U.S. Department of the Interior
Fish and Wildlife Service
Pahranagat National Wildlife Refuge

FINDING OF NO SIGNIFICANT IMPACT

ENVIRONMENTAL ASSESSMENT FOR BLACK CANYON ECOSYSTEM RESTORATION

The U.S. Fish and Wildlife Service (Service) has proposed to restore a natural flow path, improve water delivery, and restore wildlife habitat on Pahranagat National Wildlife Refuge (Refuge) by restoring a remnant channel through Black Canyon. Two alternatives, the proposed action and the no action, were described in the Draft Environmental Assessment (OBEC 2011; EA). After the Service received public comments on the draft EA, necessary changes were made to address comments and a Final EA (Service 2012) was prepared. The Final EA is herein incorporated by reference. The proposed action aims to reconnect Pahranagat Creek to the historic riverbed through Black Canyon and provide useful wildlife habitat by creating native riparian, wetland, and upland habitats that would increase the biological diversity and ecological function of this area.

DECISION

Following review and analysis, the Service selected the Proposed Action for implementation because it is the alternative that best achieves the purpose and need.

Alternatives Considered

The following is a brief description of the alternatives presented in the Final EA. For a complete description of each alternative, see the Final EA (Service 2012).

Alternative A – Proposed Action Alternative

Alternative A would include the creation of approximately one mile of a five foot wide by one foot deep meandering river channel, three wetland ponds of up to nine foot depths, and 4 hillocks with average peak heights of nine foot in Black Canyon. The channel would begin at an existing northern Highway 93 culvert crossing, continue through Black Canyon in the abandoned agriculture fields and drain into the Headquarter Ponds via an existing culvert. Excavated soils and neglected ditches within Black Canyon that are currently not in use would be graded into naturalized terrain, which would be seeded and planted with native riparian and upland vegetation.

This alternative would simulate historic flow patterns through Black Canyon and create native wetland, riparian, and upland habitat that could benefit multiple wildlife species that depend on

rare water sources in the open desert. The restored ecological processes and subsequent re-vegetation would promote native plant communities and displace currently unusable weedy habitat that has infested the old fallow agricultural field.

Alternative B - No Action

Under Alternative B, the Service would not make any alterations to the current state of Black Canyon. Abandoned agricultural fields containing noxious weeds in Black Canyon would be left alone. Managed water surface flow would continue in ditches located on the west side of Highway 93.

Effects of Implementation

As described in the Final EA, implementing Alternative A would have no *significant* impacts on any of the environmental resources identified. The proposed action is consistent with the purposes for which the Refuge was established and meets the objectives of the Refuge (Service 2009).

As described in detail in the Final EA, implementation of the proposed action (Alternative A) would be expected to result in the following environmental impacts.

Soil Impacts

Channel restoration activities and weed removal would temporarily disturb soils and expose them to erosion until native vegetation is planted. Best Management Practices would be applied to minimize erosion during restoration construction activities. Once channel construction is completed, re-vegetation of appropriate riparian or upland native trees, shrubs, and grasses would reduce erosion of newly disturbed soil surfaces and restore soil microorganisms that have been degraded with long-term agricultural land use and intensive weed management. Any impacts to geology and soils would be less than significant due to the small scale of this project.

Water Impacts

Channel and wetland restoration in Black Canyon would return water to the historic river channel and increase valuable wetland habitat on the Refuge. Water use for the Black Canyon restoration could slightly reduce water availability for other parts of the Refuge due to an increase in riparian and wetland plants that would be restored in Black Canyon as compared to the existing string of riparian trees and shrubs that currently occur along the ditch on the west side of Highway 93. However, impacts, if any, should be minimal because the area of change in flow path is very small from the west side of Highway 93 to the east side, as well as small in context to the entire water delivery throughout the Refuge. Any adverse and beneficial impacts to water resources would not be significant due to the small scale of this project.

Water Quality Impacts

Minimal to no significant water quality impacts would occur since restoration would occur in a dry channel. Herbicide residues in the soil could contaminate contact water, but potentially

contaminated soils would be buried to avoid this scenario. Restored riparian vegetation could improve the water quality of water passing through Black Canyon.

Air Quality Impacts

Traffic and equipment associated with channel construction and creation of the new channel would temporarily disturb soil and raise dust. Site conditions would be monitored and Best Management Practices would be employed to minimize dust hazards. Overall, the proposed action would have a long-term positive impact on air quality with the implementation of restoration over time. Any adverse or beneficial impacts to air quality would not be significant due to the small scale of this project.

Vegetation Impacts

Restoration would require the removal of existing vegetation within the restored area which primarily consists of non-native weeds, and should cause no long-term, adverse impacts to native vegetation. The restoration aims to establish approximately 25 acres of native trees, shrubs and herbaceous plants which provide food, shelter and nesting habitat for wildlife. This native riparian corridor would displace undesirable weed species and the need for regular herbicide application. No adverse impacts to vegetation would occur and any beneficial impacts to vegetation would be less than significant due to the small scale of this project.

Endangered and Threatened Species Impacts

No endangered or threatened species currently inhabit the restoration area. Several threatened and endangered species and their habitats occur elsewhere on the Refuge, but are well outside the area of potential impact. A chuckwalla, a species of conservation priority, was recorded on the Refuge but this species is restricted to the rocky outcrops within Black Canyon (SWCA 2011) and thus would not occur on the canyon floor where restoration would take place. The restoration would not adversely impact any non-sensitive wildlife species because the area does not currently provide a major habitat source for any wildlife species. The restoration does not focus on one particular species, but could create additional habitat that could benefit several species of migrating birds, bats, desert bighorn sheep and wildlife in general. Any beneficial impacts to wildlife resources, though, would be less than significant due to the small scale of this project.

Cultural Impacts

Gilreath et al. (2011) recently surveyed Black Canyon for cultural artifacts. High concentrations of petroglyphs occur on the canyon walls and although few to no artifacts were found on the canyon floor where the restoration would take place, additional artifacts could be buried below existing soils. Because agriculture previously disturbed these soils, creation of the new channel and areas closer to the ground surface are unlikely to unearth any new artifacts. Should any artifact(s) be unearthed during restoration, restoration activities would cease and proper reporting and investigation of the artifact(s) would follow. An onsite archaeologist or Tribal inspector may be called upon to monitor restoration activities to assure that no damage to known artifacts outside the canyon floor occurs. Because the restoration would take place in this previously disturbed area there should be no significant impacts to cultural resources.

Given the importance of the Black Canyon area to the Native American community, a Nuwuvi Working Group, composed of representatives from area Tribes, was involved in project planning during the restoration design phase. Their input was obtained and modifications were incorporated into the restoration design.

Public Availability

The Draft EA was available for public review and comment for a 30-day period from January 10th through February 10, 2012. A copy of the Draft EA and/or notification letter was distributed to potentially interested Federal, State, and local agencies, Tribes, and several special interest groups. The Draft EA was made available to the local community of Alamo, by posting a notice at the local post office, and by posting a notice and a copy of the Draft EA at the local library. The Draft EA was also made available to all interested parties via the Refuge website. Comments were received from four interested parties and necessary changes incorporated into the Final EA to address the comments. This FONSI and the Final EA will be made available to all interested parties via the Refuge website.

Conclusions

Based on review and evaluation of the information contained in the supporting references, it is my determination that the proposal does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of section 102(2)(c) of the National Environmental Policy Act of 1969 (as amended). Accordingly an environmental impact statement is not required.

This Finding of No Significant Impact and supporting references are on file at the U.S. Fish and Wildlife Service, Pahranagat National Wildlife Refuge. These documents are available to the public. This document will be placed on the Refuge's website to notify interested and affected parties of our decision.

Margaret J. Kolar

Assistant Regional Director, Refuges
Pacific Southwest Region
U.S. Fish and Wildlife Service

3/5/2012
Date

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Final Environmental Assessment
Black Canyon Ecosystem Restoration

Pahranagat National Wildlife Refuge

PO Box 510
Milepost 32, Hwy 93
Alamo, NV 89001
(775) 725-3417

February 27, 2012

<u>Final</u> Environmental Assessment
Black Canyon Ecosystem Restoration

Prepared For:

Pahranagat National Wildlife Refuge
PO Box 510
Milepost 32, Hwy 93
Alamo, NV 89001

Prepared By:

Otis Bay Ecological Consultants
PO Box 919
Verdi, NV 89439
www.otisbay.com

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Note: Comment letters were received on the Draft Environmental Assessment; thus, modifications in response to those comments were made and are noted by underlined text in this Final Environmental Assessment.

1 PURPOSE FOR THE PROPOSED ACTION

Proposed Action: The Pahranagat National Wildlife Refuge (NWR or Refuge) desires to restore a natural flow path, improve water delivery, and restore wildlife habitat on the Refuge. To accomplish these goals, the Refuge has prioritized channel restoration through Black Canyon, as part of a Refuge-wide restoration plan. A remnant bend of the ancient White River bed runs through Black Canyon, and this was the natural flow path prior to highway construction, though no naturally flowing water occurs there today. Black Canyon is located on the east side of Highway 93 across from the Refuge headquarters (Figure 1-1). Currently, noxious weeds, which provide little to no value to wildlife, have invaded the area after local soils were disturbed by past agricultural activity. Channel restoration in Black Canyon aims to reconnect Pahranagat Creek to the historic riverbed, and convert the current undesirable weed-infested field to a naturalized riparian corridor connected to native upland plant communities, to provide useful wildlife habitat.

1.1 Background

Pahranagat NWR is located at the terminus of the White River system and provides valuable wetland habitat in open desert country. Water outflowing from Hiko, Ash, and Crystal Springs, located north of the town of Alamo, flows through areas containing the historic White River channel in the Pahranagat Valley. The combined spring outflow waters of Crystal and Ash Springs flow directly into Pahranagat Creek and Ditch to provide water for irrigation in the valley north of the Refuge, and eventually form lakes and marshes for wildlife habitat on the Pahranagat NWR. Water flows into the Refuge only in the winter months, when irrigation needs in the agricultural fields upstream of the Refuge are low. According to U.S. Fish and Wildlife Service (USFWS 2009), the ancient White River formed a narrow but well-defined floodplain through Pahranagat Valley. This floodplain north and south of the Pahranagat Valley is mostly dry now, and has been for thousands of years. However, the Pahranagat Creek and Ditch continues to flow through parts of the old river channel through the town of Alamo and Pahranagat NWR. This creek, confined in many places in irrigation ditch structures, runs north to south through the Refuge. Pahranagat Creek's water provides aquatic habitat for multiple rare species such as the endangered Pahranagat roundtail chub (*Gila robusta jordani*; wild populations located off of the Refuge) and the Pahranagat speckled dace (*Rhinichthys osculus velifer*) and water from the creek supports a green belt of riparian habitats running through the Pahranagat Valley that in turn provide habitat for numerous birds, bats, mammals, insects and other wildlife. Pahranagat NWR contains a mosaic of marsh, open lake, wet meadow, alkali meadow, riparian woodland, and shrub habitats that provide a much needed and important resource for many wildlife species inhabiting or passing through the harsh desert landscape. Maintaining these diverse habitats in a system in which the water supply is extremely limited and augmented for only part of the year is the challenge and goal for Refuge managers.

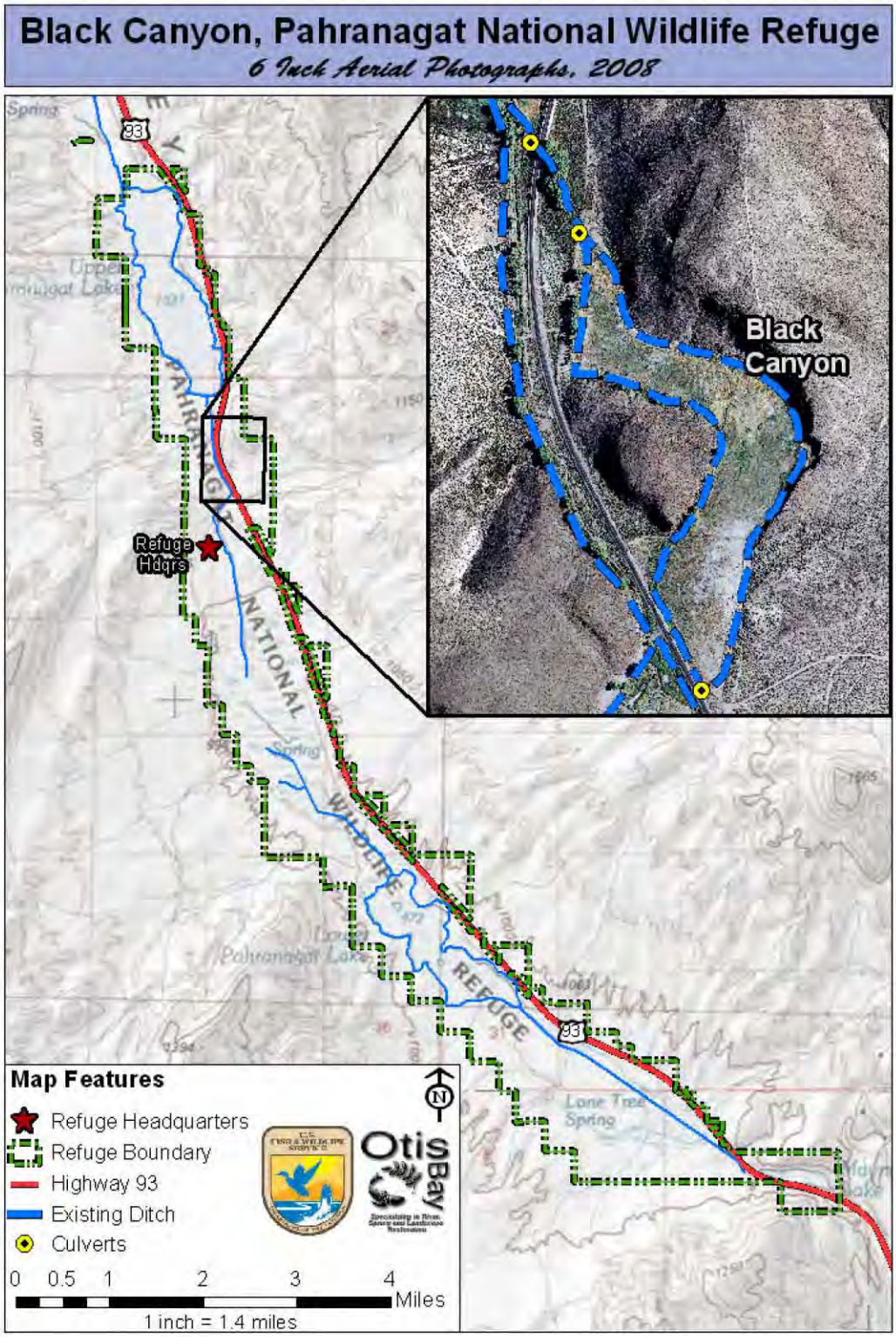

Figure 1-1. Location of Black Canyon on the Pahranagat National Wildlife Refuge. Inset shows an aerial view of the canyon, with ditches (in blue) and existing culverts (yellow dots) highlighted for reference.

1.2 Purpose

Since its establishment, the Pahranagat NWR has aimed to provide high-quality habitat for nesting and migratory birds. Budgeting and allocating the water that is received from upper parts of the valley and stored in the Upper Pahranagat Lake to maintain the diverse habitats that support high bird species diversity and abundances is the primary focus of the Refuge. As a way of improving habitat quality and quantity to benefit birds and other wildlife, channel restoration in the Black Canyon has been proposed.

The purpose of the proposed Black Canyon channel restoration is to pulse water through a dewatered drainage canyon in order to create native riparian, wetland, and upland habitats that would increase the biological diversity and ecological function of this area. This riparian section would establish desirable habitat patch connectivity. Restoration activities could contribute to the following goals identified in the Comprehensive Conservation Plan for the Refuge (USFWS 2009).

1) Wetland Habitat – The project would create migration habitat for birds.
2) Wildlife Diversity – An improved natural riparian corridor could contribute to the recovery of several bird species of conservation priority.
3) Visitor Services – The restored area would provide an aesthetically pleasing area for outdoor enthusiasts to appreciate nature.
4) Cultural Resources – The restored habitat could attract increased visitation to a culturally significant site.

The primary purpose of the proposed restoration is to create new habitat that benefits wildlife, especially migrating birds. Although rare species are not the primary focus of restoration efforts, the addition of riparian habitat could potentially provide habitat for some rare species known to occur on the Refuge and which have existing recovery/management plans as listed below.

1) Nevada Bird Conservation Plan (GBBO 2010)
   The Pahranagat NWR provides habitat for thousands of migratory birds which use the Refuge as a stopover site on the Pacific Flyway. A new riparian corridor in Black Canyon could provide new breeding, wintering, and migration stopover habitat for several landbird conservation priority species that have been recorded on the Refuge (GBBO 2011). The Nevada Bird Conservation Plan (GBBO 2010) lists the Pahranagat Valley as a region of interest for conservation of Mojave lowland riparian habitat. This habitat type is the primary focus of Black Canyon restoration efforts. Providing a patch of riparian habitat that connects to a larger landscape of scattered riparian patches could benefit multiple bird species and potentially some bird species of conservation concern that are dependent on scarce riparian habitats in the arid southwest.

2) Nevada Bat Conservation Plan (Bradley et al. 2006)
The Lincoln County bat survey (Kenney and Tomlinson 2005) identified multiple species of bats in the Pahranagat and Key Pittman areas. Restored surface water and woody riparian vegetation in Black Canyon adjacent to cliffs and rock crevices that provide optimal bat roosting areas would likely attract bats. The restored riparian zone could provide needed roosting, foraging and migration corridor habitat for multiple bat species.

3) Final Recovery Plan for the Southwestern Willow Flycatcher (USFWS 2002)
Maturing riparian habitat created in the Black Canyon restoration could potentially create new breeding habitat for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*).

4) Bighorn Sheep Management Plan (NDOW 2001)
The Black Canyon restoration would create an available, intermittent water resource for bighorn sheep on the east side of Highway 93. Currently, surface water on the Pahranagat NWR occurs primarily on the west side of the highway.

5) Recovery Plan for the Aquatic and Riparian Species of Pahranagat Valley (USFWS 1998)
The plan identifies the Pahranagat Valley montane vole, *Microtus montanus fucosus*, as a species that would benefit from riparian enhancement. Riparian vegetation could potentially provide a more connected corridor for dispersing rodents that could possibly include the vole.

2 Need for Action

Previous land use activities have severely degraded the habitat and hydrologic function of Black Canyon. The proposed action is needed to meet Refuge management goals and prevent further habitat degradation. Restoration activities are necessary to remove and prevent further spread of noxious weeds that are currently growing on the site.

3 Alternatives Including Proposed Action

3.1 Alternative A - Restoration

This alternative includes the creation of approximately 1 mile of a 5 ft wide by 1 ft deep meandering river channel, 3 wetland ponds of up to 9 ft depths, and 4 hillocks with average peak heights of 9 ft in Black Canyon. The channel would begin at an existing northern Highway 93 culvert crossing, continue through Black Canyon in the abandoned agriculture fields and drain into the Headquarter (Ducks Unlimited) Ponds via an existing culvert (Figure 1-1 inset). Excavated soils and neglected ditches within Black Canyon that are currently not in use would

be graded into naturalized terrain, which would be seeded and planted with native riparian and upland vegetation. Once restoration is complete, water from Upper Pahranagat Lake will be routed through Black Canyon. Use of the existing ditch on the west side of Highway 93 may or may not continue depending on Refuge needs. Figure 3-1 depicts the restored channel, pond, hillock features, and estimated soil volumes that would be moved for the creation of these restoration features.

This alternative would simulate historic flow patterns through Black Canyon and create native wetland, riparian, and upland habitat that could benefit multiple wildlife species that depend on rare water sources in the open desert. Because of the limited water supply, water cannot feasibly be continuously run through the canyon without depleting Upper Pahranagat Lake storage water beyond currently desired levels. Thus, water would be pulsed through the restored canyon channel on certain days on a previously agreed upon flow schedule. This flow schedule, as set by the U.S. Fish and Wildlife Service, was used to determine the restored channel design and dimensions. Wetland ponds located off of the channel would serve as local water storage areas within the Black Canyon. The purpose of these ponded areas is to hold water and soil moisture during the hotter periods when water is not flowing through the canyon, so that groundwater retention may be maintained to support wetland and riparian vegetation. The restored ecological processes and subsequent revegetation would promote native plant communities and displace currently unusable weedy habitat that has infested the old fallow agricultural field.

3.2 Alternative B - No Action

The U.S. Fish and Wildlife Service would not make any alterations to the current state of Black Canyon. Abandoned agricultural fields containing noxious weeds in Black Canyon would be left alone. Managed water surface flow would continue in ditches located on the west side of Highway 93 (Figure 1).

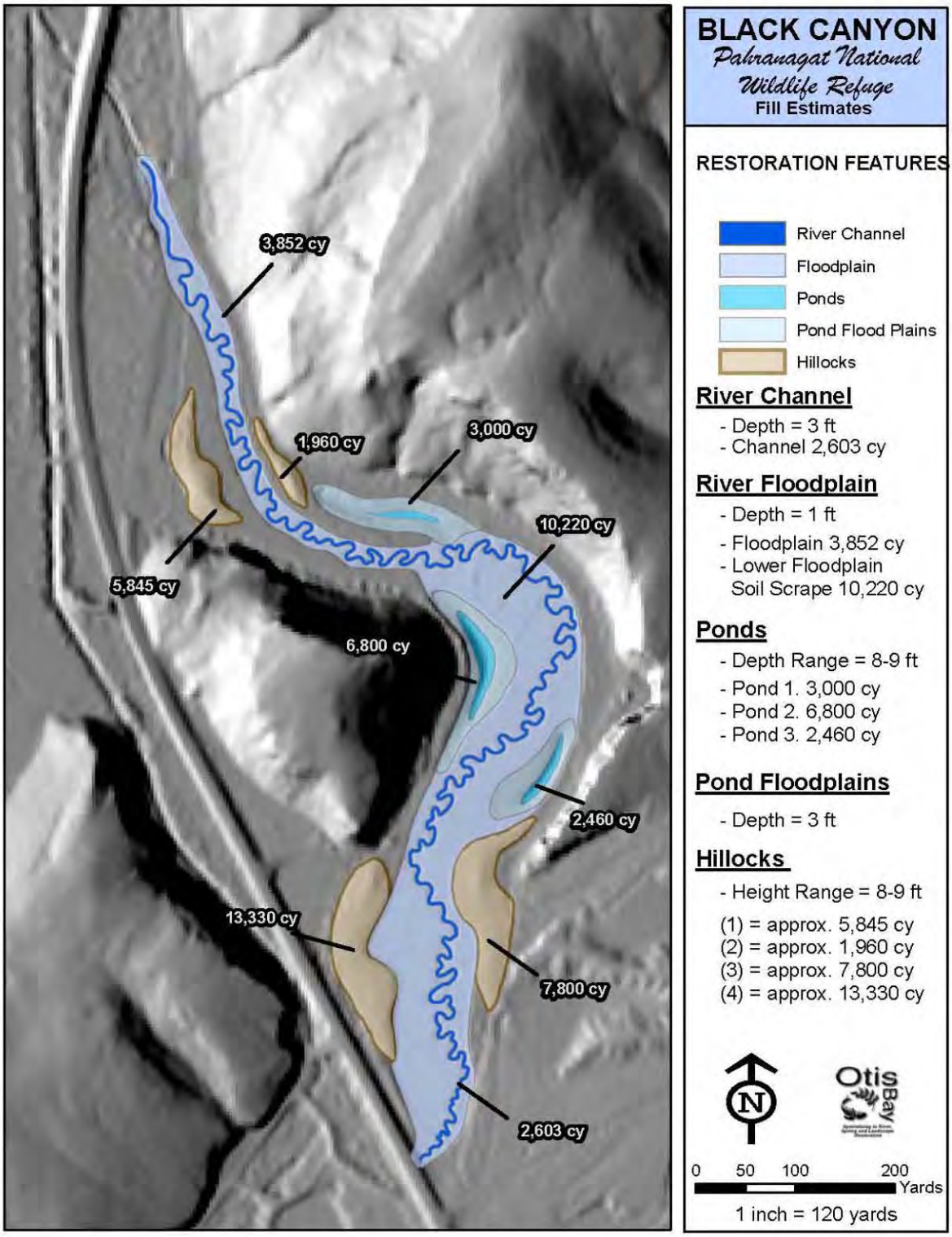

Figure 3-1. Restoration features proposed for Black Canyon.

4 AFFECTED ENVIRONMENT

4.1 Physical Environment

4.1.1 Soils

According to a Natural Resources Conservation Service Soil Survey, six soil map units occur in the Black Canyon area (NRCS 2011). These map units include LmA (Lahontan silt loam, moderately saline, 0 to 2 percent slopes), Pb (Pahranagat silt loam, drained), MKC (Maynard Lake complex, 4 to 12 percent slopes), Ar (Ash Springs silt loam, reclaimed), ARR (Akela-Rochpah-Rock outcrop association), and PIR (Pintwater-Rochpah association). The first four map units on the list, LmA to Ar, lie on the canyon floor, and are derived from alluvium, likely deposited by the ancient White River. These canyon floor soils range in character from poorly to excessively-drained. Soil surfaces on the canyon floor were previously disturbed by agricultural practices and intensive herbicide application for weed management in the canyon. Topsoil is either absent or in degraded condition. The last two map units listed, ARR and PIR, form the rocky outcrops of the canyon. The parent material of the weathered and eroded rocks originated during a time when the area was more geologically active with uplifting and volcanic activity.

Two soil pits were excavated to determine the soil profile in the northern and southern area of Black Canyon (Appendix Figure A- 1). The excavation revealed a relatively homogeneous soil profile that consisted of mostly silt and clay to approximately 30 feet below the ground surface (Table 4-1). Silt and clay in the soils from the canyon entrance extend around the bend in the canyon, and should have higher water-holding capacity to retain moisture in the restored channel and pond features. Because of the high silt and clay content, low permeability is expected. However, soils in the southern end of Black Canyon are part of a larger alluvial flow deposit that begins east of Black Canyon, continues through the southern end of Black Canyon and through the Headquarter Ponds area on the Pahranagat NWR. These soils are excessively-drained.

Table 4-1. Soil pit 1 (north) and soil pit 2 (south) soil profiles in Black Canyon.

Soil Pit 1 Depth (ft)	Soil Pit 2 Depth (ft)	Description Notes
0-3	0-3	Mostly silt with clay.
3-13	3-12	Mostly silt and clay with some sand.
13-17	12-17	Moist to wet silt and clay.
17-25	17-29	Saturated silt and clay, excavation below water table, groundwater flowing into the trench

4.1.2 Water Resources

4.1.2.1 Surface Water

Pahranagat Creek forms from combined outflows of Crystal and Ash Springs and flows downstream into Pahranagat Ditch. During colder and wetter months, primarily October through mid-April, water is not used for crop irrigation and is released downstream via a ditch into Upper Pahranagat Lake. The Upper Pahranagat Lake serves as a reservoir, to provide water for the Pahranagat NWR in the warmer months, when Pahranagat Creek and Ditch water goes dry as water is used for irrigation in farmlands upstream of the Refuge. From Upper Pahranagat Lake, water flows into a system of irrigation ditches that deliver water throughout the Refuge. Water from the main irrigation ditch located to the south of Upper Pahranagat Lake and west of Highway 93 can be diverted into Black Canyon through a 24-inch screw gate water control structure. A 24 inch culvert then carries flows to Black Canyon under Highway 93. After passing under an old highway bridge, the irrigation ditch splits into two earthen ditches, which run along the east and west edges of the canyon. Refuge managers seasonally irrigated Black Canyon as recently as 2004. Surface water diverted into the canyon may have formed a ponded area behind a low head dike at the southern end of the canyon to create seasonal wetland habitat. The groundwater table in Black Canyon lies deep below the ground surface (more than 15 ft) and groundwater discharge does not currently contribute water to Black Canyon (Wurster 2010; Table 4-1).

Water delivery to Black Canyon will be strictly limited by the Refuge's current water right. Normally, water only flows into the Refuge during non-irrigation season (October – April). During this time, water would pass through the Black Canyon to the lower Refuge areas. Water could also pass in the ditch on the west side of Highway 93. During the summer months (April to September) the Refuge holds no Pahranagat stream surface right; therefore, water for the Black Canyon can only come from storage in the Upper Pahranagat Lake. To conserve lake storage for all Refuge needs, Refuge managers will only release water to Black Canyon for approximately one day a week. This quantity of water is the minimum amount needed to keep wetland and riparian plants alive.

4.1.2.2 Groundwater

Groundwater flows in a general north to south direction, following the drainage through Pahranagat. Two groundwater aquifers lie below Pahranagat Valley. A deeper regional carbonate aquifer connects from Great Basin National Park south through Pahranagat Valley and west to Death Valley in southern California. Precipitation in higher elevation areas recharges this regional aquifer. Water from this aquifer rises to the surface in Hiko, Ash, and Crystal Springs, the three main springs of Pahranagat Valley. A smaller and shallower local basin-fill aquifer also lies under the valley and contributes to groundwater extent. All of the water in the local aquifer originates within the Pahranagat Valley, through rainfall and downward seepage of surface water. Soils located in the southern end of Black Canyon and characterized as excessively-drained may contribute to downward seepage. Although surface water occurring in this area could sink below the ground surface, this water recharges the local aquifer and resurfaces in Middle Marsh and Lower Lake (Wurster 2010).

4.1.3 Water Quality

Higher salinity and total dissolved solid levels occur in the surface water entering the Pahranagat NWR because the system is located at the terminus of the hydrologic system. Both wintertime flushing of salts from soils in upstream agricultural fields, and high evaporation rates during the summer, concentrate salts and dissolved solids in the terminal lakes on the Refuge. Relatively high amounts of boron, arsenic, and selenium occur in Refuge soils and aquatic habitats (Tuttle and Wiemeyer 1999), but discharge from the underground aquifer likely contributes to higher concentrations of some of these metals, such as selenium.

4.2 Biological Environment

4.2.1 Flora

The Black Canyon floor contains 27 acres of abandoned agricultural fields dominated by invasive weeds. According to the USFWS (2009), "Russian knapweed (*Acroptilon repens*) and various pigweeds (*Amaranthus* spp.) form monocultures in disturbed areas such as the previously cultivated fields of Black Canyon." In addition, a vegetation survey corroborated these findings and described the area of Black Canyon as having invasive weeds and herbs with some areas of cottonwood woodland (SWCA 2011). Although small patches of native vegetation that include cottonwood trees, rabbitbrush, greasewood, creosote bush and salt bush upland occur along the edges of the canyon, Black Canyon is dominated by Russian knapweed. Other documented noxious weeds in Black Canyon include Russian olive (*Elaeagnus angustifolia*), Russian thistle (*Salsola tragus*), Saltcedar (*Tamarix ramosissima*) and tall whitetop (*Lepidium latifolium*). In an attempt to manage and prevent further spread of noxious weeds, the Refuge has used a variety of herbicides in Black Canyon (Table 4-2).

Table 4-2. List of herbicides used in Black Canyon since 2007.

Chemical	Weed Target	Years Applied
Tordon	Russian knapweed	2007
Transline	Russian knapweed	2009
Milestone	Russian knapweed	2009, 2010
Telar	Tall whitetop	2010

Since 2007, the Refuge replaced picloram (Tordon) treatments primarily with aminopyralid (Milestone). Unlike Tordon, Milestone does not negatively impact as wide a variety of non-target plants, though higher concentrations may hinder the diversity and growth of re-vegetated plant communities during the first year or two post-application (Halstvedt 2010). Due to concerns that residual herbicides may prevent establishment of native plants, soils were tested at three locations in the canyon (Appendix Figure A- 2). The results of the residual herbicide analysis indicated a presence of aminopyralid (Milestone) in the top three inches of

the soil profile throughout the canyon (Appendix Table A- 1). Other herbicides were not detected.

4.2.2 Fauna

The Pahranagat NWR provides habitat for numerous species of birds, amphibians, reptiles, mammals, fish and invertebrates. Due to habitat destruction and degradation, the Black Canyon area lacks suitable habitat for the majority of wildlife species found in other areas of the Refuge.

A 2010 Refuge-wide survey of reptiles and amphibians found two reptile species, side-blotched and western whiptail lizards, within the potential area of restoration disturbance (SWCA 2011). These two species of lizards were widespread and common throughout the Refuge. Two other species were observed just outside the disturbance boundary, chuckwalla and yellow-backed spiny lizard. All observed species, whether inside or outside the boundary, were associated with upland habitat (SWCA 2011).

The chuckwalla is a large rock-dwelling lizard found in desert habitats (Stebbins 2003). Primarily herbivorous, chuckwallas forage on a variety of desert plants and occasional insects. Chuckwallas are associated with rocky upland habitat which they use for basking and hiding in crevices. In Nevada, the chuckwalla is a species of conservation priority and is currently being considered for species of concern status.

Pahranagat NWR falls within the boundaries of the Northeastern Mojave Recovery Unit (NEMRU) which is designated as essential habitat for the federally threatened desert tortoise (USFWS 2008). Out of five designated recovery units, the NEMRU had the least amount of desert tortoises per square mile (2-8) over a five year monitoring period (USFWS 2008). Restoration of degraded areas such as agricultural fields, have been recommended to reverse this trend. Agricultural activities degrade habitat by altering plant communities and rendering it unusable for burrowing sites. In addition, use of toxic chemicals and production of dust can adversely affect tortoises (USFWS 2008). After agricultural practices cease, abandoned areas usually become dominated by invasive plant species, as seen in Black Canyon, which provide little or no nutritional forage for desert tortoises.

Desert tortoises were not observed in a 2010 survey within the Refuge boundary or near the Black Canyon area. One incidental sighting occurred outside the Refuge boundary, west of the Middle Marsh in greasewood- saltbush habitat (SWCA 2011). Nevada Natural Heritage (2011) has also documented two desert tortoise sightings near Pahranagat NWR but outside the boundaries. One tortoise was observed west of the Middle Marsh and one southeast of Lower Lake.

Great Plains toads are found in Pahranagat NWR. In 2010, Great Plains toads were found at Upper Lake and Middle Marsh (SWCA 2011). The Great Plains toad is a species of conservation priority in Nevada. Currently no amphibian has been recorded in Black Canyon due to lack of

wetland habitat. Amphibian species such as the Great Plains toad require temporary or permanent ponds for breeding, while wetlands and grassy areas are utilized as summer foraging grounds.

Although the 2010 Refuge-wide inventory also documented small mammal captures and rare bird sightings, small mammals were not captured in any traps near or within Black Canyon and no rare or sensitive birds were documented (SWCA 2011). Some typical bird species associated with disturbance areas or agricultural lands, which could occur in the canyon include: western meadowlark, European starling, house sparrow, horned lark, killdeer, western kingbird, brown-headed cowbird, American kestrel, American robin, Brewer's blackbird and red-tailed hawk (GBBO 2003). None of these birds are currently sensitive species of conservation priority.

4.2.3 Soil Microbial Community

Soil microbial communities were tested at three locations in Black Canyon (Appendix Figure A-2). Soil communities consist of bacteria, fungi, protozoa, nematodes, earthworms and / or micro-arthropods. Bacteria and fungi are needed in the soil to maintain pH, nutrient cycling, and soil structure. Long after residual herbicides can be detected, the effects of herbicides on a site can still be present in the form of altered soil microbial communities. Herbicide use favors soil bacteria types, which cycle nutrients faster than soil fungi. This change in microbial community favors ruderal, weedy plant species.

Expected ranges of microbial community components are presented in the Appendix. Throughout the canyon, soil organic matter content is low (high dry weight, Appendix Table A-2). Microbial activity is also extremely low, which is common in sites where soil is dry. Higher levels of organic matter may increase microbial activity, but when soils are dry, little activity is expected. We observed a range of fungal biomass values throughout the canyon. Values are above average in a Russian knapweed-free site, which is dominated by inland saltgrass, rubber rabbitbrush and alkali sacaton. Values are within a desirable range in a patchy stand of Russian knapweed. Values are below a desirable range in the thick stand of Russian knapweed and in a transition zone into a playa.

4.3 Cultural Environment

4.3.1 Archeological

4.3.1.1 Prehistoric

Gilreath et al. (2011) recently surveyed Black Canyon for cultural artifacts. High concentrations of petroglyphs occur on the canyon walls. Surveyors also found and described isolated artifacts and rock formations that may have served as potential shelter, hunting blinds, or sacred prayer sites in the same area. Evidence suggests Black Canyon is a significant historic site to Native Americans, especially Southern Paiutes, but also Western Shoshone, Owens Valley Paiute, and Mohave peoples. The rock art located on the walls of Black Canyon were estimated at between 1,500 – 9,000 years old, though other artifacts are more recent (Gilreath et al. 2011). The

recent study suggests that even older evidence of prehistoric human use of the valley may be buried under current valley soils.

4.3.1.2 Historic

Arrival of Euro-American explorers and settlers in the Pahranagat Valley in the early 1800s brought new land uses, and remnants of these historic activities can be found in Black Canyon. An old raised gravel road, the old Highway 93, cuts across the northern end of the canyon. Two ditches that were used for irrigation also occupy the canyon edges. Other evidence of more modern habitation includes old automobiles and farm equipment, a dump site from circa 1940, and the foundation of a house. Some of the rock art found in the area display drawings of modern themes and a date of 1899 (Gilreath et al. 2011).

5 ENVIRONMENTAL CONSEQUENCES

5.1 Alternative A - Restoration

5.1.1 Soil Impacts

Channel restoration activities and weed removal would temporarily disturb soils and expose them to erosion until native vegetation is planted. Best Management Practices (BMPs) can be applied to minimize erosion during restoration activity. The BMPs include: 1) working in dry conditions and not introducing flows until the restoration is complete; 2) avoiding unnecessary disturbance; 3) placing and crimping mulch into all disturbed areas to minimize erosion; 4) placing natural fiber logs or straw bales to arrest erosion; and 5) re-vegetating all disturbed areas to prevent erosion in the long term. Other measures will pertain to the period of restoration and will include: 1) keeping all materials and equipment in a fenced, designated area, away from any water way; 2) cleaning all material and equipment prior to entering the site; 3) using designated access roads to perform restoration activities; 4) using water trucks to control dust; and 5) grading to prevent rilling and erosion.

Once channel restoration is completed, plantings of appropriate riparian or upland native trees, shrubs, and grasses would reduce erosion of newly disturbed soil surfaces. If needed, biodegradable erosion control, such as coir fabric <u>or straw logs</u>, can be applied along the banks concurrent with planting and seeding activities to prevent loosened soil from eroding into the new channel bed. Restoration practices that include re-vegetation to restore native plant communities should restore lost topsoil and soil microorganisms that have been degraded with long-term agricultural land use and intensive weed management.

Restoration would include creation of hillock areas <u>where soil removed from created channel and pond features would be deposited. Although these hillocks would add some undulating vertical relief to the currently existing flat topography of the Black Canyon floor, hillock features would blend into the surrounding landscape for a more natural appearance</u>. Because soil could potentially erode from these vertical relief areas during rain events, hillocks would be contoured to avoid development of rills and concentration of a large drainage in any one area.

Careful contour design along with additional planting efforts should reduce potential future erosion off hillock sites.

Given the limited microbial activity and low fungal biomass numbers in Black Canyon soils, soil amendments would increase the likelihood of establishing native plant species. Appropriate soil amendments include high energy sugars, as could be derived from a fish hydrolysate product, which would also improve soil fungal activity. A compost tea, including macro and micro nutrients as well as a heavy mulching, would stimulate fungal activity. Salvage plantings and inoculations of plantings, in addition to compost tea and mulch, would be of great benefit in the more heavily infested Russian knapweed and playa soil sites. If resources exist, taking small quantities of soil from desirable plant species in the wild and pairing them with the same species of plants used in revegetation efforts would help reintroduce missing members of the microbial communities. The addition of organic matter would improve soil biology, add soil structure and increase water holding capacity.

Cumulative impacts from Alternative A would be mostly positive as water added to the soil would sustain enhanced soil microbial communities, which in turn would support functioning wetlands and a riparian corridor.

5.1.2 Water Resource Impacts

Channel and wetland restoration in Black Canyon would return water to the historic river channel and increase valuable wetland habitat on the Pahranagat NWR. Refuge water stored in Upper Pahranagat Lake would be used to support these restoration features. Water use for the Black Canyon restoration could slightly reduce water availability for the Middle Marsh and lower parts of the Refuge due to evaporation and transpiration by the larger acreage of riparian and wetland plants that would be created in Black Canyon as compared to the existing string of riparian trees and shrubs that currently occur along the ditch on the west side of Highway 93. However, impacts to Middle Marsh habitats, if any, should be minimal because in a scale context with the entire Refuge, the area of change in flow path is very small as the project only changes the flow path from the west side of Highway 93 to the east side. The soils in Black Canyon are mostly impermeable silt and clay, and the water that passes through the Black Canyon restoration footprint and seeps downward through soils in the southern end of the canyon and the Headquarter Ponds area would serve to recharge the local aquifer, which feeds the surface and groundwater in the Middle Marsh. Additionally, a water budget with a fixed watering schedule constrains the amount of water allotted for the Black Canyon restoration effort. The establishment of native riparian, wetland, and upland plant communities in Black Canyon would increase the acreage of desirable wetland and riparian habitats on Pahranagat NWR that could support a diverse array of wildlife species.

5.1.3 Water Quality Impacts

Currently, water does not flow through Black Canyon. A water control structure located just upstream of the channel entrance to Black Canyon diverts current water passage into the ditch

system along the west side of Highway 93. Thus, all restoration work can be completed in dry conditions and should have no impact on water quality. Pahranagat Creek flows would be retained in the existing ditch on the west side of Highway 93 until the restored Black Canyon channel could be created. Once the entrance culvert opening has been cleared and the channel is finished, restoration crews could carefully turn the Pahranagat Creek flows into the new channel. By keeping flows in the existing ditches on the west side of the highway until restoration is complete, immediate impacts to water quality would be minimized.

Water passage through Black Canyon could transport unwanted chemicals, if present. Because chemical residues of herbicides that were used in Black Canyon for weed management may still exist in the soil, soil samples from Black Canyon were analyzed for herbicide presence. These residues, specifically Tordon if present, are of concern because water passage reintroduced through the canyon could potentially transport unwanted herbicide residues either to restoration plantings, through the soil to contaminate groundwater, or to off-site (downstream) locations where residual herbicides could unintentionally impact desirable plant species (Table 5-1). Milestone was detected in the top three inches of the soil profile throughout Black Canyon (Appendix Table A- 1). This herbicide could inhibit new plant growth at the restoration site, but potentially contaminated soils would be buried to avoid this scenario.

Residues of other herbicides that have been applied in Black Canyon in the past that include Transline, Tordon, and 2,4-D were not detected down to 18 inches below the ground surface and thus these chemicals pose no threat to the restoration. Remedying the soil microbial community (Section 5.1.1) through native revegetation efforts would further aid in the decomposition of residual herbicides.

Positive cumulative impacts on water quality from Alternative A would develop from channel and wetland creation, and the establishment of a riparian corridor that supports native plants. Native grass, forbs, trees, and shrubs could filter suspended solids and uptake nitrogen to promote improved water quality on the Refuge.

5.1.4 Air Quality Impacts

For the restoration alternative, associated traffic and creation of the new channel would disturb soil and raise dust. To minimize dust hazards, water trucks would spray water to tamp down loose soil. Site conditions would be monitored, and water truck use may be amended as needed to assure that air quality regulations are maintained. In the long-term, herbicide use for knapweed control and the associated health hazards from air-borne chemicals should be reduced or eliminated as native vegetation displaces undesirable weeds.

Table 5-1. Summary of the environmental fate of herbicides with relatively recent use (within the past 5 years) in Black Canyon.

Chemical	Effects of Water Contact	Residues in Black Canyon Soils
Picloram (Tordon 22K)	Picloram residues may remain highly toxic to many non-target broadleaf plant species, including aquatic plants, for more than one year post-application at normal rates. This herbicide readily dissolves in water and can leach through permeable soils with low organic content to contaminate surface and groundwater. Herbicide residues, if present, could impede native re-vegetation efforts and native plant establishment within and downstream of Black Canyon.	Not detected down to 18" below the ground surface.
Clopyralid (Transline)	Clopyralid is persistent in soil, with a half life of up to 11 months. It is soluble in water and very mobile in soil, thus could leach to contaminate ground and surface water. This herbicide is also volatile, meaning that it could evaporate from foliage and soil post-application and move away from the application site to adversely affect non-target broadleaf plants. Although this herbicide does not persist for as long a time as picloram, clopyralid residues, if present could inhibit new plant growth.	Not detected down to 18" below the ground surface.
Aminopyralid (Milestone)	Aminopyralid breaks down quickly in moist soils. Photolysis (decomposition caused by light) occurs when this chemical is in water. The half-life for aminopyralid in water is 0.6 days, and in soil, 34.5 days. Although aminopyralid residues could affect new plantings, this chemical's rapid decomposition rate gives this herbicide a low residual toxicity risk.	Detected in the top 3 inches of soil. These residues were found less than one year after application.
2,4-D	This chemical has a typical half life of 7-10 days in soil, and 10-50 days in water. High microbial activity in moist soils break down 2,4-D quickly in the environment. Rapid degradation of 2,4-D in the soils and removal by plant uptake minimizes the downward movement of this herbicide through the soil towards groundwater.	Not detected down to 18" below the ground surface.

5.1.5 Vegetation Impacts

Restoration would require removal of most existing vegetation within the restored area. The majority of the vegetation to be removed consists of non-native weeds, and should cause no adverse impacts to native vegetation. Restoration crews would clear areas containing invasive weeds, e.g. Russian knapweed, and the top 6 inches of soil would be scraped and buried beneath hillocks to remove the weed seed bank.

Although recent treatments with aminopyralid (Milestone®) have reduced some Russian knapweed populations from 50% cover to 25% cover, research has shown that herbicide treatment alone is not effective for continued Russian knapweed control (Beck 2008). The combination of herbicides and competition from desirable plants is the most effective method of control. Shade limits Russian knapweed persistence and spread (Dall'Armellina and Zimdahl

1988), thus with growth of planted riparian trees and shrubs in the area, a decline of Russian knapweed could be expected in a few years.

There is currently minimal riparian habitat in Black Canyon. The restoration provides an opportunity to decrease the presence of non-native species and establish approximately 25 acres of native trees, shrubs and herbaceous plants which provide food, shelter and nesting habitat for wildlife (Table 5-2; Figure 5-1). A qualified restoration ecologist would be on site to assure proper placement of the plants with respect to differences in landscape position, shade tolerance, soil type, and depth to groundwater. This native riparian corridor would displace undesirable weed species and the need for continuous herbicide application.

Note: Table 5-2 and Figure 5-1 were added to the Final Environmental Assessment to address comments received on the Draft Environmental Assessment.

Table 5-2. Vegetation types recommended for revegetation following restoration.

Vegetation Type	Acres
Emergent Marsh	2.2
Wet Meadow	1.2
Alkali Meadow	1.6
Riparian Woodland	13.8
Upland Shrubland	3.9
Rose Shrubland	2.2
Mesic Shrubland	0.3
Total	**25.2**

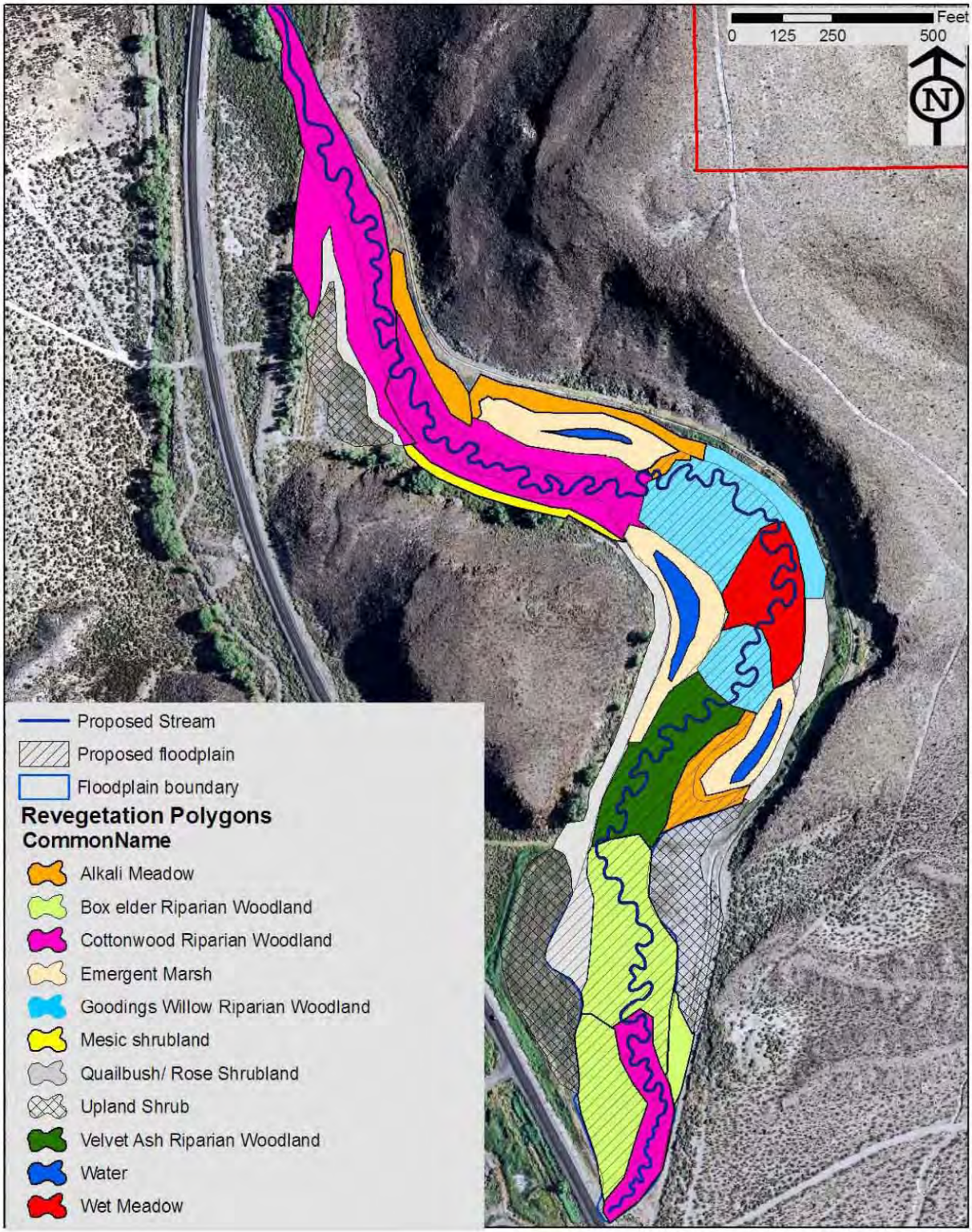

Figure 5-1. Vegetation types recommended for re-vegetation.

5.1.6 Endangered and Threatened Species Impacts

No endangered or threatened species currently inhabit the restoration area. A chuckwalla, a species of conservation priority, was recorded on Pahranagat NWR but this species was restricted to the rocky outcrops within Black Canyon (SWCA 2011) and thus would not occur on the canyon floor where restoration would take place. The restoration would not adversely impact any non-sensitive wildlife species because the area does not currently provide a major habitat source for any wildlife species.

Riparian areas are one of the most important habitat types for wildlife in desert landscapes. The restoration would create additional habitat that could benefit several species of migrating birds, bats, desert bighorn sheep and wildlife in general. Although the restoration effort does not focus on the recovery of any one particular species, the creation of willow habitat could potentially aid recovery efforts for the endangered southwestern willow flycatcher if careful water management allows restored willow patches to grow robust enough to support nesting flycatchers, and standing water during the flycatcher's breeding season can be sustained. Existing breeding habitat for the southwestern willow flycatcher located by the North Marsh should not be impacted since the water schedule for the Black Canyon was set to avoid conflicts with water management in the North Marsh. The created intermittent wetlands in Black Canyon could also provide additional habitat for amphibians such as the Great Plains toad, and the moist areas would support greater invertebrate diversity. The increased plant diversity established after restoration in the valley and created upland hillocks could provide an opportunity for desert tortoises to colonize the area.

5.1.7 Cultural Impacts

The Black Canyon restoration would potentially impact a significant cultural site. Although few to no artifacts were found on the canyon floor, where the restoration would take place, additional artifacts could be buried below existing soils. Because agriculture previously disturbed these soils, creation of the new channel and areas closer to the ground surface are unlikely to unearth any new artifacts. Should any artifacts be unearthed during restoration, restoration activities would cease and proper reporting and investigation of the artifact would follow. An onsite Tribal Inspector may be called upon to monitor restoration activities to assure that no artifact damage occurs. The location of known areas containing rock art or other cultural artifacts should be clearly marked to keep restoration efforts away from these sensitive areas.

Historical artifacts that include the two roads and ditches would be removed. Restoration activity should have no effect on existing historical or modern rock art panels.

Restoration Alternative A would create an area that is more aesthetically pleasing than the current abandoned agricultural field, potentially increasing visitor use of the area. Increased visitor use could potentially be both beneficial and damaging. Cultural education and preservation awareness would be gained, but vandalism could also increase. Refuge managers will carefully plan for protection of existing cultural resources in the canyon. This may include

planting vegetation barriers to discourage travel through sensitive areas or other appropriate measures in coordination with Tribal members and cultural resource specialists.

5.2 Alternative B - No Action

5.2.1 Soil Impacts

No impacts to the soil would occur. However, with no vegetation in the abandoned agricultural field, new topsoil would not regenerate. The soil would remain fallow and would continue to contain seeds for noxious weeds. Toxic residues of herbicide from continued weed management would remain in the soil and prevent new plant growth. The soil biotic community would not be improved.

5.2.2 Water Resource Impacts

Any surface water entering the canyon would still be diverted through the canyon via the existing ditch system.

5.2.3 Water Quality Impacts

No new impacts to water quality would occur.

5.2.4 Air Quality Impacts

Current herbicide applications in the canyon to control noxious weeds would likely continue under the no action alternative. Applicators currently take precautions to minimize the dispersal of wind-borne chemicals that contain health risks. However, disturbed and barren soil conditions from previous agriculture and current weed management policies would still create conditions susceptible to dust hazards in high winds.

5.2.5 Vegetation Impacts

Black Canyon would continue to be dominated by non-native plant species and noxious weeds, which would continue to spread to surrounding areas and further degrade other parts of the Refuge.

5.2.6 Endangered and Threatened Species Impacts

If no action is taken, Black Canyon would remain an abandoned agricultural field which provides minimal habitat for wildlife on the Refuge. The area would continue to be used marginally by side-blotched and western whiptail lizards and non-sensitive bird species associated with agricultural and disturbed lands.

5.2.7 Cultural Impacts

Soils would not be disturbed, leaving cultural artifacts within the canyon to remain. However, destruction or collection of petroglyphs and artifacts from visitors to the site could still occur. The old Highway 93 and ditch system would also remain.

6 Summary of Environmental Consequences by Alternative

6.1 Alternative A - Restoration

The following table summarizes the cumulative environmental impacts that would likely occur with Black Canyon channel restoration.

Table 6-1. Cumulative restoration impacts.

Impact	No Impact	Category	Notes
* +		Soil	Restoration would temporarily increase soil erosion. The soil biotic community would be enhanced.
#		Water Resource	Water would be budgeted and reallocated to support native plant communities in Black Canyon along the historic river channel. Increased evaporation and transpiration associated with plantings in Black Canyon could consume some water from the Upper Pahranagat Lake, but water seeping through the lower Black Canyon soils would recharge the local aquifer that supports water and meadow habitats in the Middle Marsh.
+		Water Quality	Minimal to no water quality impacts would occur since restoration would occur in a dry channel. Herbicide residues in the soil could contaminate contact water, but potentially contaminated soils would be buried to avoid this scenario. Restored riparian vegetation could improve the water quality of water passing through Black Canyon.
	*	Air Quality	Restoration would raise dust, but BMPs to reduce dust hazards would be applied to adhere to air quality regulations. Health and dust hazards from air-borne herbicides should be reduced over time.
+		Vegetation	Invasive weeds would be removed. New plantings would form native plant communities.
+		Listed Species	Restored riparian habitat could benefit some threatened and endangered species and species of concern that are not yet listed, which are known to occur on the Refuge.
#		Cultural	Restoration activity could unearth hidden artifacts. Some recent historical artifacts such as the old roads and ditches would be removed. Existing rock art or known prehistoric artifacts would not be touched.

+ Indicates a positive condition
- Indicates an undesirable condition
* Indicates a temporary condition
# Indicates a condition that is neither positive nor undesirable

The restoration alternative would have no significant negative impacts on existing Refuge resources. The addition of water in Black Canyon would enhance the soil biotic community and allow native plant establishment. This alternative would create desirable wetland and riparian habitat, and a return of limited water in Black Canyon would attract a suite of wildlife species that depend on rare water resources in the vast, arid desert for survival. Native vegetation would filter water and reduce excess nutrients and suspended solids and, therefore, improve water quality. Moreover, the establishment of native vegetation would reduce or eliminate the need for herbicide application and improve air and water quality.

6.2 Alternative B - No Action

The following table summarizes the cumulative environmental impacts if no action is taken in Black Canyon.

Table 6-2. Cumulative impacts from a no action alternative.

Impact	No Impact	Category	Notes
	-	Soil	Soil would remain undisturbed but sterile from continued herbicide applications.
	#	Water Resource	No changes would be made to the water budget.
	#	Water Quality	No impacts.
	-	Air Quality	Continued herbicide use could cause health risks. Dust hazards in the area could occur because no vegetation currently prevents dust from becoming airborne.
	-	Vegetation	Noxious weeds would remain a problem and potentially spread to outlying areas.
	-	Listed Species	Habitat within Black Canyon would continue to be unsuitable for conservation priority species.
	#	Cultural	All cultural artifacts would remain where they lie.

+ Indicates a positive condition
- Indicates an undesirable condition
* Indicates a temporary condition
# indicates a condition that is neither positive nor undesirable

The no action alternative would entail no change, and hence the continued existence of a weed-infested canyon floor that would not benefit wildlife. Air quality would continue to be negatively affected by herbicides used for weed control and dust hazards caused by low vegetation cover. Weeds could spread to areas outside Black Canyon and create the need for more weed control efforts.

7 PUBLIC AVAILABILITY

The Draft EA was available for public review and comment for a 30-day period from January 10th through February 10, 2012. A copy of the Draft EA and/or notification letter was distributed to potentially interested Federal, State, and local agencies, Tribes, and several special interest groups. The Draft EA was made available to the local community of Alamo, by posting a notice at the local post office, and by posting a notice and a copy of the Draft EA at the local library. The Draft EA was also made available to all interested parties via the Refuge website. Comments were received from four interested parties and are summarized in the following:

1. Native American Tribe – Acknowledged receipt Draft EA; reviewed document and did not have any comments.
2. Private Citizen – Primarily concerned with water delivery through restored area impacting areas further south on the Refuge. Believes reduced water on Refuge south of Black Canyon would result in impacts to species habitat and an increase of non-native plant species.
3. Red Rock Audubon Society – Supported the proposed restoration; however, had some concerns about the plan. Identified detail lacking in EA in order to evaluate relative merits. Provided numerous suggestions for restoration design options (e.g., more narrow, sinuous channel) and techniques (e.g., weed eradication strategies, native vegetation planting options, etc.).
4. Nevada Department of Wildlife – Supported the proposed restoration concept; however, concerned with lack of detail in the Draft EA. General concerns for and identified lack of descriptive content in the Draft EA centered on water management, and species and habitats targeted or benefitted. Specific comments for numerous sections of the Draft EA were provided.

Based on the comments received, modifications were incorporated into and are noted in the Final EA by underlined text. Relevant changes were also made to the project's revegetation implementation plan. This Final EA and associated Finding of No Significant Impact (FONSI) will be available to all interested parties via the Refuge website.

8 LIST OF PREPARERS

Diane Wong – Otis Bay Ecological Consultants
Jessica Saenz – Otis Bay Ecological Consultants
Lea Condon – Otis Bay Ecological Consultants
Nathan Bristow – Otis Bay Ecological Consultants
Susan Mortenson – Otis Bay Ecological Consultants

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10 APPENDIX

Figure A- 1. Soil pit 1 (north) and soil pit 2 (south) locations in Black Canyon (Google Earth 2007) were sampled for soil composition analysis.

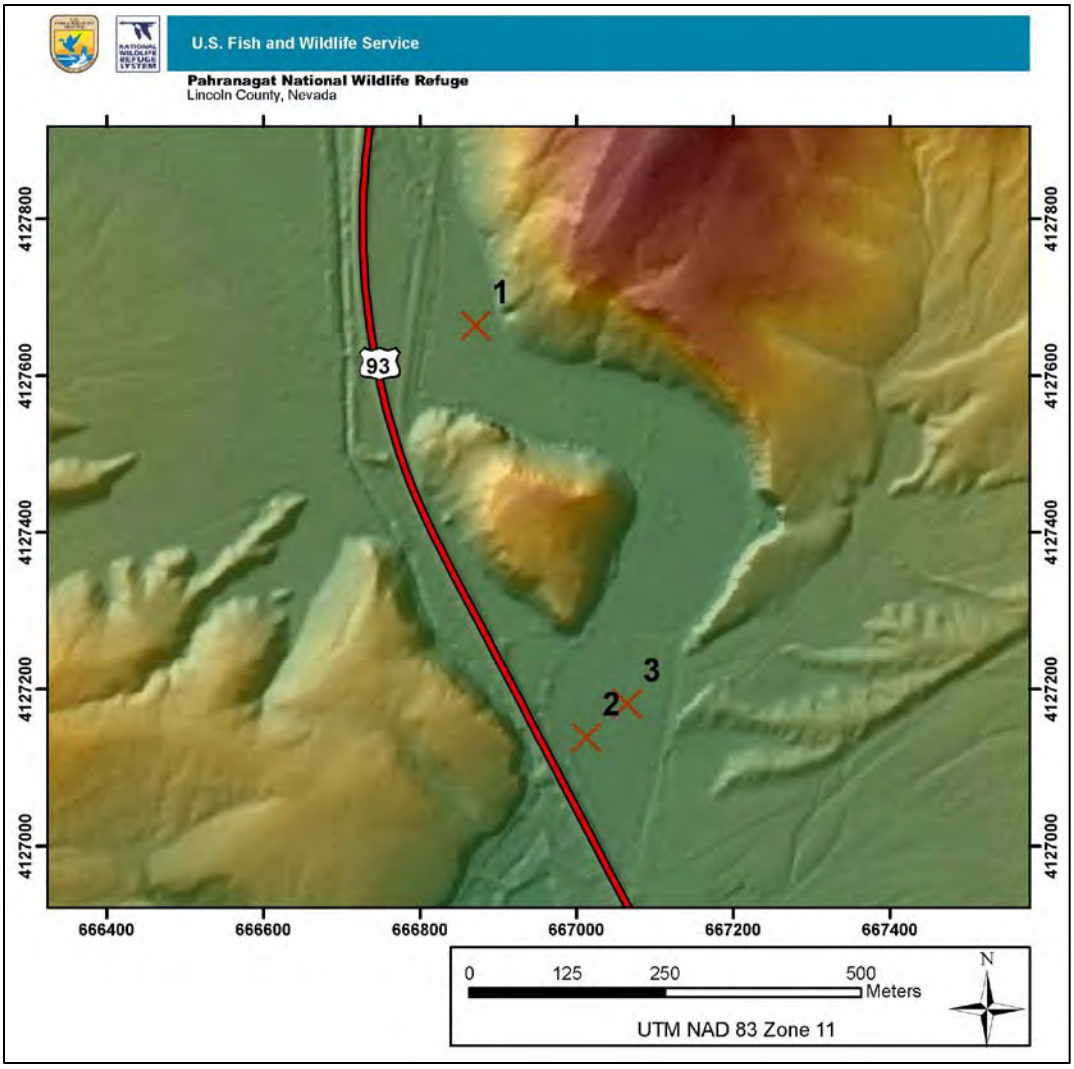

Figure A- 2. Soil sampling locations within Black Canyon, Pahranagat National Wildlife Refuge. These samples were analyzed for herbicide residues and soil microorganisms. 1- Russian knapweed at about 15% cover and bare interspaces, 2- Russian knapweed at about 50% cover, and 3- Playa, minimal knapweed, and field bindweed at 1-3% cover.

Table A- 1. Results of residual herbicide analysis of Black Canyon Soils.

Sample (number and depth)	**Aminopyralid, Milestone** (ppm)	**2,4-D** (ppm)	**Picloram , Tordon** (ppm)	**Clopyralid, Transline** (ppm)
Detection Limit	0.025	0.015	0.030	0.004
#1, 0-3”	0.529	Not detected	Not detected	Not detected
#1, 9-12”	Not detected	Not detected	Not detected	Not detected
#1, 15-18”	Not detected	Not detected	Not detected	Not detected
#2, 0-3”	0.074	Not detected	Not detected	Not detected
#2, 9-12”	Not detected	Not detected	Not detected	Not detected
#2, 15-18”	Not detected	Not detected	Not detected	Not detected
#3, 0-3”	0.102	Not detected	Not detected	Not detected
#3, 9-12”	Not detected	Not detected	Not detected	Not detected
#3, 15-18”	Not detected	Not detected	Not detected	Not detected

Table A- 2. Results of microbial analysis of Black Canyon soils. Font in italics represent ranges of concern.

Existing Vegetation	Dry Weight	Active Bacteria µ / g	Total Bacteria µ / g	Active Fungi µ / g	Total Fungi µ / g	Ratio of Total Fungi to Total Bacteria	Ratio of Active to Total Fungi	Ratio of Active to Total Bacteria	Ratio of Active Fungi to Active Bacteria
Inland saltgrass, alkali sacaton and rubber rabbitbrush	0.990 *above range*	2.59 *below range*	238 in range	0 *below range*	384 above range	1.61 high	0 *low*	0.001 *low*	0 *low*
Russian knapweed (low cover)	0.930 *above range*	0.37 *below range*	342 above range	0 *below range*	232 in range	0.68 *low*	0 *low*	0.001 *low*	0 *low*
Russian knapweed (high cover)	0.960 *above range*	2.67 *below range*	511 above range	0 *below range*	127 *below range*	0.25 *low*	0 *low*	0.005 *low*	0 *low*
Playa with low cover of Russian knapweed and field bindweed	0.970 *above range*	1.5 *below range*	721 above range	0 *below range*	93.7 *below range*	0.13 *low*	0 *low*	0.002 *low*	0 *low*
Expected ranges for perennials forbs	0.45-0.85	5-10	100-300	10-25	200-600	2-5	0.1-0.15	0.1-0.15	1-2
Expected ranges for grasses	0.45-0.85	10-25	150-300	10-25	150-300	0.8-1.5	0.1-0.15	0.1-0.15	0.75-1.5