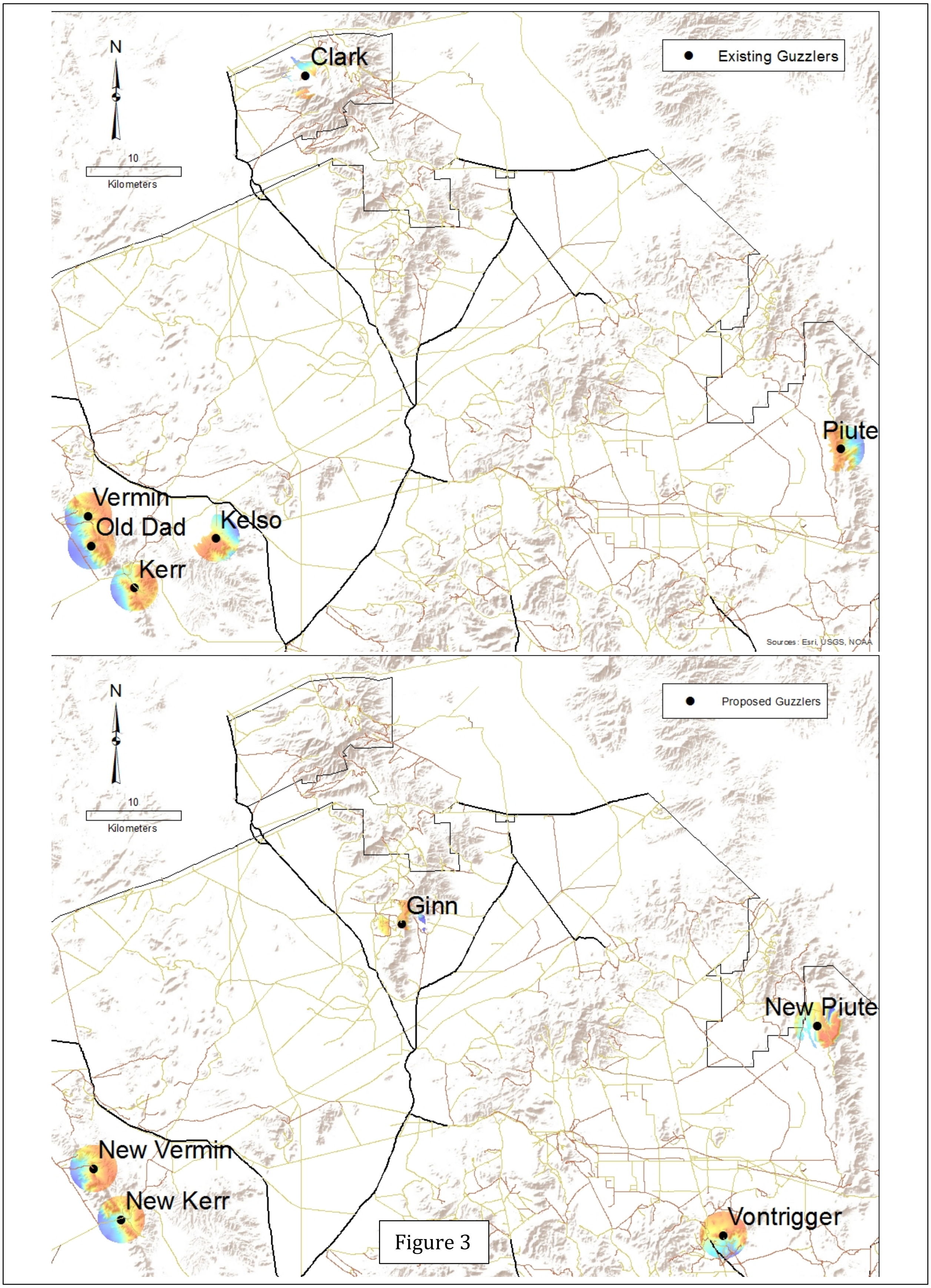

Figure 3

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