United States Department of the Interior
Bureau of Land Management

Draft Environmental Assessment
DOI-BLM-NV-S030-2020-0003-EA

Nevada Wild Horse Range HMA
Wild Horse Gather Plan

U.S. Department of the Interior
Bureau of Land Management
Southern Nevada District
Pahrump Field Office
4701 N Torrey Pines Dr
Las Vegas, NV 89130
(702)515-5000

BLM

1.0 Purpose and Need for Action

1.1 Introduction

This Environmental Assessment (EA) has been prepared to analyze the Bureau of Land Management's (BML) Pahrump Field Office (PFO) proposal to gather and remove excess wild horses and burros from within and outside the Nevada Wild Horse Range (NWHR). The gather plan would allow for an initial gather and follow-up maintenance gathers to be conducted over the next 10 years from the date of the initial gather operation to achieve and maintain appropriate management levels. The proposed gather would include removing excess wild horses and burros from inside and outside the HMA and treating mares and studs with population growth suppression techniques.

This Environmental Assessment (EA) is a site-specific analysis of the potential impacts that could result with the implementation of the Proposed Action or alternatives to the Proposed Action. Preparation of an EA assists the BLM authorized officer to determine whether to prepare an Environmental Impact Statement (EIS) if significant impacts could result, or a Finding of No Significant Impact (FONSI) if no significant impacts are expected.

This document is tiered to the Nevada Test and Training Range Resource Management Plan and Final Environmental Impact Statement signed July 2004.

1.2 Background

Since the passage of the Wild Free-Roaming Horses and Burros Act (WFRHBA) of 1971, BLM has refined its understanding of how to manage wild horse population levels. By law, BLM is required to control any overpopulation, by removing excess animals, once a determination has been made that excess animals are present and removal is necessary. Program goals have always been to establish and maintain a "thriving natural ecological balance," which requires identifying the Appropriate Management Level (AML) for individual herds. In the past two decades, goals have also explicitly included conducting gathers and applying contraceptive treatments to achieve and maintain wild horse populations within the established AML, so as to manage for healthy wild horse populations and healthy rangelands. The use of fertility controls helps reduce total wild horse population growth rates in the short term, and increases gather intervals and the number of excess horses that must be removed from the range. Other management efforts include improving the accuracy of population inventories and collecting genetic baseline data to support genetic health assessments. Decreasing the numbers of excess wild horses on the range is consistent with findings and recommendations from the National Academy of Sciences (NAS), American Horse protection Association (AHPA), the American Association of Equine Practitioners (AAEP), Humane Society of the United States (HSUS), Government Accountability Office (GAO), Office of Inspector General (OIG) and current BLM policy.

The NWHR is located in the northern portion of the Nevada Test and Training Range (NTTR) within Nye County, in south-central Nevada. The NWHR comprises of approximately 1.3 million acres of public land withdrawn for use by the military. Due to this, no public access such as livestock grazing or recreational use is permitted within NTTR. See Map 1 (Appendix A).

The 2004 NTTR ROD and Approved RMP designated a "core use area" located within the entire North Range of NTTR. The RMP restricts the active management of wild horses to the Herd Management Area (HMA) Core Area which is approximately 484,000 acres. The plan specifies that repeated gathers on a four-year cycle will be conducted to maintain a population size within the AML range. The 2004 NTTR RMP allows the horses to continue to use forage and water throughout much of Cactus Flat, the Cactus Range, the Kawich Range, and Kawich Valley.

The management of wild horse is further outlined in the Nevada Wild Horse Range Herd Management Plan signed June 2008. The management strategy would incorporate a number of population control methods such as fertility control, 60/40 sex ratio in favor of males, and a non-reproducing component of geldings. The plan also proposed the maintenance and/or reconstruct existing water developments. The reconstruct was completed on the water sources in the summer of 2016. There are 20 ephemeral/intermittent water sources within NTTR, with only 6 being able to be developed for wild horse and wildlife use with surface flow redirection and storage. Water is a limiting factor within the NWHR and out of the 6 spring developments only 1 provides reliable water during the hot summer months. Due the continuing drought conditions 4 out of the 6 springs are dry and 1 of the remaining springs goes dry seasonally during the summer months. Even with BLM installing water storage tanks in place to store and hold excess water from spring sources. The water supply cannot support the overpopulation of wild horses.

The Appropriate Management Level (AML) is defined as the number of wild horses that can be sustained within a designated HMA so as to achieve and maintain a thriving natural ecological balance (TNEB) in keeping with the multiple-use management concept for the area. The range of AML for the Nevada Wild Horse Range is 300-500 wild horses. This population range was established at a level that would maintain healthy wild horses and rangelands over the long-term based on monitoring data collected over time as well as an in-depth analysis of habitat suitability. The AML range was established through prior decision-making process and re-affirmed through the Record of Decision (ROD) and approved Nevada Test and Training Range Resources Management Plan (RMP)/Environmental Impact Statement (EIS) (July 2004).

The NWHR was last flown in May 2019, and the inventory was conducted using the Double Simultaneous Count Method, in which observers in an aircraft independently observe and record groups of wild horses. Sighting rates are estimated by comparing sighting records of the observers. Sighting probabilities for the observers is then computed from the information collected and population estimated generated. The NWHR has an estimated population of 800 wild horses and 100 wild burros. These values are based on an aerial survey made using simultaneous double-observer methods (Griffin et al. 2020), and annual herd growth rates of 20% for horses, and 15% for burros since then. The current population is about 2.5 times over the AML lower limit.

Since 2007, NWHR has had a series of emergency gathers due to lack of water resources and animals in poor body condition. The last emergency gather was conducted in August of 2018. The bait and water trap gather operation gathered and removed 801 excess wild horses.

Based upon all information available at this time, the BLM has determined that approximately 500 excess wild horses and 100 excess wild burros reside within the Nevada Wild Horse Range and need to be removed in order to achieve the established AML, restore a thriving natural ecological balance (TNEB) and prevent further degradation of rangeland resources resulting from the current overpopulation of wild horses and burros.

1.3 Purpose and Need for Action

The purpose of the Proposed Action is to remove excess wild horses and burros from within and outside the Nevada Wild Horse Range, to manage wild horses to achieve and maintain established AML ranges for the HMA, to reduce the wild horse population growth rate in order to prevent undue or unnecessary degradation of the public lands associated with an overpopulation excess wild horses within and outside the HMA, and to restore a thriving natural ecological balance and multiple use relationship on the public lands consistent with the provisions of Section 1333 (a) of the Wild Free- Roaming Horses and Burros Act of 1971 [1].

The need for the Proposed Action is to protect rangeland resources and to prevent unnecessary or undue degradation of the public lands associated with excess population of wild horses and burros within the Nevada Wild Horse Range.

1.4 Land Use Plan Conformance

The Proposed Action is in conformance with the NTTR ROD and Approved RMP (July 2004) as required by regulation (43 CFR 1610.5-3(a)) as follows:

- **Objective:** "*Manage for healthy, genetically viable herds of wild horses in a natural, thriving ecological balances with other rangeland resources.*"
- **Objective:** "*Maintain the wild, free-roaming character of the wild horses on the withdrawn public lands.*"

1.5 Relationship to Laws, Regulations, and Other Plans

Statutes and Regulations

- The Action Alternatives are in conformance with the WFRHBA (as amended), applicable regulations at 43 CFR § 4700 and BLM policies.
- State Protocol Agreement between the Bureau of Land Management, Nevada and the Nevada Historic Preservation Office (1999)
- Final Environmental Assessment for the Nevada Wild Horse Range Herd Management Area Plan EA NV052-2008-223
- Endangered Species Act – 1973
- Wilderness Act – 1964
- National Environmental Policy Act of 1969 (as amended)
- Migratory Bird Treaty Act (1918 as amended) and Executive Order 13186 (1/11/01)
- Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.)
- Federal Land Policy and Management Act (FLPMA) of 1976 (43 U.S.C. 1701 et seq.)
- American Indian Religious Freedom Act of 1979
- Archaeological Resource Protection Act of 1979
- National Historic Preservation Act of 1966, as amended
- Appropriations Act, 2001 (114 Stat. 1009) (66 Fed. Reg. 753, January 4, 2001)
- United States Department of the Interior Manual (910 DM 1.3).
- Fundamentals of Rangeland Health (43 CFR 4180)

1.6 Conformance with Rangeland Health Standards and Guidelines

- Mojave/Southern Great Basin Resource Advisory Council (RAC) Standards and Guidelines (February 12, 1997)
  Mojave/Southern Great Basin RAC Standards and Guidelines

1.7 Decision to be Made

The Authorized Officer would determine whether to implement all, part, or none of the Proposed Action as described in Section 2.2.1 to manage wild horses within the NWHR. The Authorized Officer's

[1] The Interior Board of Land Appeals (IBLA) defined the goal for managing wild horse (or burro) populations in a thriving natural ecological balance as follows: "As the court stated in Dahl vs. Clark, supra at 594, the 'benchmark test' for determining the suitable number of wild horses on the public range is 'thriving natural ecological balance.' In the words of the conference committee which adopted this standard: 'The goal of WH&B management should be to maintain a thriving ecological balance (TNEB) between WH&B populations, wildlife, livestock and vegetation, and to protect the range from the deterioration associated with overpopulation of wild horses and burros.'"

decision may select gather methods, numbers of horses gathered, and population growth suppression technique depending on the alternative or parts of any alternative chosen. The Authorized Officer would not set or adjust AML since these were set through previous decisions.

1.8 Scoping and Identification of Issues

Issues identified by the BLM interdisciplinary team included rangeland health and vegetation, wetlands and riparian, wild horses, and wildlife. These resources are discussed in Chapter 3. Resources which were considered but would not be affected to the level requiring detailed analysis, are listed on pages 8-9.

2.0 Description of the Alternatives

2.1 Introduction

This section of the EA describes the Proposed Action and alternatives, including any that were considered but eliminated from detailed analysis. Four alternatives are considered in detail:

- Alternative 1: Proposed Action – Over a 10-year period, use gathers to remove excess animals in order to achieve and maintain within AML range, apply fertility control methods (vaccines and/ or IUDs) to released mares, establish a 60% male 40% female sex ratio, and a non-reproducing component of males (geldings).
- Alternative 2: Alternative 2 is the same as Alternative 1 but would include a non-reproducing (i.e. spayed mares) portion of the population.
- Alternative 3: Under Alternative 3, Gather and removal of excess animals to achieve and maintain wild horse and burro herd sizes within AML.
- Alternative 4: No Action — Continuation of Existing Management.

The Action Alternatives were developed to achieve and maintain the established AML so as to ensure a thriving natural ecological balance, remove excess wild horses and burros from the range, prevent further deterioration to the range, and ensure the long-term management of wild horses within the NWHR. Fertility control treatments to released animals would assist with slowing population growth. Under the No Action Alternative, no gather would occur, and no additional management actions would be undertaken to control the size of the wild horse and burro population at this time. The No Action Alternative would not achieve the identified Purpose and Need. The No Action Alternative does not comply with the WFRHBA of 1971, regulations, and the approved NTTR RMP (July 2004). However, it is analyzed in this EA to provide a basis for comparison with the other action alternatives, and to assess the effects of not conducting a gather at this time.

2.2 Description of Alternatives Considered in Detail

2.2.1 Management Actions Common to Alternatives 1-3

- The ten-year period would begin after the first gather is initiated. Additional gathers over the next 10 years may be needed to reach the lower AML based on gather success, holding capacity limitations, population growth rates, and other national gather priorities. Several factors such as animal condition, herd health, weather conditions, budget, or other considerations could result in adjustments to gathers and follow up gathers.
- All excess wild burros residing within the NWHR boundaries will be removed during gather operations.
- Gather operations would be conducted in accordance with the Comprehensive Animal Welfare Program (CAWP) for Wild Horses and Burro Gathers, which includes provisions of the Comprehensive Animal Welfare Program (BLM Instructional Memorandum 2015-151) (Appendix B). A combination of gather methods may be used to complete the management actions and the

methods to be used would depend on the needs of the specific actions including management needs regarding emergency situations.

- Trap sites and temporary holding facilities will be located in previously used sites or other disturbed areas whenever possible. Undisturbed areas identified as potential trap sites or holding facilities would be inventoried for cultural resources. If cultural resources are encountered, these locations would not be utilized unless they could be modified to avoid impacts to cultural resources.
- An Animal and Plant Inspection Service (APHIS) or other veterinarian may be on-site or on-call during the gather, as needed, to examine animals and make recommendations to BLM for care and treatment of wild horses.
- Decisions to humanely euthanize animals in field situations will be made in conformance with BLM policy (Washington Office Instruction Memorandum (IM) 2015-70).
- Data including sex and age distribution.
- Hair samples would be collected from a minimum of 25 animals, to determine whether BLMs management is maintaining an acceptable genetic diversity (avoiding inbreeding depression) of the herd, as measured by observed heterozygosity, in keeping with IM 2009-062 or current policy.
- Excess animals would be transported to the nearest BLM off-range corrals (ORC) with available space where they will be prepared (freezemarked, vaccinated and de-wormed) for adoption, sale (with limitations or most current policy) or off-range pastures (ORP).
- During gathers 1-3 studs and/or mares from a different HMA, with similar or desired characteristics of the horses within the NWHR could be released to maintain the genetic diversity.
- Funding limitations and competing priorities may require delaying the gather and population control component which would increase the number of horses that would need to be gathered.
- Population inventories and routine resource/habitat monitoring would be completed between gathers to document current population levels, growth rates, and area of continued resource concern (horse concentrations, riparian impacts, over-utilization, etc.) prior to any follow-up gather.

2.2.2 Management Actions Common to Alternatives 1-2

- Mares released back to the range would be treated with fertility control methods (vaccines and / or IUDs). Approximately 60 to 100 stallions would be gelded, and then released back to the range after they have healed from the procedure. Gelding and fertility control treatment would be conducted in accordance with standard operating procedures (SOPs, Appendices E and F). Mares and stallions would be selected to maintain a diverse age structure, herd characteristics, and conformation (body type).
- All mares treated would be clearly marked and photographed for future application/monitoring. Any gathered animals that are subsequently returned to the range would receive a uniquely numbered RFID chip, placed in the nuchal ligament, for permanent identification.
- All stallions gelded would be clearly marked and receive an RFID chip for future identification and monitoring.

2.2.3 Alternative 1 (Proposed Action)

The Proposed Action would gather approximately 90% of the existing wild horses and gather and remove 100% of the existing wild burros (approximately 720 wild horses with the 2020 foal crop and 100 wild burros with the 2020 foal crop) in the initial gather. Approximately 300-400 wild horses would be released back into NWHR and BLM will return periodically over the next ten years to gather excess wild horses and all burros to maintain AML and administer or booster population control measures to other gathered horses. After the initial gather, the target removal number would be adjusted accordingly based off population inventories for the NWHR and the resulting projection of excess animals over AML. All mares released back to the range would be treated with fertility control vaccine and/or IUDs. Some gelded horses that would otherwise be excess animals permanently removed from the range and sent to holding facilities for adoption/sales or long-term holding, may be returned to the range and managed as a non-breeding population of geldings. Animals selected for release would be done with the objective of adjusting the sex ratio in favor of males by 60% and 40% mares.

Under the Proposed Action a sufficient number of wild horses and burros would be gathered primarily from heavily concentrated areas within the project area and areas with limited water availability to reduce resource impacts in the most impacted areas and all wild horses and burros residing outside the NWHR boundary would be gathered and removed.

Selective removal procedures would prioritize removal of younger excess wild horse after achieving AML within the Range and allow older less adoptable wild horses to be released back to the HMA. Animals would be removed using the following removal criteria:: (1) First Priority: Age Class - Four Years and Younger; (2) Second Priority: Age Class - Five to Ten Years Old; (3) Third Priority: Age Class Eleven to Nineteen Years; (4) Fourth Priority: Age Class Twenty and Older should not be removed unless specific exceptions prevent them from being turned back to the range.

However, if gather efficiencies during the initial gather do not allow for the attainment of the Proposed Action during the initial gather (i.e., not enough horses are successfully captured to reach low AML), or if BLM is otherwise unable to permanently remove a sufficient number of excess horses to achieve low AML, the Pahrump Field Office would return to the NWHR to remove excess horses above low AML and would conduct follow-up gathers over a 10 year period after the initial gather to remove any additional wild horses necessary to achieve and maintain the low range of AML as well as to gather a sufficient number of wild horses so as to implement the population control components of the Proposed Action for wild horses remaining on the range.

If gather efficiencies of the initial gather should exceed the target removal number of horses necessary to bring the population within the AML range of 300-500 wild horses during the initial gather, BLM would begin implementing the population control components (fertility control vaccine and/or IUDs, gelding) of this alternative with the initial gather. The NWHR would continue to have a reproducing core breeding population range of 240-400 wild horses. The remaining balance of the herd (about 60-100 wild horses) would be managed as a non-breeding population of geldings. Population inventories and routine resource/habitat monitoring would be completed between gather cycles to document current population levels, growth rates and areas of continued resource concern (horse concentrations, riparian impacts, over-utilization, etc) prior to any follow-up gather. The subsequent maintenance gather activities would be conducted in a manner consistent with those described for the initial gather and could be conducted during the period of November through February which is identified as the period of maximum effectiveness for fertility control application. Funding limitations and competing priorities might impact the timing of maintenance gather and population control components of the Proposed Action.

The procedures to be followed for implementing fertility control are detailed in Appendix E. At the AML level established for the NWHR and based on known seasonal movements of the horses within the Range, sufficient genetic exchange should occur to maintain the genetic health of the population. All horses identified to remain in the NWHR population would be selected to maintain a diverse age structure, herd characteristics and body type (conformation). Please refer to Appendix D for further information on BLM’s use of contraception in wild horse management.

2.2.4 Alternative 2
Alternative 2 is similar to Alternative 1 with the exception that some fraction of the mares returning to the Range would be sterilized. The NWHR would continue to have reproducing core breeding population range of 240-400 wild horses. The balance of the herd (about 60-100 wild horses) would be managed as a

non-breeding population of sterilized mares and geldings. Gelded males and sterilized mares, horses that would otherwise be excess animals permanently removed from the range and sent to holding facilities for adoption/sales or long-term holding, may be returned to the range and managed as a non-breeding population of geldings Some sterilized mares (approximately 40 mares) will be included in the herd, in order to reduce the expected growth rate, and to allow more mares to remain on the range. All mares released back to the range and not selected for sterilization would be treated with fertility control (vaccine and/or IUDs). Animals selected for release would be done with the objective of adjusting the sex ratio in favor of males by 60% and 40% mares.

2.2.5 Alternative 3

Gather and remove excess animals to the low range of AML without fertility control, sex ratio adjustments, or a non-reproducing component. Impacts from this alternative would be similar to the gathering and handling impacts under the Proposed Action, however there would be no horses released or population growth suppression techniques administered to released horses. Wild horses would be gathered to the low range of AML, the AML would be exceeded sooner than under the Proposed Action or Alternative 2 since fertility rates would be higher without the use population growth suppression techniques.

2.2.6 Alternative 4: No Action

Under the No Action Alternative, no gather would occur, and no additional management actions would be undertaken to control the size of the wild horse and burro population at this time. The No Action Alternative would not achieve the identified Purpose and Need. The No Action Alternative does not comply with the WFRHBA of 1971, regulations, and the approved NTTR RMP (July 2004). However, it is analyzed in this EA to provide a basis for comparison with the other action alternatives, and to assess the effects of not conducting a gather at this time.

2.3 Alternatives Considered but Dismissed from Detailed Analysis

2.3.1 Gather the HMA to the AML Upper Limit

This alternative was dismissed from detailed study because AML would be exceeded the foaling season following the initial gather. This would result in the need to follow up with another gather within one year, and in increased stress to individual wild horses and the herd and continuing resource damage due to wild horse overpopulation in the interim. Nor would this alternative be consistent with the WFRHBA, which upon determination excess wild horses are present, requires their immediate removal.

2.3.2 Fertility Control Treatment Only (No Removal)

An alternative to gather a significant portion of the existing population (95% or more) and implement fertility control treatments only, without removal of excess wild horses was modeled using a three-year gather/treatment interval over a 11-year period, in the WinEquus software. Based on this modeling, this alternative would not result in attainment of the AML range for the NWHR and the wild horse population would continue to have an average population growth rate of 12.3% to 19.4%, adding to the current wild horse overpopulation, albeit at a slower rate of growth. In 11 years and 100 trials, the lowest number of 0 to 20+ year-old horses ever obtained was 727 and the highest was 5827. In half the trials, the minimum population size in 11 years was less than 865 and the maximum was less than 3842. The average population size across 11 years ranged from 1323 to 2767. With the average population size, this would lead to approximately 660 mares at a minimum that would need to be treated each gather and this would still leave the average population of wild horses over 4 times above the low-end AML. It is important to understand that in this scenario, each time a wild horse is gathered it is counted, even though the same wild horse may be gathered multiple times during the

11-year period. And each time wild horse is treated with PZP-22, it is counted even though the same wild horse may be treated multiple times over the 11-year period.

This alternative would not bring the wild horse population back to AML, would allow the wild horse population to continue to grow even further in excess of AML, and would allow resource concerns to further escalate. Implementation of this alternative would result in increased gather and fertility control costs without achieving a thriving natural ecological balance or resource management objectives. This alternative would not meet the purpose and need and therefore was eliminated from further consideration.

2.3.3 Field Darting with ZonaStat-H (Native PZP) and Gonacon

This alternative was eliminated from further consideration due to the difficulties inherent in darting wild horses in the project area. Field darting of wild horses works in small areas with good access where animals are acclimated to the presence of people who come to watch and photograph them. The size of the NWHR is very large (1,300,000 acres) and many areas do not have access. Access to military lands and the lack of approachability on the NWHR are such that it is not expected that delivering vaccine dose via darting could be possible with any regularity. The presence of water sources within the Range make it almost impossible to restrict wild horse access to be able to dart horses consistently. Horse behavior limits their approachability/accessibility, so that the number of mares expected to be treatable via darting would be insufficient to control growth. BLM would have difficulties keeping records of animals that have been treated due to common and similar colors and patterns. This formulation of PZP and Gonacon also requires a booster given every year following treatment to maintain the highest level of efficacy. Annual darting of wild horses in large areas can be very difficult to replicate and would be unreliable. For these reasons, this alternative was determined to not be an effective or feasible method applying population controls to wild horses from the NWHR.

2.3.4 Predators as Population Control Method

Predators such as mountain lions will prey on wild equids. However, monitoring indicates that the population of wild horses and burros within the NWHR HMA grows at a rate of about 15-20% per year. This annual rate of growth indicates predator populations within the NWHR are not sufficient to effectively slow wild horse and burro population growth. Further, wildlife management is the responsibility of the Nevada Department of Wildlife; BLM does not have the authority to manage predators within the state of Nevada. Therefore, this alternative was not considered in detail.

2.3.5 Use of Chemical Vasectomy instead of Gelding

The 2013 NAS report found that the three ‘most promising’ fertility control methods at that time were PZP vaccines, GonaCon vaccine, and “chemical vasectomy.” However, up to this time, the only known study assessing chemical vasectomy in horses was published by Scully et al. (2015), and stallions treated in that study were not consistently sterilized. Stallions treated with the chemical vasectomy method still had viable sperm and were still potentially as fertile as untreated ‘control’ stallions in the study. BLM’s goal in having sterile stallions in Alternatives 1 and 2 is to retain some sterile stallions on the range, that would otherwise have to be removed. For that reason, BLM is not assessing sterilization techniques from the perspective of which methods would or would not minimize changes in behavior. From the perspective of the stallions that are gelded but returned to the range, their lives are expected to be changed less by gelding and return to the range than if they are gelded and removed from the range. Even though the chemical agent used in Scully et al (2015) and Collins and Kasbohm (2016) is available for use in the USA, it was not shown to be successful. In this context, <u>BLM’s choice to use gelding as a management tool is not primarily motivated to reduce female fertility but rather, to allow some number of sterile males to return to the range that would otherwise be removed. For that reason, it is expedient to use a stallion sterilization method that is well established and common: namely, gelding.</u> Some gelded horses that would otherwise be excess animals permanently removed from the range and sent to holding facilities for adoption/sales or long-term holding, may be returned to the range and managed as a non-breeding population of geldings so long as the geldings do not result in the population exceeding mid-range AML.

2.3.6 Chemical Immobilization

Chemical immobilization as a method of capturing wild horses is not a viable alternative because it is a very specialized technique and is strictly regulated. Currently the BLM does not have sufficient expertise to implement this method and it would be impractical to use given the size of the HMA, access limitations, and approachability of the horses.

2.3.7 Use of Wrangler on Horseback Drive-trapping

Use of wranglers on horseback drive-trapping to remove excess wild horses can be somewhat effective on a small scale but due to the number of horses to be gathered, the large geographic size of the HMA, and lack of approachability of the animals, this technique would be ineffective and impractical as a substitute for helicopter trapping. Wild horses often outrun and outlast domestic horses carrying riders. Helicopter assisted roping is typically only used if necessary and when the wild horses are in close proximity to the gather site. For these reasons, this method was eliminated from further consideration.

2.3.8 Raising the Appropriate Management Level for wild horses

Delay of a gather until the AMLs can be reevaluated is not consistent with the WFRHBA, Public Rangelands Improvement Act (PRIA) or FLPMA or the existing NTTR RMP. Monitoring data collected within the Range does not indicate that an increase in AML is warranted at this time. On the contrary, such monitoring data confirms the need to remove excess wild horses above AML to reverse downward trends and promote improvement of rangeland health. Delay of a gather until AML can be evaluated and adjusted is not consistent with the WFRHBA, Public Rangelands Improvement Act (PRIA) or FLPMA or NTTR RMP. Severe range degradation would occur in the meantime and large numbers of excess wild horses would ultimately need to be removed from the range in order to achieve the AMLs or to prevent the death of individual animals under emergency conditions. This alternative was eliminated from further consideration because it is contrary to the WFRHBA which requires the BLM to manage the rangelands to prevent the range from deterioration associated with an overpopulation of wild horses.
Raising the AML where there are known resource degradation issues associated with an overpopulation of wild horses does not meet the Purpose and Need to restore a thriving natural ecological balance or meet Rangeland Health Standards.

3.0 Affected Environment

This section of the EA briefly discusses the relevant components of the human environment which would be either affected or potentially affected by the Action Alternatives or No Action (refer to Table 2). .

3.1 General Description of the Affected Environment

The NWHR HMA encompasses 1.3 million acres of withdrawn public land, within Nye County, NV, (Map 1, Appendix A).

The NWHR is located within the southern part of the Great Basin, the northernmost sub-province of the Basin and Range physiographic province. The physiography of the NTTR is typical of the Basin and Range Province, with north-south trending mountain ranges separated by broad valleys. Elevation within the North Range varies from 4,500 feet in the valley bottoms to 7,000-9,000 feet on the mountain tops.

The amount of annual precipitation is strongly influenced by the elevation, with valley bottoms receiving about 6 inches to 12-16 inches at the highest elevations. Temperatures also vary, from -20 degrees Fahrenheit in winter to between 100-105 degrees Fahrenheit in summer.

3.2 Description of Affected Resources/Issues

Table 2 lists the elements of the human environment subject to requirements in statute, regulation, or executive order which must be considered.

Supplemental Authorities (Critical Elements of the Human Environment)

Supplemental Authorities	**Present**	**Affected**	**Rationale**
ACECs	**NO**	**NO**	Not present.
Air Quality	**YES**	**NO**	The planning area is outside a non-attainment area. Implementation of the Proposed Action would result in small and temporary areas of disturbance.
Cultural Resources	**YES**	**NO**	To prevent any impacts to cultural resources, trap sites and temporary holding facilities would be located in previously disturbed areas. Cultural resource inventory and clearance would be required prior to using trap sites or holding facilities outside existing areas of disturbance per the State Protocol under Appendix A.10.
Environmental Justice	**NO**	**NO**	Not present.
Fish Habitat	**NO**	**NO**	Not present.
Floodplains	**Yes**	**NO**	Rangelands would be impacted by the proposed action. See analysis below.
Forest and Rangelands/Vegetation	**YES**	**YES**	Present and affected – see analysis.
Fuels and Fire Management	**YES**	**NO**	Follow standard stipulations and mitigation measures to prevent human caused wildfires. Consult with the Fire Management Officer on current fire danger two weeks prior to field activities. See Appendix H for standard stipulations and mitigation measures.
Wildlife including Migratory Birds	**YES**	**YES**	Proposed action would occur outside of the migratory bird nesting season. Wildlife are present, see analysis below.
Native American Religious Concerns	**YES**	**NO**	No new ground disturbance is authorized. There will not be any historic properties under Section 106 that will be affected by the action.
Noxious Weeds	**YES**	**NO**	To prevent the risk for spread weeds, hay is to be free of any weed seeds and any noxious weeds or non-native invasive weeds would be avoided when establishing and accessing trap sites and holding facilities. In addition, standard stipulations and mitigation measures would be followed to prevent the spread of weeds. See Appendix H for standard stipulations and mitigation measures.
Prime or Unique Farmlands	**NO**	**NO**	Not present.
Riparian-Wetland Zones/Soils	**YES**	**YES**	Present- see analysis.
T&E Species	**NO**	**NO**	No federally listed or proposed to be listed species are known to be present. No Designated Critical Habitat present.

Water Quality	**YES**	**No**	Reduced wild horse and burro populations as outlined within the Proposed Action will mitigate and improve water quality concerns within the NWHR.
Waste (Hazardous or Solid)	**NO**	**NO**	Not present.
Wild and Scenic Rivers	**NO**	**NO**	Not present.
Wilderness and Wilderness Study Area	**NO**	**NO**	Not present.
Wild Horse and Burro	**YES**	**YES**	Present- see analysis.

Critical elements of the human environment identified as present and potentially affected by the Action Alternatives (Alternative 1-3) and/or the No Action Alternative include:

- Forest and Rangelands/Vegetation
- Wildlife including Migratory Birds
- Riparian-Wetland Zones/Soils
- Wild Horse and Burro

3.2.1 Forest and Rangelands/Vegetation
Floristically, the North Range of the NTTR (where the proposed gather would take place) is within the Great Basin floristic province. The lower elevation vegetation of this area is characterized by shadscale and greasewood (*Sarcobatus vermiculatus*). Intermediate elevations are dominated by Great Basin desert scrub characterized by horsebrush (*Tetradymia* spp.), rabbitbrush (*Chrysothamnus* spp.), hopsage (*Grayia spinosa*), greasewood, shadscale, and sagebrush (*Artemisia spinescens*). The higher elevations have pinyon and juniper trees with an understory of rabbitbrush and ephedra (*Ephedra* sp.). Much of this habitat has been invaded by the non-native grass species cheatgrass (*Bromus tectorum*), which is not palatable to horses or burros most of the year.

Rangeland or wild horse monitoring data collected from the NWHR shows that vegetative utilization attributable to wild horses has remained moderate to severe use in areas surround key water sources. Wild horse numbers have continued to increase while wildlife numbers have remained fairly constant. Excess utilization in key grazing areas and trampling in riparian areas by wild horses is currently impacting rangeland health and inhibiting recovery of both uplands and riparian areas. Without the removal of wild horses and burros in excess of low-end AML we would not see improvement of rangeland resources.

The Proposed Action would impact vegetation temporarily with trampling and disturbance of vegetation occurring at gather sites and holding locations. Disturbance would occur to native vegetation in and around temporary gather corrals and holding facilities due to the use of vehicles and concentration of horses in the immediate area of such facilities. The disturbed area, however, would make up less than one acre. Gather corrals and holding facility locations are usually selected in areas easily accessible to livestock trailers and standard equipment, utilizing roads, gravel pits or other previously disturbed sites, and which are accessible using existing roads. New roads are not created to construct capture corrals.

3.2.2 Riparian-Wetland Zones/Soils
Water is a limiting factor on the Nevada Wild Horse Range. Of the 20 spring sources located within the NWHR only 6 have the production capability to develop storage for long term use. Cactus, Rose, Silverbow, Tunnel, Corral, and Cedar Springs were all developed with storage capabilities for wild horse and wildlife use. Of these developments, Silverbow, Tunnel, Corral, and Cedar Springs are permanently dry. During the summer months, the majority of the NWHR HMA herd waters at Rose Spring and at Cactus Spring if enough water can be stored during dryer months. The current over population of wild horses is increasing beyond to springs production capability, creating resource damage, and preventing

recovery of key sites and wildlife habitat. Even with the development of water storage and troughs of different springs current water supply is unable to meet the demands of the excessive wild horse and burro population within the HMA.

The NWHR core use area contains small riparian areas and their associated plant species occur near seeps, springs, and along sections of perennial drainages. Many of these areas support limited riparian habitat and water flows. Available data show that wild horse and burro use of most of these areas currently ranges between moderate to severe use. Trampling and trailing damage by wild horses is evident at most locations; Soil compaction and surface and rill erosion is evident.

In terms of direct impacts there are no negative impacts. However, in terms of indirect impacts, water quality will increase once wild horse and burro numbers are reduced. And under the No Action alternative water quality will further deteriorate. The majority of the springs are allowed to flow naturally over the landscape, which gets impacted by wild horse and burro use. To avoid the direct impacts potentially associated with the gather operation, temporary trap sites and holding/processing facilities would not be located within riparian areas. Managing the wild horse populations within the established AMLs over the next 10 years would be expected to initiate recovery of damaged riparian habitats. The amount of trampling/trailing would be reduced. Utilization of the available forage within the riparian areas would also be reduced to within allowable levels. Over the longer-term, continued management of wild horses within the established AMLs would be expected to result in healthier, more vigorous vegetative communities. Hoof action on the soil around unimproved springs and stream banks would be lessened which should lead to increased stream bank stability and decreased compaction and erosion. Improved vegetation around riparian areas would dissipate stream energy associated with high flows, and filter sediment, resulting in associated improvements in water quality. The Proposed Action would make progress towards achieving and maintaining proper functioning condition at riparian areas. There would also be reduced competition among wildlife, and wild horses for the available water. But if the No Action Alternative it selected then water quality throughout the HMA will continue to decline.

3.2.2 Wildlife including Migratory Birds

The NWHR provides habitat for many species of wildlife, including large mammals like mule deer, pronghorn antelope, and Desert Bighorn Sheep, and several BLM sensitive animal species are found within the NWHR including several species of bats, raptors, greater sage-grouse, and other birds.

The greater sage-grouse (BLM sensitive species) is a high-profile sensitive species that has been determined by the U.S. Fish and Wildlife Service to be warranted for listing but precluded due to higher priority species, and therefore considered a candidate species. The NWHR lies at the edge of the greater sage-grouse's range in Nevada and delineated habitat for Greater Sage-Grouse is identified in the north/northeastern portion of the NWHR, around the Kawich Range. The habitat identified around the Kawich Range that falls within the NWHR is winter habitat for greater sage-grouse. Only a small area of habitat within the NWHR is identified as summer habitat. Immediately north of the NWHR boundary is identified as nesting habitat for greater sage-grouse. Greater sage-grouse require a herbaceous understory of forbs and grass to provide nest concealment, as well as provide a diet of forbs and insects for sage-grouse and their chicks. Riparian areas are frequently used by sage-grouse for late brood-rearing habitat. The NWHR overlaps the Kawich population management unit (PMU) identified in the local sage-grouse conservation plan. There are no known sage-grouse leks within the NWHR, but there are known leks north of the NWHR boundary.

There is year-round pronghorn antelope habitat throughout the majority of the NWHR. Pronghorn prefer gentle rolling topography and flat prairie or tablelands. In some areas they are found utilizing the more mountainous terrain. In the NWHR, the valleys between mountain ranges are the areas where you would expect to find Pronghorn.

Desert bighorn sheep (BLM sensitive species) year-round habitat has been identified by Nevada Department of Wildlife (NDOW) in the western half of the NWHR. Desert bighorn sheep inhabit the Cactus Range, Stonewall Mountain, and Pahute Mesa within NWHR. Typical Desert Bighorn terrain is rough, rocky and steep, broken up by canyons and washes. This type of terrain affords them the advantage in coping with predation. Desert Bighorns live in regions of the state marked by hot summers and little annual precipitation. Bighorn sheep require daily access to freestanding water during summer months, and in drought conditions they may need to water daily throughout the year.

Mule deer year-round habitat is also present throughout the NWHR, particularly in the mountainous areas. Designated NDOW mule deer habitat occurs in the Kawich Range, Cactus Range, Stonewall Mountain, Pahute Mesa, Shoshone Mountain, and Belted Range. Mule Deer move between various zones from the forest edges at higher elevations to the desert floor, depending on the season. Generally, they summer at higher elevations and winter at lower elevations, following the snow line. Mule Deer occupy almost all types of habitat within their range, yet they seem to prefer arid, open areas and rocky hillsides. Areas with bitterbrush and sagebrush provide common habitat. Mature bucks tend to prefer rocky ridges for bedding grounds, while the doe and fawn is more likely to bed down in the open.

3.2.4 Wild Horses and Burros

The NWHR pre-dates the 1971 Wild Free-Roaming Horses and Burros Act (WFRHBA). The NWHR was created in June 1962 through a cooperative agreement between BLM Nevada and the Commander of Nellis Air Force Base. The original NWHR was reduced to 399,000 acres in June 1965.

The NWHR was formally designated as a herd management area (HMA) through the July 2004 ROD for the approved NTTR RMP. The decision to designate 1.3 million acres of the NTTR as an HMA was based on the best available historical information that indicated wild horses probably used much of the northern portion of the range in 1971. Under the 2004 ROD, the 484,000-acre NWHR HMA core area was used in establishing the AML as a range of 300-500 wild horses[1]. Based on this in-depth analysis, 500 animals is the upper limit of the population range that will lead to a thriving natural ecological balance in the NWHR HMA. Removing excess wild horses before reaching the upper limit of the population range (500 animals) is expected to maintain a thriving natural ecological balance and multiple-use relationship between wild horses, wildlife, vegetation and water resources and provide for safe and efficient military operations over the long-term.

Based on analysis of data from an aerial survey in late May 2017 (Ekernas 2017), it was estimated that there were 970 adults on the NWHR at that time. In surveys, yearlings are included with adults in a single count, and young-of-the-year are recorded as foals. If the approximate growth rate of 20% per year is added to that estimate, the estimated herd size as of August 2018 would have been 1396 wild horses. The most recent removal of excess wild horses from the NWHR HMA was completed in August 2018 when 801 horses were gathered and 801 were removed. The May 2019 aerial survey included a direct count of 564 adults. These estimated numbers of adults in May 2017, animals removed in August 2018, and adults seen in May 2019 are consistent with an approximate growth rate of 18.5% -20%. The current estimated population of approximately 800 wild horses and 100 wild burros in the NWHR HMA is based on an aerial population survey completed in May 2019.

[1] A key management area is an area of land that influences or limits the use of the land surrounding it. Management actions are based on the key management area.

Water is a limiting factor on the Nevada Wild Horse Range. During the summer months, the majority of the NWHR herd waters at two primary water sources within the NWHR HMA core area; they are Cactus Spring and Rose Spring. Some horses water at other ephemeral/intermittent springs to a lesser extent; these springs have a reduced amount of water available to wild horses. As a result, the BLM and Department of Defense (DoD) have had to provide supplemental water during the hot, dry summer months at several locations since July 2005 to sustain the excess wild horses on the NWHR HMA. This is a clear indication that the number of animals present on the NWHR exceeds the naturally available resources. This shortage of water has led to wild horses concentrating around the few remaining water sources, many of which are located adjacent to roads critical to military operations.

The NWHR has had a number of emergency removals since 2007 due to lack of water resources within the Range. Since 2007 BLM has removed 1,928 excess wild horses from the range due to emergency removals. The area still has water issues due to the current overpopulation of wild horses within the Nevada Wild Horse Range.

Monitoring data shows moderate to severe utilization of available forage within a 1-2-mile radius of the available water; horses are often traveling long distances to obtain adequate forage and social space. At the present time, wild horses are mostly in good physical condition; however, the health of the current wild horse population cannot be sustained based on the current available water without continued artificial supplementation by the BLM and DoD. Which is not in compliance with the WFRHBA of 1971 of managing wild horses and burros within a "Thriving Natural Ecological Balance" and 43 CFR 4710.4 "management shall be at the minimum level necessary to attain the objectives identified in approved Land Use Plans (LUPs) and Herd Management Area Plans (HMAPs). The Wild Horses and Burros Management Handbook 4700 further defines that supplemental feed or rely on water developments that require frequent maintenance is not consistent with management at the minimal level. It may, however, be appropriate to provide water in temporary emergency situations.

Genetic analysis of the NWHR HMA herd was completed in June 2004[2], using a set of blood-based genetic markers. In that study (Cothran 2004), data indicated that while observed heterozygosity in the herd was relatively low, it was above the critical threshold for concern. Genetic similarity (S) of sampled horses was highest with the Heavy Draft horse breeds and Iberian breeds. Samples from the NWHR HMA herd had greatest similarity with horses from the Stone Cabin HMA, and the Antelope Valley and Dolly Varden herds. There is a high incidence of club-footed horses within the population; this condition may be attributed to a recessive gene within the breeding population. New genetic monitoring samples were collected during the gather in August of 2018; those results are still pending completion and analysis.

The 2013 National Academies of Sciences (2013) recommended that single HMAs should not be considered isolated genetic population. Rather, managed herds of wild horses should be considered as components of interacting metapopulations, connected by interchange of individuals and gens due to both natural and human-facilitated movements. In the specific case of the NWHR, the ancestry of horse in this area is a mixed origin, apparently from a number of domestic breeds (Cothran 2004). The NAS report included further evidence that shows that the NWHR HMA herd is not genetically unusual, with respect to other wild horse herds. Specifically, Appendix F of the 2013 NAS report is a table showing the estimated 'fixation index' (Fst) values between 183 pairs of samples from wild horse herds. Fst is a measure of genetic differentiation, in this case as estimated by the pattern of microsatellite allelic diversity analyzed by Dr. Cothran's laboratory. Low values of Fst indicate that a given pair of sampled

[2] Genetic Analysis of the Feral Horse Herd from the Nevada Test and Training Range (Nellis), E. Gus Cothran, June 23, 2004, Department of Veterinary Science, University of Kentucky, Lexington, KY 40546-0076 (copy on file in the Las Vegas Field Office).

herds has a shared genetic background. The lower the Fst value, the more genetically similar are the two sampled herds. Values of Fst under approximately 0.05 indicate virtually no differentiation. Values of 0.10 indicate very little differentiation. Only if values are above about 0.15 are any two sampled subpopulations considered to have evidence of elevated differentiation[3]. In the 2013 NAS report appendix, samples from the NWHR HMA are listed in the table under the heading, "NV Nellis." Fst values for the NWHR HMA herd had pairwise Fst values that were less than 0.05 with 134 other sets of samples. This high level of genetic similarity was found in relation to other sampled herds including from California, Colorado, Idaho, Nevada, Oregon, Utah, and Wyoming. These results support the interpretation that NWHR HMA horses are components in a highly connected metapopulation that includes horse herds in many other HMAs.

Population modeling was completed for the Nevada Wild Horse Range using Version 3.2 of the WinEquus population (Jenkins 200) to analyze how the alternatives would affect the wild horse population. This modeling analyzed removal of excess wild horses within no fertility control, as compared to removal of excess wild horses with fertility control for released horses. The No Action (no removal) Alternative was also modeled. One objective of the modeling was to identify whether any of the alternatives "crash" the population or cause extremely low population numbers or growth rates. Minimum population levels and growth rates were found to be within reasonable levels and adverse impacts to the population not likely. Graphic and tabular results are also displayed in detail in Appendix C.

4.0 Environmental Consequences

4.1 Introduction

This section of the EA documents the potential environmental impacts which would be expected with implementation of the Action Alternatives (Alternatives 1-3), and/or the No Action Alternative. These include the direct impacts (those that result from the management actions) and indirect impacts (those that exist once the management action has occurred).

4.2 Predicted Effects of Alternatives

The direct and indirect impacts to these resources which would be expected to result with implementation of the Action Alternatives or No Action Alternative are discussed in detail below.

4.2.1 Forest and Rangelands/Vegetation

Impacts from Action Alternatives 1-2

Temporary trap sites may have a short term impact on vegetation resources. These vegetative resources are currently being utilized by the existing wild horse population, the additional impact from a potential trap site would be minimal.

Achieving and maintain the established AML, would benefit the vegetation by reducing the grazing pressure on the forage resources. Removal of excess wild horses would reduce the population to levels that would be in balance with the available water and forage resources. Maintaining AML within the NWHR would prevent overgrazing, damage by trampling or pawing, and would help promote improved rangeland health.

Impacts from Alternative 3

Impacts would be the same as in the proposed action; however, improved vegetative conditions for all plant species may not last as long because wild horse populations may exceed the high end of AML more quickly than under the proposed action

[3] Frankham, R., J. D. Ballou, and D. A. Briscoe. 2010. Introduction to conservation genetics, second edition. Cambridge University Press, New York, New York.

Impacts from No-Action Alternative 4

Under the No Action alternative wild horse and burro levels would continue to increase and as a result areas of vegetative communities (rangeland) across the NTTR would continue to be over utilized by horses and burros. No short-term, localized disturbance would take place as no temporary corrals would be erected, but the continued presence of horses and burros over AML degrades habitat and removes forage plants for other wildlife species. Under the no action alternative, the impacts to the rangeland would be detrimental overall.

4.2.2 Wildlife including Migratory Birds

Impacts from Action Alternatives 1-3

The actions common to Alternatives 1-3 would add slightly to impacts discussed in the Reasonably Foreseeable Future Actions (Section 4.4) through wild horse gather activities. Disturbance to migratory birds, special status species, and wildlife from the helicopter and wild horses could occur but would be short-term and minimal. Damage to vegetation at trap sites would be on a small scale and would not have a measurable impact. Human presence at trap sites would temporarily disrupt wildlife activities. Short and long-term impacts would result from reducing wild horse numbers within the assessment area. The removal of excess wild horses would provide immediate benefit to migratory birds, special status species, and wildlife through less competition for forage and water and would allow gradual improvement of upland and riparian health.

The project area contains riparian and sagebrush habitats, therefore potential impacts to neotropical migrants may be expected. If the gather occurs in the winter, this is when migratory species are not expected to be present within the HMA. However, in the event that weather or other factors (budget constraints, holding space limitations, etc.) prevent a winter gather, the gather could be during a portion of the migratory bird breeding season. As described in Appendix B, BLM policy prohibits the gathering of wild horses with helicopter (unless under emergency conditions) during the period of March 1st to June 30th which includes and covers the six weeks that precede and follow the peak of foaling (mid-April to mid-May). The migratory bird breeding season for occurs during (March 1st through August 31st). Noise and activity from gathers occurring June 30th through August 31st may disturb migratory birds during the remaining portion of the breeding season. Migratory bird surveys would occur prior to gather sites being constructed during migratory bird breeding season to avoid or minimize potential impacts to breeding migratory birds.

This impact would be minimal (generally less than 0.5 acre/trap site), temporary, and short-term (two weeks or less) in nature. Indirect impacts would be related to wild horse densities and patterns of use. The reduction in the current wild horse populations would provide opportunity for vegetative communities to progress toward achieving a thriving natural ecological balance. The action alternatives would support a more diverse vegetative composition and structure through improvement and maintenance of healthy populations of native perennial plants. Habitat improvements would result for migratory bird species including loggerhead shrikes, Brewer's sparrows, sage thrashers, burrowing owls and migratory and resident raptor species. According to Paige and Ritter (1999), "Long–term heavy grazing may ultimately reduce prey habitat and degrade the vegetation structure for nesting and roosting. Light to moderate grazing may provide open foraging habitat."

Competition with wildlife for water at developed springs, or natural springs and seeps, would be drastically reduced. For example, if the AML for a given HMA is 48 horses, and a population of 200 horses used 10 gallons per day per horse at these isolated to limited scattered sources during the heat of the summer, approximately 14,400 gallons in a month would be consumed if AML is achieved instead of

60,000 gallons at the population level before gather. More water would be available for a longer period of time for the number of horses at AML and wildlife species dependent on the same source(s).

Impacts from Action Alternative 1-2
Cumulative impacts under these alternatives would be beneficial in nature with improved habitat conditions and a reduction in wild horse population growth rates that slows down the amount of time before the population again reaches or exceeds AML. Wildlife may be temporarily disturbed during wild horse gather operations but once gather operations are complete, the wildlife should return to normal activities. Because trap sites and holding corrals would not be located where sensitive animal and plant species are known to occur, there would be no impact from the placement of and activities at these facilities. Nor would there be any impacts to populations of special status species as a result of gather operations.

Removing excess wild horses from the NWHR and managing wild horses within AMLs would result in improved habitat conditions for all special status animal species by increasing herbaceous vegetative cover in the uplands and improving riparian vegetation and water quality springs and seeps, thereby improving the habitat on which they depend.

Impacts from Action Alternative 3
This alternative would be similar to Alternative 1 and 2, however the benefits would diminish sooner without sex ratio adjustment and the use of fertility control. Wildlife may be temporarily disturbed during gather operations but once gather operations are complete, the wildlife should return to normal activities. Because trap sites and holding corrals would not be located where sensitive animal and plant species are known to occur, there would be no impact from the placement of and activities at these facilities. Nor would there be any impacts to populations of special status species as a result of gather operations.

Removing excess wild horses from the NWHR and managing wild horses within AMLs would result in improved habitat conditions for all special status animal species by increasing herbaceous vegetative cover in the uplands and improving riparian vegetation and water quality springs and seeps, thereby improving the habitat on which they depend. However, improved habitat conditions for all special status animal species may not last as long because wild horse populations may exceed the high end of AMLs more quickly than under the proposed action.

Impacts from No-Action Alternative 4
Negative direct impacts such as disturbance and possible injury to wildlife due to a gather would not occur under this alternative, therefore resulting in less direct negative impacts. Individual animals would not be disturbed or displaced because gather operations would not occur under the No Action alternative. Beneficial indirect impacts to bird, wildlife, and special status species habitats, however, would not be realized and wild horse numbers in excess of AML would result in continuing decline of habitat condition and could adversely affect the viability of some bird and wildlife populations.

4.2.3 Riparian-Wetland Zones/Soils
Impacts from Action Alternatives 1-2
Removal of excess wild horses and burros may increase vegetation cover, which in turn, may increase interception of precipitation. This may decrease surface water run-off and increase local infiltration rates. The composition of the recovering vegetation (native versus non-native vegetation) may also affect infiltration and precipitation interception based on variation in plant density. As the diverse coverage of grasses, trees, and shrubs increases, interception rates may increase, allowing for more infiltration of water into groundwater aquifers. Evapotranspiration rates may also be altered as a result of the proposed action, but such changes may be small.

In addition, the Proposed Action will help restore previous hydrologic conditions at perched aquifer fed wetlands and springs, which have been impacted by wild burros digging away soils and consuming vegetation, causing severe erosion. This erosion and reduction in vegetation has resulted in a lowered potentiometric perched aquifer surface.

Impacts from Action Alternative 3

Impacts from this alternative would be similar to the Alternatives 1 and 2. AMLs would be achieved as a result of the gather, but wild horse populations may exceed the high end of AML sooner than under Alternatives 1 and 2. When wild horses numbers reach the high range of AML or exceeded, damage to riparian areas may be more evident. Water quality and quantity would diminish sooner and soil compactions from excessive trailing and loitering would be more evident.

Impacts from No Action Alternative 4

Under the No Action alternative wild horse and burro levels would continue to increase and vegetative cover would continue to decrease. This removal of vegetation may decrease interception of precipitation on the surface as bare ground is exposed, especially following large-scale rain events. Loss of living vegetative cover from invasive species may increase surface water run-off. Such impacts may be most pronounced in the areas of concentrated animal numbers. Grazing affects the species composition and biomass production of native plant communities through selective foraging. It is generally agreed that present-day local ecosystems did not evolve with significant selective pressure from large-bodied herbivores, and desert vegetation is very slow to recover if overgrazed or disturbed. As these current unsustainable population levels are likely to reduce the overall density of vegetation, interception rates may decline causing more surface water run-off. Overall, impacts from the proposed no action may include lower transpiration and decreased interception of water from a lack of mature vegetative cover.

Further, under the No Action alternative the severe erosion and lowering of the potentiometric of perched aquifer surfaces would continue, probably at an accelerated rate, potentially to a point where restoration would not be possible.

4.2.4 Wild Horses and Burros

Impacts Common to Action Alternatives 1-3

Helicopter/ Bait and water trap impacts to wild horses

Indirect impacts can occur to horses after the initial stress event (capture) and could include increased social displacement or increased conflict between studs. These impacts are known to occur intermittently during wild horse gather operations. Traumatic injuries could occur and typically involve biting and /or kicking bruises. Horses may potentially strike or kick gates, panels or the working chute while in corrals or trap which may cause injuries. Lowered competition for forage and water resources would reduce stress and fighting for limited resources (water and forage) and promote healthier animals. Indirect individual impacts are those impacts which occur to individual wild horses after the initial stress event, and may include spontaneous abortions in mares. These impacts, like direct individual impacts, are known to occur intermittently during wild horse gather operations. An example of an indirect individual impact would be the brief skirmish which occurs among studs following sorting and release into the stud pen, which lasts less than a few minutes and ends when one stud retreats. Traumatic injuries usually do not result from these conflicts. These injuries typically involve a bite and/or kicking with bruises which don't break the skin. Like direct individual impacts, the frequency of occurrence of these impacts among a population varies with the individual animal.

Spontaneous abortion events among pregnant mares following capture is also rare, though poor body condition at time of gather can increase the incidence of spontaneous abortions. Given the two different capture methods proposed, spontaneous abortion is not considered to be an issue for either of the two proposed capture methods, since helicopter/drive trap method would not be utilized during peak foaling season (March 1 thru June 30), unless an emergency exists, and the water/bait trapping method is anticipated to be low stress.

Foals are often gathered that were orphaned on the range (prior to the gather) because the mother rejected it or died. These foals are usually in poor, unthrifty condition. Orphans encountered during gathers are cared for promptly and rarely die or have to be euthanized. It is unlikely that orphan foals would be encountered since majority of the foals would be old enough to travel with the group of wild horses. Also depending on the time of year the current foal crop would be six to nine months of age and may have already been weaned by their mothers.

Gathering wild horses during the summer months can potentially cause heat stress. Gathering wild horses during the fall/winter months reduces risk of heat stress, although this can occur during any gather, especially in older or weaker animals. Adherence to the SOPs and techniques used by the gather contractor or BLM staff would help minimize the risks of heat stress. Heat stress does not occur often, but if it does, death can result. Most temperature related issues during a gather can be mitigated by adjusting daily gather times to avoid the extreme hot or cold periods of the day. The BLM and the contractor would be pro-active in controlling dust in and around the holding facility and the gather corrals to limit the horses' exposure to dust.

The BLM has been gathering excess wild horses from public lands since 1975, and has been using helicopters for such gathers since the late 1970's. Refer to Appendix I for information on the methods that are utilized to reduce injury or stress to wild horses and burros during gathers.

Since 2006, BLM Nevada has gathered over 40,000 excess animals. Of these, gather related mortality has averaged only 0.5%, which is very low when handling wild animals. Another 0.6% of the animals captured were humanely euthanized due to pre-existing conditions and in accordance with BLM policy. This data affirms that the use of helicopters and motorized vehicles are a safe, humane, effective and practical means for gathering and removing excess wild horses and burros from the range. BLM policy prohibits gathering wild horses with a helicopter (unless under emergency conditions) during the period of March 1 to June 30 which includes and covers the six weeks that precede and follow the peak of foaling period (mid-April to mid-May).

Through the capture and sorting process, wild horses are examined for health, injury and other defects. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy. BLM Euthanasia Policy IM 2015-070 is used as a guide to determine if animals meet the criteria and should be euthanized. Animals that are euthanized for non-gather related reasons include those with old injuries (broken hip, leg) that have caused the animal to suffer from pain or which prevent them from being able to travel or maintain body condition: old animals that have lived a successful life on the range, but now have few teeth remaining, are in poor body condition, or are weak from old age; and wild horses that have congenital (genetic) or serious physical defects such as club foot, or sway back and should not be returned to the range.

Temporary Holding Facilities During Gathers

Wild horses gathered would be transported from the trap sites to a temporary holding corral within the NWHR in goose-neck trailers or straight-deck semi-tractor trailers. At the temporary holding corral, the wild horses would be aged and sorted into different pens based on sex. The horses would be provided ample supply of good quality hay and water. Mares and their un-weaned foals would be kept in pens together. All horses identified for retention in the HMA would be penned separately from those animals identified for removal as excess. All mares identified for release would be treated with fertility control vaccine in accordance with the Standard Operating Procedures (SOPs) for Fertility Control Implementation in Appendix III.

At the temporary holding facility, a veterinarian, would provide recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) would be humanely euthanized using methods acceptable to the American Veterinary Medical Association (AVMA).

Transport, Short Term Holding, and Adoption Preparation

Wild horses removed from the range as excess would be transported to the receiving short-term holding facility in a goose-neck stock trailer or straight-deck semi-tractor trailers. Trucks and trailers used to haul the wild horses would be inspected prior to use to ensure wild horses can be safely transported and that the interior of the vehicle is in a sanitary condition. Wild horses would be segregated by age and sex when possible and loaded into separate compartments. Mares and their un-weaned foals may be shipped together. Transportation of recently captured wild horses is limited to a maximum of 8 hours. During transport, potential impacts to individual horses can include stress, as well as slipping, falling, kicking, biting, or being stepped on by another animal. Unless wild horses are in extremely poor condition, it is rare for an animal to die during transport.

Upon arrival, recently captured wild horses are off-loaded by compartment and placed in holding pens where they are fed good quality hay and water. Most wild horses begin to eat and drink immediately and adjust rapidly to their new situation. At the short-term holding facility, a veterinarian provides recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) that was not diagnosed previously at the temporary holding corrals at the gather site would be humanely euthanized using methods acceptable to the AVMA. Wild horses in very thin condition or animals with injuries are sorted and placed in hospital pens, fed separately and/or treated for their injuries. Recently captured wild horses, generally mares, in very thin condition may have difficulty transitioning to feed. A small percentage of animals can die during this transition; however, some of these animals are in such poor condition that it is unlikely they would have survived if left on the range.

After recently captured wild horses have transitioned to their new environment, they are prepared for adoption or sale. Preparation involves freeze-marking the animals with a unique identification number, vaccination against common diseases, castration, and de-worming. During the preparation process, potential impacts to wild horses are similar to those that can occur during transport. Injury or mortality during the preparation process is low, but can occur.

Mortality at short-term holding facilities averages approximately 5% (GAO-09-77, Page 51), and includes animals euthanized due to a pre-existing condition, animals in extremely poor condition, animals that are injured and would not recover, animals which are unable to transition to feed; and animals which die accidentally during sorting, handling, or preparation.

Adoption

Adoption applicants are required to have at least a 400 square foot corral with panels that are at least six feet tall. Applicants are required to provide adequate shelter, feed, and water. The BLM retains title to the horse for one year and the horse and facilities are inspected. After one year, the applicant may take title to the horse at which point the horse become the property of the applicant. Adoptions are conducted in accordance with 43 CFR § Subpart 4750.

Sale with Limitation

Buyers must fill out an application and be pre-approved before they may buy a wild horse. A sale-eligible wild horse is any animal that is more than 10 years old; or has been offered unsuccessfully for adoption at least 3 times. The application also specifies that all buyers are not to sell to slaughter buyers or anyone who would sell the animals to a commercial processing plant. Sale of wild horses are conducted in accordance with the 1971 WFRHBA and congressional limitations that are presently in place.

Off-range Pastures

During the past 5 years (FY2015-2019), the BLM has removed approximately 30,000 excess wild horses or burros from the Western States. Most animals not immediately adopted or sold have been transported to Off-Range pastures in the Midwest given current Congressional prohibitions on selling excess animals without limitations, or on euthanizing healthy animals for which no adoption or sale demand exists as required by the WFRHBA.

Potential impacts to wild horses from transport to adoption, sale or Off-range Pastures (ORP) are similar to those previously described. One difference is that when shipping wild horses for adoption, sale or ORP, animals may be transported for a maximum of 24 hours. Immediately prior to transportation, and after every 24 hours of transportation, animals are offloaded and provided a minimum of 8 hours on-the-ground rest. During the rest period, each animal is provided access to unlimited amounts of clean water and 2 pounds of good quality hay per 100 pounds of body weight with adequate bunk space to allow all animals to eat at one time. The rest period may be waived in situations where the anticipated travel time exceeds the 24-hour limit but the stress of offloading and reloading is likely to be greater to the animals than the stress involved in the additional period of uninterrupted travel.

Off-range pastures are designed to provide excess wild horses with humane, and in some cases life-long care in a natural setting off the public rangelands. There wild horses are maintained in grassland pastures large enough to allow free-roaming behavior (i.e., the horses are not kept in corrals) and with the forage, water, and shelter necessary to sustain them in good condition. About 33,429 wild horses that are in excess of the current adoption or sale demand (because of age or other factors such as economic recession), are currently located on private land pastures in Oklahoma, Kansas, and South Dakota [SAB1], And Iowa, Missouri, Wyoming, Montana, Nebraska, & Utah. Establishment of an ORP is subject to a separate NEPA and decision-making process. Located in mid or tall grass prairie regions of the United States, these ORPs are highly productive grasslands compared to the more arid western rangelands. These pastures comprise about 256,000 acres (an average of about 10-11 acres per animal). Of the animals currently located in ORP, less than one percent is age 0-4 years, 49 percent are age 5-10 years, and about 51 percent are age 11+ years.

Mares and sterilized stallions (geldings) are segregated into separate pastures except at one facility where geldings and mares coexist. Although the animals are placed in ORP, they remain available for adoption or sale to qualified individuals; and foals born to pregnant mares in ORP are gathered and weaned when they reach about 8-12 months of age and are also made available for adoption. The ORP contracts specify the care that wild horses must receive to ensure they remain healthy and well-cared for. Handling by humans is minimized to the extent possible, although regular on-the-ground observation by the ORP contractor and periodic counts of the wild horses to ascertain their well-being and safety are conducted by BLM personnel and/or veterinarians. A very small percentage of the animals may be humanely euthanized if they are in very poor condition due to age or other factors. Natural mortality of wild horses in ORP averages approximately 8% per year, but can be higher or lower depending on the average age of the horses pastured there (GAO-09-77, Page 52). Wild horses residing on ORP facilities live longer, on the average, than wild horses residing on public rangelands,

Euthanasia and Sale Without Limitation

Under the WFRHBA, healthy excess wild horses can be euthanized or sold without limitation if there is no adoption demand for the animals. However, while euthanasia and sale without limitation are allowed under the statute, these activities have not been permitted under current Congressional appropriations for over a decade and are consequently inconsistent with BLM policy. If Congress should remove this prohibition, then excess horses removed from the NWHR could potentially be sold without limitations or humanely euthanized, as required by statute, if no adoption or sale demand exists for some of the removed excess horses.

Wild Horses Remaining or Released into the HMA following Gather

Under the Proposed Action, the post-gather population of wild horses would be about 145 wild horses, which is the low end of the AML range for the NWHR. Reducing population size would also ensure that the remaining wild horses are healthy and vigorous, and not at risk of death or suffering from starvation due to insufficient habitat coupled with the effects of frequent drought (lack of forage and water).

The wild horses that are not captured may be temporarily disturbed and move into another area during the gather operations. With the exception of changes to herd demographics, direct population wide impacts have proven, over the last 20 years, to be temporary in nature with most if not all impacts disappearing within hours to several days of when wild horses are released back into the NWHR. No observable effects associated with these impacts would be expected within one month of release, except for a heightened awareness of human presence.

As a result of lower density of wild horses across the NWHR following the removal of excess horses, competition for resources would be reduced, allowing wild horses to utilize preferred, quality habitat. Confrontations between stallions would also become less frequent, as would fighting among wild horse bands at water sources. Achieving the AML and improving the overall health and fitness of wild horses could also increase foaling rates and foaling survival rates over the current conditions.

The primary effects to the wild horse population that would be directly related to this proposed gather would be to herd population dynamics, age structure or sex ratio, and subsequently to the growth rates and population size over time.

The remaining wild horses not captured would maintain their social structure and herd demographics (age and sex ratios). No observable effects to the remaining population associated with the gather impacts would be expected except a heightened shyness toward human contact.

Table 3.8-2 of the Ely Proposed Resource Management Plan/Final Environmental Impact Statement (November 2007) Pinyon Management Framework Plan (1983) shows that the NWHR reproductive viability is adequate. However, genetic data would be collected to continue monitor genetic diversity throughout the NWHR. At this time, there is no evidence to indicate that the NWHR wild horses suffer from reduced genetic fitness at the established AML.

Impacts to the rangeland as a result of the current overpopulation of wild horses would be reduced under the two gather and removal alternatives. Fighting among stud horses would decrease since they would protect their position at water sources less frequently; injuries and death to all age classes of animals would also be expected to be reduced as competition for limited forage and water resources is decreased.

Indirect individual impacts are those impacts which occur to individual wild horses after the initial stress event, and may include spontaneous abortions in mares, and increased social displacement and conflict in studs. These impacts, like direct individual impacts, are known to occur intermittently during wild horse gather operations. An example of an indirect individual impact would be the brief skirmish which occurs among older studs following sorting and release into the stud pen, which lasts less than two minutes and ends when one stud retreats. Traumatic injuries usually do not result from these conflicts. These injuries typically involve a bite and/or kicking with bruises which don't break the skin. Like direct individual impacts, the frequency of occurrence of these impacts among a population varies with the individual animal.

Spontaneous abortion events among pregnant mares following capture is also rare, though poor body condition can increase the incidence of such spontaneous abortions. Given the timing of this gather, spontaneous abortion is not considered to be an issue for the proposed gather.

A few foals may be orphaned during gathers. This may occur due to:

- The mare rejects the foal. This occurs most often with young mothers or very young foals,
- The foal and mother become separated during sorting, and cannot be matched,
- The mare dies or must be humanely euthanized during the gather,
- The foal is ill, weak, or needs immediate special care that requires removal from the mother,
- The mother does not produce enough milk to support the foal.

Oftentimes, foals are gathered that were already orphans on the range (prior to the gather) because the mother rejected it or died. These foals are usually in poor, unthrifty condition. Orphans encountered during gathers are cared for promptly and rarely die or have to be euthanized.

Most foals that would be gathered would be over four months of age and some would be ready for weaning from their mothers. In private industry, domestic horses are normally weaned between four and six months of age.

Gathering the wild horses during the fall reduces risk of heat stress, although this can occur during any gather, regardless of season, especially in older or weaker animals. Adherence to the SOPs as well and techniques used by the gather contractor help minimize the risks of heat stress. Heat stress does not occur often, but if it does, death can result.

During summer gathers, roads and corrals may become dusty, depending upon the soils and specific conditions at the gather area. The BLM ensures that contractors mitigate any potential impacts from dust by slowing speeds on dusty roads and watering down corrals and alleyways. Despite precautions, it is possible for some animals to develop complications from dust inhalation and contract dust pneumonia. This is rare, and usually affects animals that are already weak or otherwise debilitated due to older age or poor body condition. Summer gathers pose increased risk of heat stress so Contractors use techniques that minimize heat stress, such as conducting gather activities in the early morning, when temperatures are coolest, and stopping well before the hottest period of the day. The helicopter pilot also brings in the horses at an easy pace. If there are extreme heat conditions, gather activities are suspended during that time. Water consumption is monitored, and horses or burros are often lightly sprayed with water as the corrals are being sprayed to reduce dust. The wild horses and burros appear to enjoy the cool spray during summer gathers. Individual animals are also monitored and veterinary or supportive care administered as needed. Electrolytes can be administered to the drinking water during gathers that involve animals in weakened conditions or during summer gathers. Additionally, BLM Wild Horse and Burro staff maintains supplies of electrolyte paste if needed to directly administer to an affected animal. As a result of adherence to SOPs and care taken during summer gathers, potential risks to wild horses associated with summer gathers can be minimized or eliminated.

During winter gathers, wild horses and burros are often located in lower elevations, in less steep terrain due to snow cover in the higher elevations. Subsequently, the animals are closer to the potential gather corrals, and need to maneuver less difficult terrain in many cases. However, snow cover can increase fatigue and stress during winter gathers, therefore the helicopter pilot allows horses to travel slowly at their own pace. The Contractor may plow trails in the snow leading to the gather corrals to make it easier for animals to travel to the gather site and to ensure the wild horses can be safely gathered.

Through the capture and sorting process, wild horses are examined for health, injury and other defects. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy. BLM Euthanasia Policy IM-2015-070 is used as a guide to determine if animals meet the criteria and should be euthanized (refer to SOPs Appendix I). Animals that are euthanized for non-gather related reasons include those with old injuries (broken hip, leg) that have caused the animal to suffer from pain or which prevent them from being able to travel or maintain body condition; old animals that have lived a successful life on the range, but now have few teeth remaining, are in poor body condition, or are weak from old age; and wild horses that have congenital (genetic) or serious physical defects such as club foot, or sway back and should not be returned to the range.

It is not expected that observed heterozygosity would be greatly reduced by the Action Alternatives. The AML range of 300-500 should provide for a relatively high genetic effective population size and correspondingly low rate of loss of observed heterozygosity (well below 1% per generation, which is a suggested level in BLM 2010). In the unlikely event that ongoing genetic monitoring revealed an unacceptably low level of observed heterozygosity, fertile animals from other HMAs could be introduced from other similar herds, in keeping with guidelines from the BLM WHB herd management handbook 4700 (BLM 2010).

Impacts Common to Alternatives 1-2

<u>BLMs Use of Contraception in Wild Horse Management</u>

BLM has identified fertility control as a method that could be used to protect rangeland ecosystem health and to reduce the frequency of wild horse and wild burro gathers and removals. Expanding the use of population growth suppression to slow population growth rates and reduce the number of animals removed from the range and sent to ORP is a BLM priority. The WFRHBA of 1971 specifically provides for contraception (section 3.b.1). No finding of excess animals is required for BLM to pursue contraception in wild horses or wild burros. .

Contraception has been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used with other techniques, to reduce horse population size (Bartholow 2004, de Seve and Boyles-Griffin 2013, Fonner and Bohara 2017). All fertility control methods in wild animals are associated with potential risks and benefits, including effects of handling, frequency of handling, physiological effects, behavioral effects, and reduced population growth rates (Hampton et al. 2015). Contraception by itself does not remove excess horses from an HMA's population, so if a wild horse population is in excess of AML, then contraception alone would result in some continuing environmental effects of horse overpopulation. Successful contraception reduces future reproduction.

Successful contraception would be expected to reduce the frequency of horse gather activities, as well as wild horse management costs to taxpayers. Bartholow (2007) concluded that the application of 2 or 3-year contraceptives to wild mares could reduce operational costs in a project area by 12-20%, or up to 30% in carefully planned population management programs. He also concluded that contraceptive treatment would likely reduce the number of horses that must be removed in total, with associated cost reductions in the number of private placements and total holding costs. Population suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000). Although contraceptive treatments may be associated with a number of potential physiological, behavioral, demographic, and genetic effects, detailed below and in Appendix D, those concerns do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013).

Fertility Control Vaccines

Fertility control vaccines (also known as immunocontraceptives) meet BLM requirements for safety to mares and the environment (EPA 2009a, 2012). Because they work by causing an immune response in treated animals, there is no risk of hormones or toxins being taken into the food chain when a treated mare or jenny dies. The BLM and other land managers have mainly used three fertility control vaccine formulations for fertility control of wild horse mares on the range: ZonaStat-H, PZP-22, and GonaCon-Equine. As other formulations become available they may be applied in the future.

In any vaccine, the antigen is the stimulant to which the body responds by making antigen-specific antibodies. Those antibodies then signal to the body that a foreign molecule is present, initiating an immune response that removes the molecule or cell. Adjuvants are additional substances that are included in vaccines to elevate the level of immune response. Adjuvants help to incite recruitment of lymphocytes and other immune cells which foster a long-lasting immune response that is specific to the antigen.

BLM has SOPs for fertility control vaccine application (BLM IM 2009-090, Appendix E). Herds selected for fertility control vaccine use should have annual growth rates over 5%, have a herd size over 50 animals, and have a target rate of treatment of between 50% and 90% of female wild horses or burros. The IM requires that treated mares be identifiable via a visible freeze brand or individual color markings, so that their vaccination history can be known. The IM calls for follow-up population surveys to determine the realized annual growth rate in herds treated with fertility control vaccines.

Porcine Zona Pellucida (PZP) Vaccine

PZP may be applied to mares or jennies prior to their release back into the HMA. PZP vaccines meet most of the criteria that the National Research Council (2013) used to identify promising fertility control methods, in terms of delivery method, availability, efficacy, and side effects. PZP is relatively inexpensive, meets BLM requirements for safety to mares and jennies and the environment, and is produced as the liquid PZP vaccine ZonaStat-H, an EPA-registered commercial product (EPA 2012, SCC 2015), or as PZP-22, which is a formulation of PZP in polymer pellets that may lead to a longer immune response (Turner et al. 2002, Rutberg et al. 2017).

For the PZP-22 vaccine pellet formulation administered during gathers, each released mare or jenny would receive a single dose of the PZP contraceptive vaccine pellets at the same time as a dose of the liquid PZP vaccine with modified Freund's Complete adjuvant. Most mares and jennies recover from the stress of capture and handling quickly once released back into the HMA and none are expected to suffer serious long-term effects from the injections, other than the direct consequence of becoming temporarily infertile. Injection site reactions associated with fertility control treatments are possible in treated mares

(Roelle and Ransom 2009, Bechert et al. 2013, French et al. 2017), but swelling or local reactions at the injection site are expected to be minor in nature.

The historically accepted hypothesis explaining PZP vaccine effectiveness posits that when injected as an antigen in vaccines, PZP causes the mare's immune system to produce antibodies that are specific to zona pellucida proteins on the surface of that mare's eggs. The antibodies bind to the mare's eggs surface proteins (Liu et al. 1989), and effectively block sperm binding and fertilization (Zoo Montana, 2000). Because treated mares do not become pregnant but other ovarian functions remain generally unchanged, PZP can cause a mare to continue having regular estrus cycles throughout the breeding season. Other research has shown, though, that there may be changes in ovarian structure and function due to PZP vaccine treatments (e.g., Joonè et al. 2017b, 2017c). Research has demonstrated that contraceptive efficacy of an injected liquid PZP vaccine, such as ZonaStat-H, is approximately 90% or more for mares treated twice in one year (Turner and Kirkpatrick 2002, Turner et al. 2008). The highest success for fertility control has been reported when the vaccine has been applied November through February. High contraceptive rates of 90% or more can be maintained in horses that are boostered annually with liquid PZP (Kirkpatrick et al. 1992). Approximately 60% to 85% of mares are successfully contracepted for one year when treated simultaneously with a liquid primer and PZP-22 pellets (Rutberg et al. 2017). Application of PZP for fertility control would reduce fertility in a large percentage of mares for at least one year (Ransom et al. 2011).

Detailed effects of PZP are located in Appendix D.

Gonadotropin Releasing Hormone (GnRH) Vaccine (GonaCon)
GonaCon may be applied to mares prior to their release back into the HMA. Taking into consideration available literature on the subject, the National Research Council concluded in their 2013 report that GonaCon-B (which is produced under the trade name GonaCon-Equine for use in feral horses and burros) was one of the most preferable available methods for contraception in wild horses and burros (NRC 2013), in terms of delivery method, availability, efficacy, and side effects. GonaCon-Equine is approved for use by authorized federal, state, tribal, public and private personnel, for application to wild and feral equids in the United States (EPA 2013, 2015).

GonaCon is an immunocontraceptive vaccine which has been shown to provide multiple years of infertility in several wild ungulate species, including horses (Killian et al., 2008; Gray et al., 2010). GonaCon uses the gonadotropin-releasing hormone (GnRH), a small neuropeptide that performs an obligatory role in mammalian reproduction, as the vaccine antigen. When combined with an adjuvant, the GnRH vaccine stimulates a persistent immune response resulting in prolonged antibody production against GnRH, the carrier protein, and the adjuvant (Miller et al., 2008). The most direct result of successful GnRH vaccination is that it has the effect of decreasing the level of GnRH signaling in the body, as evidenced by a drop in luteinizing hormone levels, and a cessation of ovulation. The lack of estrus cycling that results from successful GonaCon vaccination has been compared to typical winter period of anoestrus in open mares. As anti-GnRH antibodies decline over time, concentrations of available endogenous GnRH increase and treated animals usually regain fertility (Power et al., 2011).

Changes in hormones associated with anti-GnRH vaccination lead to measurable changes in ovarian structure and function. The volume of ovaries reduced in response to treatment (Garza et al. 1986, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Botha et al. 2008, Gionfriddo 2011a, Dalmau et al. 2015). Treatment with an anti-GnRH vaccine changes follicle development (Garza et al. 1986, Stout et al. 2003, Imboden et al. 2006, Elhay et al. 2007, Donovan et al. 2013, Powers et al. 2011, Balet et al. 2014), with the result that ovulation does not occur.

BLM may apply GonaCon-Equine to captured mares. As is true for PZP vaccines, the expectation at NWHR is that the majority of vaccine treatments would take place after animals are captured via bait/ water trapping or via helicopter drive trapping. GonaCon-Equine can safely be reapplied as necessary to control the population growth rate. Even with one booster treatment of GonaCon-Equine, it is expected that most, if not all, mares would return to fertility at some point, although the average duration of effect after booster doses has not yet been quantified. Although it is unknown what would be the expected rate for the return to fertility rate in mares boosted more than once with GonaCon-Equine, a prolonged return to fertility would be consistent with the desired effect of using GonaCon (e.g., effective contraception). Once the herd size in the project area is at AML and population growth seems to be stabilized, BLM could make a determination as to the required frequency of new mare treatments and mare re-treatments with GonaCon, to maintain the number of horses within AML

Injection site reactions associated with immunocontraceptive treatments are possible in treated mares (Roelle and Ransom 2009). Whether injection is by hand or via darting, GonaCon-Equine is associated with some degree of inflammation, swelling, and the potential for abscesses at the injection site (Baker et al. 2018). Swelling or local reactions at the injection site are generally expected to be minor in nature, but some may develop into draining abscesses.

Detailed effects of GonaCon are located in Appendix D.

PZP and GonaCon Indirect Effects
One expected long-term, indirect effect on wild horses treated with fertility control, such as PZP or GonaCon would be an improvement in their overall health (Turner and Kirkpatrick 2002). Many treated mares would not experience the biological stress of reproduction, foaling and lactation as frequently as untreated mares and jennies. The observable measure of improved health is higher body condition scores (Nuñez et al. 2010). After a treated mare returns to fertility, her future foals would be expected to be healthier overall and would benefit from improved nutritional quality in the mare's milk. This is particularly to be expected if there is an improvement in rangeland forage quality at the same time, due to reduced wild horse population size. Past application of fertility control has shown that mares' overall health and body condition remains improved even after fertility resumes. Fertility control vaccine treatment may increase mare survival rates, leading to longer potential lifespan (Turner and Kirkpatrick 2002, Ransom et al. 2014a). To the extent that this happens, changes in lifespan and decreased foaling rates could combine to cause changes in overall age structure in a treated herd (i.e., Turner and Kirkpatrick 2002, Roelle et al. 2010), with a greater prevalence of older mares in the herd (Gross 2000). Observations of mares treated in past gathers showed that many of the treated mares were larger than, maintained higher body condition than, and had larger healthy foals than untreated mares.

Effects of Gelding
Various forms of fertility control can be used in wild horse and burro herd management. These can help with the goals of maintaining herds at or near AML, reducing fertility rates, and reducing the frequency of gathers and removals. The WFRHBA of 1971 specifically provides for contraception and sterilization (16 U.S.C. 1333 section 3.b.1). Fertility control measures have been shown to be a cost-effective and humane treatment to slow increases in wild horse herds or, when used in combination with gathers, to reduce herd size (Bartholow 2004, de Seve and Boyles-Griffin 2013, Fonner and Bohara 2017). An extensive body of peer-reviewed scientific literature details the expected impacts of various fertility control methods on wild horses and burros. No finding of excess animals is required for BLM to pursue sterilization in wild horses or wild burros.

Although fertility control treatments may be associated with a number of potential physiological, behavioral, demographic, and genetic effects, those impacts are generally minor and transient, do not prevent overall maintenance of a self-sustaining population, and do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013). Fertility control that affects individual horses and burros does not prevent BLM from ensuring that there will be self-sustaining populations of wild horses and burros in single herd management areas (HMAs), in complexes of HMAs, and at regional scales of multiple HMAs and complexes. Under the WFRHBA of 1971, BLM is charged with maintaining self-reproducing populations of wild horses and burros. The National Academies of Sciences (2013) encouraged BLM to manage wild horses and burros at the spatial scale of "metapopulations" – that is, across multiple HMAs and complexes in a region. In fact, many HMAs have historical and ongoing genetic and demographic connections with other HMAs, and BLM routinely moves animals from one to another to improve local herd traits and maintain high genetic diversity. Some HMAs may be managed as non-reproducing, in whole or in part. Thus, although treated individuals may experience long-lasting effects, such as sterility, that does not of itself cause significant impacts at the level of populations, which are the object of BLM management.

Discussions about herds that are 'non-reproducing' in whole or in part are in the context of this 'metapopulation' structure, where self-sustaining herds are not necessarily at the scale of single HMAs. So long as the definition of what constitutes a self-sustaining population includes the larger set of HMAs that have past or ongoing demographic and genetic connections – as is recommended by the NAS 2013 report – it is clear that single HMAs can be managed as nonreproducing in whole or in part while still allowing for a self-sustaining population of wild horses or burros at the broader spatial scale. Wild horses and burros are not an endangered species (USFWS 2015), nor are they rare. Nearly 72,000 adult wild horses and nearly 16,000 adult wild burros roam BLM lands as of March 1, 2019, and those numbers do not include at least 12,000 WH&B on US Forest Service lands, and at least 60,000 feral horses on tribal lands in the Western United States.

Neutering (gelding)
Stallions between the ages of 6 months and 20 years, with a Henneke body condition score of 3 or higher (Henneke 1983) could be selected for gelding (see Appendix F). No animals which appear to be distressed, injured, or in poor health or condition would be selected for gelding. Stallions would not be gelded within 72 hours of capture. The surgery would be performed by a veterinarian using general anesthesia and appropriate surgical techniques. The final determination of which specific animals would be gelded would be based on the professional opinion of the attending veterinarian in consultation with the authorized officer (see Gelding SOPs in Appendix F).

When gelding procedures are done in the field, geldings would be released near a water source, when possible, approximately 24 to 48 hours following surgery. When the procedures are performed at a BLM-managed ORC, selected stallions would be shipped to the facility, gelded, held in a separate pen to minimize risk for disease, and returned to the range within 30 days.

Though castration (gelding) is a common surgical procedure, some level of minor complications after surgery may be expected (Getman 2009), and it is not always possible to predict when postoperative complications would occur. Fortunately, the most common complications are almost always self-limiting, resolving with time and exercise. Individual impacts to the stallions during and following the gelding process should be minimal and would mostly involve localized swelling and bleeding. Complications may include, but are not limited to: minor bleeding, swelling, inflammation, edema, infection, peritonitis, hydrocele, penile damage, excessive hemorrhage, and eventration (Schumacher 1996, Searle et al. 1999, Getman 2009). A small amount of bleeding is normal and generally subsides quickly, within 2-4 hours following the procedure. Some degree of swelling is normal, including swelling of the prepuce and scrotum, usually peaking between 3-6 days after surgery (Searle et al. 1999).

Swelling should be minimized through the daily movements (exercise) of the horse during travel to and from foraging and watering areas. Most cases of minor swelling should be back to normal within 5-7 days, more serious cases of moderate to severe swelling are also self-limiting and are expected to resolve with exercise after one to 2 weeks. Older horses are reported to be at greater risk of post-operative edema, but daily exercise can prevent premature closure of the incision, and prevent fluid buildup (Getman 2009). In some cases, a hydrocele (accumulation of sterile fluid) may develop over months or years (Searle et al. 1999). Serious complications (eventration, anesthetic reaction, injuries during handling, etc.) that result in euthanasia or mortality during and following surgery are rare (e.g., eventration rate of 0.2% to 2.6% noted in Getman 2009, but eventration rate of 4.8% noted in Shoemaker et al. 2004) and vary according to the population of horses being treated (Getman 2009). Normally one would expect serious complications in less than 5% of horses operated under general anesthesia, but in some populations these rates have been as high as 12% (Shoemaker 2004). Serious complications are generally noted within 3 or 4 hours of surgery but may occur any time within the first week following surgery (Searle et al. 1999). If they occur, they would be treated with surgical intervention when possible, or with euthanasia when there is a poor prognosis for recovery.

For intact stallions, testosterone levels appear to vary as a function of age, season, and harem size (Khalil et al 1998). It is expected that testosterone levels will decline over time after castration. Domestic geldings had a significant prolactin response to sexual stimulation but lacked the cortisol response present in stallions (Colborn et al. 1991). Although libido and the ability to ejaculate tends to be gradually lost after castration (Thompson et al. 1980), some geldings continue to intromit (Rios and Houpt 1995, Schumacher 2006).

Detailed effects of neutering or gelding are located in Appendix D.

Use of intra-Uterine Devices (IUDs)
Up through the present time, BLM has not used IUDs to control fertility as a wild horse and burro fertility control method on the range. The BLM has supported and continues to support research into the development and testing of effective and safe IUDs for use in wild horse mares (Baldrighi et al. 2017). However, existing literature on the use of IUDs in horses allows for inferences about expected effects of any management alternatives that might include use of IUDs.

IUDs may be implanted into mares in conjunction with the fertility control drug or by itself. The use of them simultaneously may provide for more effective fertility control. Any mare that receives an IUD will be documented and photos taken for field identification. The mares would be observed on occasion to see if/when the mare has another foal. It is expected that the IUD will eventually fall out.

Detailed effects of the use of IUDs are located in Appendix D.

Impacts of Alternative 1 (Proposed Action)
The Proposed Action would remove all excess wild burros within and outside the NWHR. Under this alternative, excess wild horses would be removed to the lower range of the AML. All wild horses residing outside the HMA would be removed. Fertility control would be applied to all breeding age mares that are captured and released after low AML is achieved. Successful implementation of this alternative requires a 90-95% gather efficiency in order to have enough animals in the initial gather available for release post-gather. Historically, gather efficiencies have average about 80% for the NWHR. If gather efficiencies do not allow for the attainment of the chosen action, or if BLM is unable to remove a sufficient number of wild horses in the initial gather, the Pahrump FO would return following the initial gather to remove excess wild horses. This would allow the Pahrump FO to achieve the desired goal of reaching the low

range of AML as well as to gather a sufficient number of remaining horses to implement fertility control treatments to control population growth.

When gather efficiencies have been able to achieve horse numbers within the range of AML, maintenance gathers to reapply fertility control and to remove adoptable excess wild horses would be conducted for the next 10 years following the date of the initial gather. All mares selected for release would be treated with fertility control vaccine and/or IUDs. During the initial gather approximately 90% of the existing wild horses would be gathered and 100% of the existing wild burros would be gathered and removed (approximately 720 wild horses with the 2020 foal crop and 100 wild burros). Approximately 300-400 wild horses would be released back into NWHR and BLM will Some gelded horses that would otherwise be excess animals permanently removed from the range and sent to holding facilities for adoption/sales or long-term holding, may be returned to the range and managed as a non-breeding population of geldings. The NWHR would continue to have a reproducing core breeding population range of 240-400 wild horses. The remaining balance of the herd (about 60-100 wild horses) would be managed as a non-breeding population of geldings. Population inventories and routine resource/habitat monitoring would be completed between gather cycles to document current population levels, growth rates and areas of continued resource concern (horse concentrations, riparian impacts, over-utilization, etc) prior to any follow-up gather. All population growth suppression techniques would be conducted in accordance with the approved standard operating and post-treatment monitoring procedures (SOPs, Appendices E & F). Animals selected for release would be done with the objective of adjusting the sex ratio in favor of males by 60% and 40% mares. Mares and studs would be selected to maintain a divers age structure, herd characteristics and body type (conformation).

Decreased competition for forage following removal of excess animals, coupled with reduced reproduction as a result of fertility control treatments, should result in improved health and condition of mares and foals and would maintain healthy range conditions over the longer-term. Additionally, reduced reproduction rates would be expected to extend the time interval between gathers reduce disturbance to individual animals as well as herd social structure over the foreseeable future.

The removal of excess horse to AML and maintaining it would reduce damage to the range from the current overpopulation of wild horses and allow vegetation resources time to recover over the next 4-5 years. Removal of excess wild horse would also improve herd health. Less competition for forage and water resources would reduce stress and promote healthier animals.

Impacts of Alternative 2

Alternative 2 is similar to Alternative 1 with the exception that some fraction of the mares returning to the Range would be sterilized. The NWHR would continue to have reproducing core breeding population range of 240-400 wild horses. The balance of the herd (about 60-100 wild horses) would be managed as a non-breeding population of sterilized mares and geldings. Gelded males and sterilized mares that would otherwise be excess animals permanently removed from the range and sent to holding facilities for adoption/sales or long-term holding, may be returned to the range and managed as a non-breeding population of geldings Some sterilized mares (approximately 40 mares) will be included in the herd, in order to reduce the expected growth rate, and to allow more mares to remain on the range. All mares released back to the range and not selected for sterilization would be treated with fertility control (vaccine and/or IUDs).

Effects of Spaying

Population growth suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000), such as with spaying and neutering. For the purposes of this EA, 'spaying' is defined to be the sterilization of a female horse (mare) by either surgical or other physical means. Usually this is accomplished by removal of the ovaries, but other physical methods such as tubal ligation or oviduct blockage that lead to sterility may also be considered a form of spaying. The three methods considered in this document are ovariectomy via colpotomy, ovariectomy via flank laparoscopy, and non-surgical physical sterilization. Unlike in dog and cat spaying, spaying a horse or burro does not entail removal of the uterus.

Ovariectomy via Colpotomy Procedure
Colpotomy is a surgical technique in which there is no external incision, reducing susceptibility to infection. For this reason, ovariectomy via colpotomy has been identified as a good choice for feral or wild horses (Rowland et al. 2018). Ovariectomy via colpotomy is a relatively short surgery, with a relatively quick expected recovery time. In 1903, Williams first described a vaginal approach, or colpotomy, using an ecraseur to ovariectomize mares (Loesch and Rodgerson 2003). The ovariectomy via colpotomy procedure has been conducted for over 100 years, normally on open (non-pregnant), domestic mares. It is expected that the surgeon should be able to access ovaries with ease in mares that are in the early- or mid-stage of pregnancy. The anticipated risks associated with the pregnancy are described below. When wild horses or burros are gathered or trapped for fertility control treatment there would likely be mares in various stages of gestation. Removal of the ovaries is permanent and 100 percent effective, however the procedure is not without risk.

Ovariectomy via Flank Laparoscopy Procedure
Flank laparoscopy (Lee and Hendrickson 2008) is commonly used in domestic horses for application in mares due to its minimal invasiveness and full observation of the operative field. Ovariectomy via flank laparoscopy was seen as the lowest risk method considered by a panel of expert reviewers convened by USGS (Bowen 2015). In a review of unilateral and bilateral laparoscopic ovariectomy on 157 mares, Röcken et al. (2011) found that 10.8% of mares had minor post-surgical complications and recorded no mortality. Mortality due to this type of surgery, or post-surgical complications, is not expected, but is a possibility. In two studies, ovariectomy by laparoscopy or endoscope-assisted colpotomy did not cause mares to lose weight, and there was no need for rescue analgesia following surgery (Pader et al. 2011, Bertin et al. 2013). This surgical approach entails three small incisions on the animal's flank, through which three cannulae (tubes) allow entry of narrow devices to enter the body cavity: these are the insufflator, endoscope, and surgical instrument. The surgical procedure involves the use of narrow instruments introduced into the abdomen via cannulas for the purpose of transecting the ovarian pedicle, but the insufflation should allow the veterinarian to navigate inside the abdomen without damaging other internal organs. The insufflator blows air into the cavity to increase the operating space between organs, and the endoscope provides a video feed to visualize the operation of the surgical instrument. This procedure can require a relatively long duration of surgery but tends to lead to the lowest post-operative rates of complications. Flank laparoscopy may leave three small (<5 cm) visible scars on one side of the horse's flank, but even in performance horses these scars are considered minimal. It is expected that the tissues and musculature under the skin at the site of the incisions in the flank will heal quickly, leaving no long-lasting effects on horse health. Monitoring for up to two weeks at the facility where surgeries take place will allow for veterinary inspection of wound healing. The ovaries may be dropped into the abdomen, but this is not expected to cause any health problem; it is usually done in ovariectomies in cattle (e.g., the Willis Dropped Ovary Technique) and Shoemaker et al. (2014) found no problems with revascularization or necrosis in a study of young horses using this method.

Physical, Non-surgical Mare Sterilization

This type of procedure would include any physical form of sterilization that does not involve surgery. This could include any form of physical procedure that leads a mare to be unable to become pregnant, or to maintain a pregnancy. For example, one form of physical, non-surgical sterilization causes a long-term blockage of the oviduct, so that fertile eggs cannot go from the ovaries to the uterus. The mare retains her ovaries. The mare would be sterile, although she would continue to have estrus cycles. Because of the retention of estrus cycles, it is expected that behavioral outcomes would be similar to those observed for PZP vaccine treated mares. The procedure is transcervical, so the treated mare cannot have a fetus in the uterus at the time of treatment. Treated mares would need to be screened to ensure they are not pregnant, because transcervical procedures can cause a pregnancy to terminate. Screening could be with transrectal palpation or ultrasonography. Those procedures require restraint and evacuation of the colon, and for a veterinarian to feel across the rectum, or hold an ultrasound probe there, but do not require sedation or analgesia.

One form of oviduct blockage infuses medical-grade N-butyl cyanoacrylate glue into the oviduct to cause long-term blockage (Bigolin et al. 2009). A pilot project used this approach in six domestic mares, and has shown that after three years of breeding by a fertile stallion, all six mares remained infertile (Dr. I. Liu, UC Davis Emeritus Professor, personal communication to BLM). A three person team of experts is required to manipulate and operate an endoscope monitor, insert and hold the endoscope, manipulate and position a fine-tipped catheter into the oviduct, and infuse the fluid into the oviduct. After restraint, sedation and analgesic administration, fecal material is removed from the rectum, the tail is wrapped and suspended, and the vaginal area is cleaned with betadine. An endoscope is inserted through the cervix to the uterotubal junction (which is the entrance to the oviduct). A sterile catheter is inserted into the uterotubal junction. A half mL of N-butyl cyanoacrylate is infused into each oviduct. A new catheter is used for the procedure on the second oviduct. The mares are monitored initially for 10 minutes, but no further pain management is expected to be needed.

Detailed effects of spaying are located in Appendix D.

All fertility control methods affect the behavior and physiology of treated animals (NAS 2013), and are associated with potential risks and benefits, including effects of handling, frequency of handling, physiological effects, behavioral effects, and reduced population growth rates (Hampton et al. 2015). Because spaying and neutering animals requires capturing and handling, the risks and costs associated with capture and handling of horses may be comparable to those of gathering for removal, but with expectedly lower adoption and long-term holding costs

Impacts of Alternative 3

Implementation of Alternative 3 would result in capturing fewer wild horses than would be captured in Alternative 1 in the initial gather. Alternative 3 does not include any fertility control method use, so annual herd growth rates are expected to be higher under Alternative 3 than under Alternatives 1 or 2. As a result, over the 10-year period of analysis covered by this EA, a greater number of animals would need to be removed under Alternative 3 than under Alternatives 1 or 2.. A gate cut removal would be implemented rather than a selective removal (i.e., the gather would end when the number of excess wild horses which requires removal has been captured). Alternative 3 would not involve fertility control; mares would not undergo the additional stress of receiving fertility control injections or freeze-marking and would foal at normal rates until the next gather is conducted. The post-gather sex ratio would be about 50:50 mares to studs, or would slightly favor mares. This would be expected to result in fewer and smaller bachelor bands, increased female reproduction on a proportional basis within the herd, larger band sizes, and individual mares would likely begin actively producing at a slightly older age.

Impacts of Alternative 4 (No Action)

Under the No Action Alternative, there would be no active management to control the population size within the established AML at this time. In the absence of a gather, wild horse and burro populations would continue to grow at an average rate of approximately 20% per year. Without a gather and removal now, the wild horse population would grow to approximately 1,670 in four years' time based on the average annual growth rate. Wild burro populations would grow to approximately 207 in four years' time based on the average annual growth rate, approximately 15%.

Use by wild horses and burros would continue to exceed the amount of forage available for their use. Competition between wildlife, wild burros, and wild horses for limited forage and water resources would continue. Damage to rangeland resources would continue or increase. Over time, the potential risks to the health of individual horses and burros would increase, and the need for emergency removals to prevent their death from starvation or thirst would also increase. Over the long-term, the health and sustainability of the wild horse and burro population is dependent upon achieving a thriving natural ecological balance and sustaining healthy rangelands. Allowing wild horses and burros to die of dehydration or starvation would be inhumane and would be contrary to the WFRHBA which requires that excess wild horses be immediately removed. Allowing rangeland damage to continue to result from wild horse and burro overpopulation would also be contrary to the WFRHBA which requires the BLM to "*protect the range from the deterioration associated with overpopulation*", "*remove excess animals from the range so as to achieve appropriate management levels*", and "*to preserve and maintain a thriving natural ecological balance and multiple-use relationship in that area*."

4.3 Cumulative Effects for All Alternatives

The NEPA regulations define cumulative impacts as impacts on the environment that result from the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions (40 CFR 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The cumulative impacts study area (CSA) for the purposes of evaluating cumulative impacts is the Nevada Wild Horse Range HMA.

According to the 1994 BLM *Guidelines for Assessing and Documenting Cumulative Impacts*, the cumulative analysis should be focused on those issues and resource values identified during scoping that are of major importance. Accordingly, the issues of major importance to be analyzed are:

4.3.1 Past and Present Actions

4.3.1.1 Wild Horses

In 1971 Congress passed the Wild Free- Roaming Horses and Burros Act which place wild and free-roaming horses, that were not claimed for individual ownership, under the protection of the Secretaries of Interior and Agriculture. In 1976 the Federal Land Policy and Management Act (FLPMA) gave the Secretary the authority to use motorized equipment in the capture of wild free- roaming horses as well as continued authority to inventory the public lands. In 1978, the Public Range Improvement Act (PRIA) was passed which amended the WFRHBA to provide additional directives for BLM's management of wild free-roaming horses on public lands.

Past actions include establishment of wild horse Herd Management Areas, establishment of AML for wild horses, wild horse gathers, vegetation treatment and range improvements throughout the area.

The NTTR RMP designated the NWHR HMA for the long-term management of wild horses. The HMA established in 2004 is actually larger than the original range that was designated for the wild horses in June 1965, which was 399,000 acres. The current size of 1.3 million acres just nearly triple the original range boundaries. Management of wild horses within the HMA today is guided by the NTTR RMP (July 2004). AML was established as a population range of 300-500 wild horses and 0 wild burros in 2004 through issuance of the NTTR RMP.

A Herd Management Area Plan was signed June 2008 which provided further guidance on short and long-term management and monitoring objectives for the herd and its habitat (Final Environmental Assessment for the Nevada Wild Horse Range Herd Management Area Plan EA NV052-2008-223).
The herd management plan also incorporate a number of population control methods such as fertility control, 60/40 sex ratio in favor of males, and a non-reproducing component of geldings. The plan also proposed the maintenance and/or reconstruct existing water developments. The reconstruct was completed on the water sources in the summer of 2016.

The actions which have influenced today's wild horse population are primarily wild horse gathers, which have resulted in the capture of 3,579 wild horses, the removal of 3,025 excess horses, and release of 500 horses back into the HMA in the past 17 years.

4.4 Reasonably Foreseeable Future Actions

4.4.1 Wild Horses

In the future, the BLM would manage wild horses within the HMAs that have suitable habitat for a population range, while maintaining age structure, and sex ratios. Current policy is to express all future wild horse AMLs as a range, to allow for regular population growth, as well as better management of populations rather than individual HMAs. The BLM would continue to conduct monitoring to assess progress toward meeting rangeland health standard. Wild Horses would continue to be a component of the public lands and manage within a multiple use concept.

While there is no anticipation for amendments to the Wild Free- Roaming Horses and Burros Act that would change the way wild horses could be managed on the public lands, the Act has been amended three times since 1971. Therefore, there is potential for amendment as a reasonably foreseeable future action.

Over the next 10-year period, reasonably foreseeable future actions include gathers about every 2-3 years to remove excess wild horses in order to manage population size within the established AML range. The excess animals removed would be transported to ORC where they would be prepared for adoption, sale (with limitations), or ORP.

4.5 Summary of Past, Present, and Reasonably Foreseeable Future Actions

Impacts Common to Action Alternatives (1-3)

The cumulative effects associated with the capture and removal of excess wild horses and burros includes gather-related mortality of less than 1% of the captured animals, about 5% per year associated with transportation, short term holding, adoption or sale with limitations and about 8% per year associated with long-term holding. This compares with natural mortality on the range ranging from about 5-8% per year for foals (animals under age 1), about 5% per year for horses ages 1-15, and 5-100% for animals age 16 and older (Jenkins 1996, Garrott and Taylor 1990). In situations where forage and/or water are limited, mortality rates increase, with the greatest impact to young foals, nursing mares and jennies, and older horses and burros. Animals can experience lameness associated with trailing to/from water and forage, foals may be orphaned (left behind) if they cannot keep up with their mother, or animals may become too weak to travel. After suffering, often for an extended period, the animals may die. Before these conditions arise, the BLM generally removes the excess animals to prevent their suffering from dehydration or starvation.

While humane euthanasia and sale without limitation of healthy horses and burros for which there is no adoption demand is authorized under the WFRHBA, Congress prohibited the use of appropriated funds between 1987 and 2004 and again since 2010 for this purpose.

The other cumulative effects which would be expected when incrementally adding either of the Action Alternatives to the CSA would include continued improvement of upland vegetation conditions, which would in turn benefit native wildlife and wild horse population as forage (habitat) quality and quantity is improved over the current level. Benefits from a reduced wild horse and burro population would include fewer animals competing for limited forage and water resources. Cumulatively, there should be more stable wild horse populations, healthier rangelands, healthier wild horses, and fewer multiple use conflicts in the area over the short and long-term. Over the next 15-20 years, continuing to manage wild horses and burros within the established AML range would achieve a thriving natural ecological balance and multiple use relationship on public lands in the area.

Impacts of Alternative 1 (Proposed Action)
Application of fertility control, gelding stallions, and adjustment in sex ratios to favor males should slow population growth rates, and result in fewer gathers and, therefore, fewer gather-related impacts. Having a number of mares treated with fertility control methods (vaccines and / or IUDs) could decrease the annual growth rate for the herd for a few years after the end of the 10-year time period analyzed in this EA. . However, return of wild horses back into the HMA could lead to decreased ability to effectively gather horses in the future as released horses learn to evade the helicopter and water/bait traps.

Impacts of Alternative 2
Application of fertility control and the spay and gelding of individuals will slow population growth and result in fewer gathers and, therefore, fewer gather-related impacts. Having a number of mares treated with fertility control methods (vaccines and / or IUDs) could decrease the annual growth rate for the herd for a few years after the end of the 10-year time period analyzed in this EA. However, return of wild horses back into the HMA could lead to decreased ability to effectively gather horses in the future as released horses learn to evade the helicopter and water/bait traps.

Impacts of Alternative 3
Removal of wild horses from the HMA would be associated with all the gather-related impacts noted in this EA. Wild horses left in the HMA would possibly develop a decreased ability to effectively to be gathered in the future as the horses learn to evade or avoid the helicopter and water/bait traps.

Impacts of Alternative 4 (No Action)
Under the No Action Alternative, the wild horse population could exceed 1600 animals in four years and the wild burro population could exceed 200 animals in four years. Movement outside the HMA would be expected as greater numbers of horses and burros search for food and water for survival, thus impacting larger areas of public lands. Heavy to excessive utilization of the available forage would be expected and the water available for use could become increasingly limited. Eventually, ecological plant communities would be damaged to the extent that they are no longer sustainable, and the wild horse and burro population would be expected to crash.

Emergency removals could be expected in order to prevent individual animals from suffering or death as a result of insufficient forage and water. Considering that water hauling has been required in recent years, and that the herd continues to grow, these emergency removals could occur as early as 2020. During emergency conditions, competition for the available forage and water increases. This competition generally impacts the oldest and youngest horses and burros as well as lactating mares and jennies first. These groups would experience substantial weight loss and diminished health, which could lead to their prolonged suffering and eventual death. If emergency actions are not taken, the overall population could be affected by severely skewed sex ratios towards stallions and jacks as they are generally the strongest and healthiest portion of the population. An altered age structure would also be expected.

Cumulative impacts would result in foregoing the opportunity to improve rangeland health and to properly manage wild horses and burros in balance with the available forage and water and other multiple uses. Attainment of site-specific vegetation management objectives and Standards for Rangeland Health would not be achieved. AML would not be achieved and the opportunity to collect the scientific data necessary to re-evaluate AML levels, in relationship to rangeland health standards, would be foregone.

5.0 Monitoring and Mitigation Measures

The BLM COR and PI assigned to the gather would be responsible for ensuring contract personnel abide by the contract specifications and the SOPs (Appendix F). Ongoing monitoring of forage condition and utilization, water availability, aerial population surveys, and animal health would continue.

Fertility control monitoring would be conducted in accordance with the SOPs (Appendix B). Informal monitoring of the herd’s social behavior would be incorporated into routine monitoring. This informal monitoring could include observations of fertile stallions, geldings, females, and foals, with a goal of making additional, ground-based, observations of foal to adult ratios.

Genetic monitoring could continue to take place in association with gather events. In the unlikely event that ongoing genetic monitoring revealed an unacceptably low level of observed heterozygosity, fertile animals from other HMAs could be introduced, in keeping with guidelines from the BLM WHB herd management handbook 4700 (BLM 2010).

6.0 List of Preparers

The following list identifies the interdisciplinary team member's area of responsibility:

Name	Resource	Email	Phone Number
Boris Poff	Water/Soils (SNDO)	bpoff@blm.gov	(702) 515-5154
Braydon Gaard	Wilderness (SNDO)	bgaard@blm.gov	(702) 515-5457
Connor Murphy	Geology/Minerals (LVFO)	csmurphy@blm.gov	(702) 515-5288
Corey Lange	Wildlife (PFO)	clange@blm.gov	(702) 515-5082
Deborah Downs	Editor (LVFO/PFO)	dadowns@blm.gov	(702) 515-5278
Peter (Evan) Myers	Wildlife (LVFO)	pmyers@blm.gov	(702) 515-5157
Janyne Pringle	Natural Resource Specialist (LVFO)	jpringle@blm.gov	(702) 515-5030
James Grof	Recreation (PFO)	jgrof@blm.gov	(702) 515-5064
Kim Mangum	Tribal Liaison (Energy and Infrastructure)	kmangum@blm.gov	(702) 515-5034
Lara Kobelt	Livestock Grazing/Vegetation (SNDO)	lkobelt@blm.gov	(702) 515-5022
Lee Kirk	Planning and Environmental Coordinator (LVFO/PFO)	jkirk@blm.gov	(702) 515-5026
Lisa Christianson	Air/Greenhouse Gas/Waste (SNDO)	l50chris@blm.gov	(702) 515-5127
Mike Chondoronek	Cultural (PFO)	mchodoronek@blm.gov	(702) 515-5059
Michael Evans	Geologist/Minerals (PFO)	mevans@blm.gov	(702) 515-5153
Sean McEldery	Fuels/Fire (SNDO)	smcelder@blm.gov	(702) 515-5285
Steve Leslie	Visual Resources	sleslie@blm.gov	(702) 515-5054
Tabitha Romero	Wild Horse and Burro Specialist (SNDO)	tromero@blm.gov	(702) 515-5171
Tarl Norman	Invasive Species (SNDO)	tnorman@blm.gov	(702) 515-5295

7.0 Consultation and Coordination

The Southern Nevada District Office held the state-wide meeting on June 24, 2019; eight letters were received, and one public participant attended. Specific concerns included whether most were not in support of the use of helicopters and the gathering of excess wild horses. Their comments were entered into the record for this hearing. Standard Operating Procedures were reviewed in response to these concerns and no changes to the SOPs were indicated based on this review.

8.0 Public Involvement

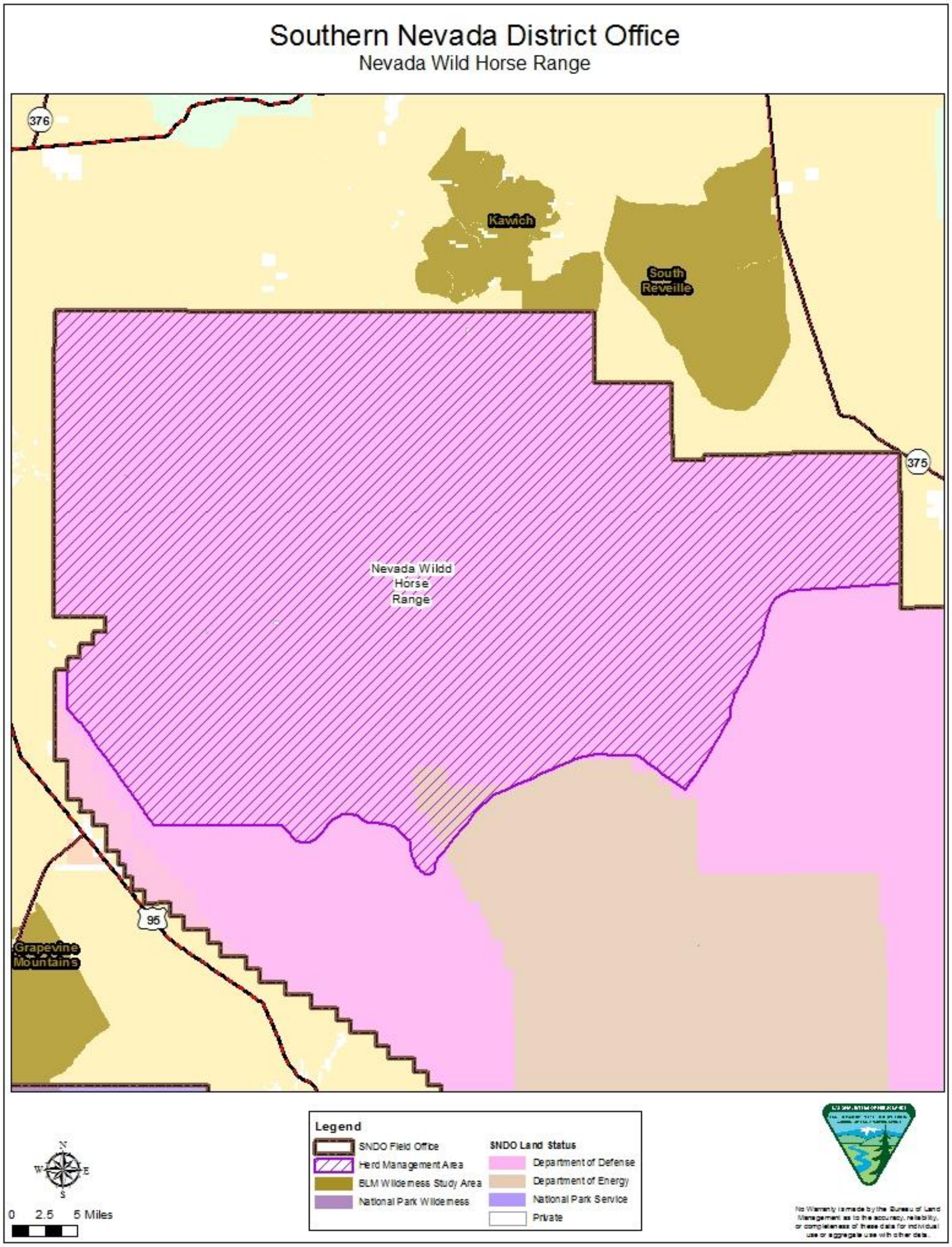
The draft environmental assessment will be made available to interested individuals, agencies and groups for a 30-day public review and comment period.

10.0 Appendices

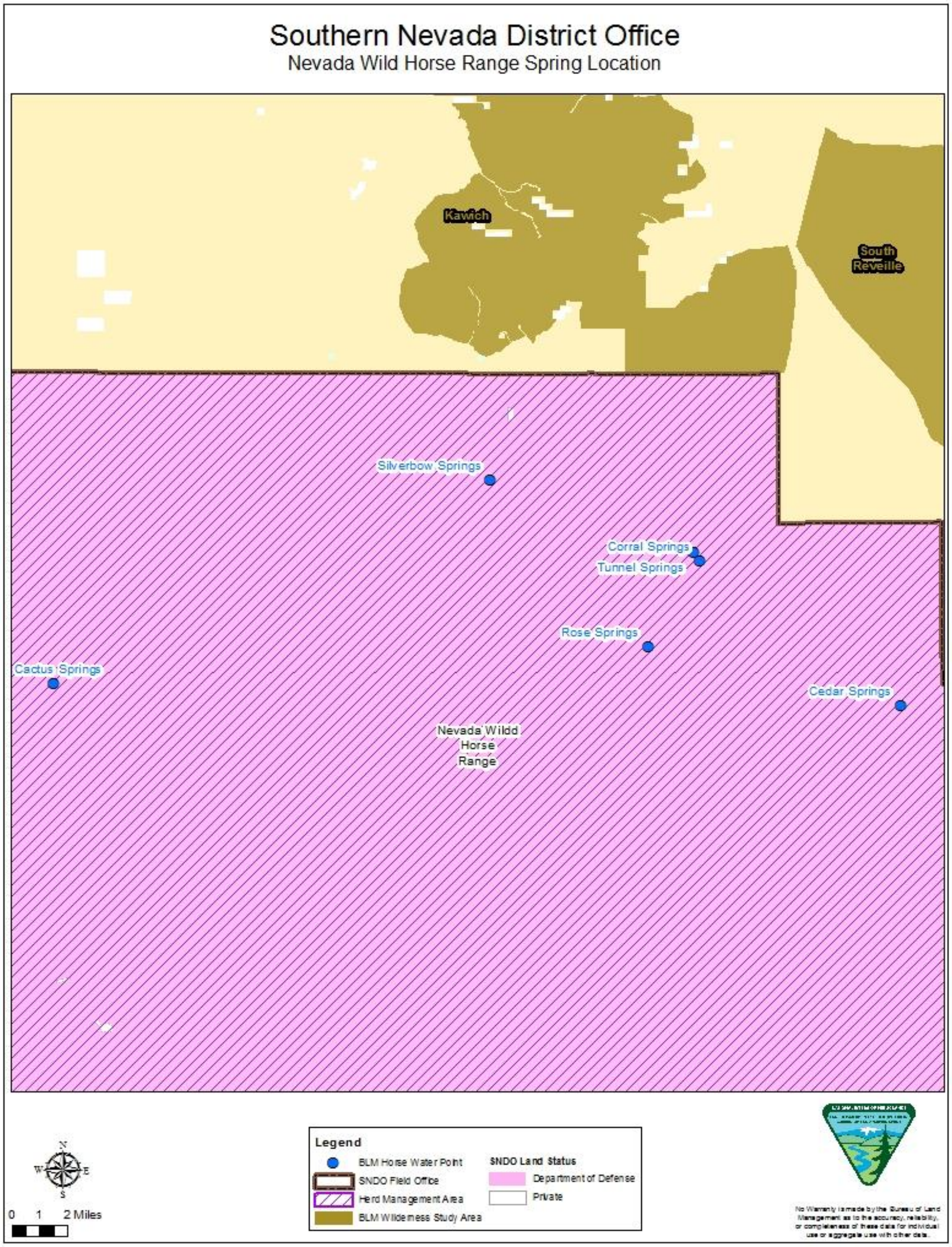
Appendix A – Maps
Appendix B – Comprehensive Animal Welfare Program (Gather Operations SOP's)
Appendix C – Win Equus Population Modeling Results
Appendix D – PZP, GonaCon, Spay, Geld Literature Reviews
Appendix E – Fertility Control Treatment Standard Operating Procedures
Appendix F – Standard Operating Procedures for Field Castration (Gelding) of Wild Horse Stallions
Appendix G – Literature Cited
Appendix H – Standard Stipulations and Mitigation Measures
Appendix I – Summary of Public Comments Received

Appendix A. Maps

Map 1: Nevada Wild Horse Range



Map 2: Nevada Wild Horse Range Developed Spring Locations



Appendix B. Gather Operations Standard Operating Procedures

Gathers would be conducted by utilizing contractors from the Wild Horse Gathers-Western States Contract, or BLM personnel. The following procedures for gathering and handling wild horses would apply whether a contractor or BLM personnel conduct a gather. For helicopter gathers conducted by BLM personnel, gather operations will be conducted in conformance with the *Wild Horse Aviation Management Handbook* (January 2009).

Prior to any gathering operation, the BLM will provide a pre-gather evaluation of existing conditions in the gather area(s). The evaluation will include animal conditions, prevailing temperatures, drought conditions, soil conditions, road conditions, and a topographic map with wilderness boundaries, the location of fences, other physical barriers, and acceptable trap locations in relation to animal distribution. The evaluation will determine whether the proposed activities will necessitate the presence of a veterinarian during operations. If it is determined that a large number of animals may need to be euthanized or gather operations could be facilitated by a veterinarian, these services would be arranged before the gather would proceed. The contractor will be apprised of all conditions and will be given instructions regarding the gather and handling of animals to ensure their health and welfare is protected.

Trap sites and temporary holding sites will be located to reduce the likelihood of injury and stress to the animals, and to minimize potential damage to the natural resources of the area. These sites would be located on or near existing roads whenever possible.

The primary gather methods used in the performance of gather operations include:
1. Helicopter Drive Trapping. This gather method involves utilizing a helicopter to herd wild horses into a temporary trap.

2. Helicopter Assisted Roping. This gather method involves utilizing a helicopter to herd wild horses or burros to ropers.

3. Bait Trapping. This gather method involves utilizing bait (e.g., water or feed) to lure wild horses into a temporary trap.

The following procedures and stipulations will be followed to ensure the welfare, safety and humane treatment of wild horses in accordance with the provisions of 43 CFR 4700.

Helicopter Gather Methods used in the Performance of Gather Contract Operations

The primary concern of the contractor is the safe and humane handling of all animals gathered.

All gather attempts shall incorporate the following:

1. All trap and holding facilities locations must be approved by the Contracting Officer's Representative (COR) and/or the Project Inspector (PI) prior to construction. All trap and holding facilities locations must be approved by the LCOR/COR/PI prior to construction. The Contractor may also be required to change or move trap locations as determined by the LCOR/COR/PI. LCOR/COR/PI will determine when capture objectives are met. All traps and holding facilities not located on public land must have prior written approval of the landowner that will be provided to the LCOR prior to use. Selection of all traps and holding sites will include consideration for public and media observation.

2. The rate of movement and distance the animals travel must not exceed limitations set by the LCOR/COR/PI who will consider terrain, physical barriers, access limitations, weather, condition of the animals, urgency of the operation (animals facing drought, starvation, fire, etc.) and other factors. The trap site shall be moved close to WH&B locations whenever possible to minimize the distance the animals need to travel.

3. All traps, wings, and holding facilities shall be constructed, maintained and operated to handle the animals in a safe and humane manner and be in accordance with the following:

a. When moving the animals from one pasture/allotment to another pasture/allotment, the fencing wire needs to be let down for a distance that is approved by the LCOR on either side of the gate or crossing.

b. If jute is hung on the fence posts of an existing wire fence in the trap wing, the wire should either be rolled up or let down for the entire length of the jute in such a way that minimizes the possibility of entanglement by WH&Bs unless otherwise approved by the LCOR/COR/PI. No modification of existing fences will be made without authorization from the LCOR/COR/PI. The Contractor shall be responsible for restoration of any fence modification which they have made.

c. Building a trail using domestic horses through the fence line, crossing or gate may be necessary to avoid animals hitting the fence.

d. The trap site and temporary holding facility must be constructed of stout materials and must be maintained in proper working condition. Traps and holding facilities shall be constructed of portable panels, the top of which shall not be less than 72 inches high for horses and 60 inches for burros, and the bottom rail of which shall not be more than 12 inches from ground level. All traps and holding facilities shall be oval or round in design with rounded corners.

e. All portable loading chute sides shall be a minimum of 6 feet high and shall be fully covered on the sides with plywood, or metal without holes.

f. All alleyways that lead to the fly chute or sorting area shall be a minimum of 30 feet long and a minimum of 6 feet high for horses, and 5 feet high for burros and the bottom rail must not be more than 12 inches from ground level. All gates and panels in the animal holding and handling pens and alleys of the trap site must be covered with plywood, burlap, plastic snow fence or like material approximately 48" in height to provide a visual barrier for the animals. All materials shall be secured in place. These guidelines apply:

i. For exterior fences, material covering panels and gates must extend from the top of the panel or gate toward the ground.

ii. For alleys and small internal handling pens, material covering panels and gates shall extend from no more than 12 inches below the top of the panel or gate toward the ground to facilitate visibility of animals and the use of flags and paddles during sorting.

iii. The initial capture pen may be left uncovered as necessary to encourage animals to enter the first pen of the trap.

iv. Padding must be installed on the overhead bars of all gates used in single file ally.

v. An appropriate chute designed for restraining WH&B's must be available for necessary procedures at the temporary holding facility. The government furnished portable fly chute to restrain, age, or provide additional care for the animals shall be placed in the alleyway in a manner as instructed by or in concurrence with the LCOR/COR/PI.

vi. There must be no holes, gaps or openings, protruding surfaces, or sharp edges present in fence panels, latches, or other structures that may cause escape or possible injury.

vii. Hinged, self-latching gates must be used in all pens and alleys except for entry gates into the trap, which may be secured with tie ropes or chains.

viii. When dust conditions occur within or adjacent to the trap or holding facility, the Contractor shall be required to wet down the ground with water.

All animals gathered shall be sorted into holding pens as to age, size, temperament, sex, condition, and whether animals are identified for removal as excess or retained in the HMA. These holding pens shall be of sufficient size to minimize, to the extent possible, injury due to fighting and trampling as well as to allow animals to move easily and have adequate access to water and feed. All pens will be capable of expansion on request of the LCOR/COR/PI. Alternate pens, within the holding facility shall be furnished by the Contractor to separate mares or Jennies with small foals, sick and injured animals, and private animals from the other animals. Under normal conditions, the BLM will require that animals be restrained to determine an animal's age, sex, and ownership. In other situations restraint may be required to conduct other procedures such as veterinary treatments, restraint for fertility control vaccinations, castration, spaying, branding, blood draw, collection of hair samples for genetic monitoring, testing for equine diseases, and any application of GPS collars and radio tags (if called for). In these instances, a portable restraining chute may be necessary and will be provided by the government. Alternate pens shall be furnished by the Contractor to hold animals if the specific gathering requires that animals be released back into the capture area(s) following selective removal and/or population suppression treatments. In areas requiring one or more satellite traps, and where a centralized holding facility is utilized, the contractor may be required to provide additional holding pens to segregate animals transported from remote locations so they may be returned to their traditional ranges. Either segregation or temporary marking and later segregation will be at the discretion of the LCOR/COR/PI. The LCOR will determine if the corral size needs to be expanded due to horses staying longer, large.

FEEDING AND WATERING

a. Adult WH&Bs held in traps or temporary holding pens for longer than 12 hours must be fed every morning and evening and provided with drinking water at all times other than when animals are being sorted or worked.

b. Dependent foals must be reunited with their mares/jennies at the temporary holding facility within four hours of capture unless the LCOR/COR/PI authorizes a longer time or foals are old enough to be weaned. If a nursing foal is held in temporary holding pens for longer than 4 hours without their dams, it must be provided with water and good quality weed seed free hay.

c. Water must be provided at a minimum rate of 10 gallons per 1,000 pound animal per day, adjusted accordingly for larger or smaller horses, burros and foals, and environmental conditions, with each trough placed in a separate location of the pen (i.e. troughs at opposite ends of the pen) with a minimum of one trough per 30 horses. Water must be refilled at least every morning and evening when necessary.

d. Good quality weed seed free hay must be fed at a minimum rate of 20 pounds per 1,000 pound adult animal per day, adjusted accordingly for larger or smaller horses, burros and foals.

1. Hay must not contain poisonous weeds or toxic substances.
2. Hay placement must allow all WH&B's to eat simultaneously.

e. When water or feed deprivation conditions exist on the range prior to the gather, the LCOR/COR/PI shall adjust the watering and feeding arrangements in consultation with the onsite veterinarian as necessary to provide for the needs of the animals to avoid any toxicity concerns.

TRAP SITE

A dependent foal or weak/debilitated animal must be separated from other WH&Bs at the trap site to avoid injuries during transportation to the temporary holding facility. Separation of dependent foals from mares must not exceed four hours unless the LCOR/COR/PI authorizes a longer time or the decision is made to wean the foals.

TEMPORARY HOLDING FACILITY

a. All WH&B's in confinement must be observed at least twice daily during feeding time to identify sick or injured WH&Bs and ensure adequate food and water.

b. Non-ambulatory WH&B's must be located in a pen separate from the general population and must be examined by the LCOR/COR/PI and/or on-call or on-site veterinarian no more than 4 hours after recumbency (lying down) is observed. Unless otherwise directed by a veterinarian, hay and water must be accessible to an animal within six hours after recumbency.

c. Alternate pens must be made available for the following:

1. WH&Bs that are weak or debilitated
2. Mares/jennies with dependent foals
3. Aggressive WH&B's that could cause serious injury to other animals.

d. WH&B's in pens at the temporary holding facility shall be maintained at a proper stocking density such that when at rest all WH&B's occupy no more than half the pen area.

e. It is the responsibility of the Contractor to provide security to prevent loss, injury or death of captured animals until delivery to final destination.

f. It is the responsibility of the Contractor to provide for the safety of the animals and personnel working at the trap locations and temporary holding corrals in consultation with the LCOR/COR/PI. This responsibility will not be used to exclude or limit public and media observation as long as current BLM policies are followed.

g. The contractor will ensure that non-essential personnel and equipment are located as to minimize disturbance of WH&Bs. Trash, debris, and reflective or noisy objects shall be eliminated from the trap site and temporary holding facility.

h. The Contractor shall restrain sick or injured animals if treatment is necessary in consultation with the LCOR/COR/PI and/or onsite veterinarian. The LCOR/COR/PI and/or onsite veterinarian will determine if injured animals must be euthanized and provide for the euthanasia of such animals. The Contractor may be required to humanely euthanize animals in the field and to dispose of the carcasses as directed by the LCOR/COR/PI, at no additional cost to the Government.

i. Once the animal has been determined by the LCOR/COR/PI to be removed from the HMA/HA, animals shall be transported to final destination from temporary holding facilities within 48 hours after capture unless prior approval is granted by the LCOR/COR/PI. Animals to be released back into the HMA following gather operations will be held for a specified length of time as stated in the Task Order/SOW. The Contractor shall schedule shipments of animals to arrive at final destination between 7:00 a.m. and 4:00 p.m. unless prior approval has been obtained by the LCOR. No shipments shall be scheduled to arrive at final destination on Sunday and Federal holidays, unless prior approval has been obtained by the LCOR. Animals shall not be allowed to remain standing on gooseneck or semi-trailers while not in transport for a combined period of greater than three (3) hours. Total planned transportation time from the temporary holding to the BLM facility will not exceed 10 hours. Animals that are to be released back into the capture area may need to be transported back to the original trap site per direction of the LCOR.

CAPTURE METHODS THAT MAY BE USED IN THE PERFORMANCE OF A GATHER

Helicopter Drive Trapping

a. The helicopter must be operated using pressure and release methods to herd the animals in a desired direction and shall not repeatedly evoke erratic behavior in the WH&B's causing injury or exhaustion. Animals must not be pursued to a point of exhaustion; the on-site veterinarian must examine WH&B's for signs of exhaustion.

b. The rate of movement and distance the animals travel must not exceed limitations set by the LCOR/COR/PI who will consider terrain, physical barriers, access limitations, weather, condition of the animals, urgency of the operation (animals facing drought, starvation, fire, etc.) and other factors.

i. WH&B's that are weak or debilitated must be identified by BLM staff or the contractors. Appropriate gather and handling methods shall be used according to the direction of the LCOR/COR/PI as defined in this contract.

ii. The appropriate herding distance and rate of movement must be determined the LCOR/COR/PI on a case-by-case basis considering the weakest or smallest animal in the group (e.g., foals, pregnant mares, or horses that are weakened by body condition, age, or poor health) and the range and environmental conditions present.

iii. Rate of movement and distance travelled must not result in exhaustion at the trap site, unless the exhausted animals were already in a severely compromised condition prior to the gather. Where compromised animals cannot be left on the range or where doing so would only serve to prolong their suffering, the LCOR/COR/PI will determine if euthanasia will be performed in accordance with BLM policy.

c. WH&B's must not be pursued repeatedly by the helicopter such that the rate of movement and distance travelled exceeds the limitation set by the LCOR/COR/PI. Abandoning the pursuit or alternative capture methods may be considered by the LCOR/COR/PI in these cases.

d. The helicopter is prohibited from coming into physical contact with any WH&B regardless of whether the contact is accidental or deliberate.

e. WH&B's may escape or evade the gather site while being moved by the helicopter. If there are mare/dependent foal pairs in a group being brought to a trap and half of an identified pair is thought to have evaded capture, multiple attempts by helicopter may be used to bring the missing half of the pair to the trap or to facilitate capture by roping. In these instances, animal condition and fatigue will be evaluated by the LCOR/COR/PI or on-site veterinarian on a case-by-case basis to determine the number of attempts that can be made to capture an animal.

f. Horse captures must not be conducted when ambient temperature at the trap site is below 10ºF or above 95ºF without approval of the LCOR/COR/PI. Burro captures must not be conducted when ambient temperature is below 10ºF or above 100ºF without approval of the LCOR/COR/PI. The LCOR/COR/PI will not approve captures when the ambient temperature exceeds 105 ºF.

g. The contractor shall assure that dependent foals shall not be left behind. Any animals identified as such will be recovered as a priority in completing the gather.

h. Any adult horse or burro that cannot make it to the trap due to physical limitations shall be identified to the LCOR/COR/PI by the pilot or contractor immediately. An inspection of the animal will be made to determine the problem and the LCOR/COR/PI and/or veterinarian will decide if that animal needs to be humanely euthanized.

ROPING

a. The roping of any WH&B must be approved by the LCOR/COR/PI prior to the action.

b. The roping of any WH&B will be documented by the LCOR/COR/PI along with the circumstances. WH&Bs may be roped under circumstances which include but are not limited to the following: reunite a mare or jenny and her dependent foal; capture nuisance, injured or sick WH&Bs or those that require euthanasia; environmental reasons such as deep snow or traps that cannot be set up due to location or environmental sensitivity; and public and animal safety or legal mandates for removal.

c. Ropers should dally the rope to their saddle horn such that animals can gradually be brought to a stop and must not tie the rope hard and fast to the saddle, which can cause the animals to be jerked off their feet.

d. WH&Bs that are roped and tied down in recumbency must be continuously observed and monitored by an attendant at a maximum of 100 feet from the animal.

e. WH&Bs that are roped and tied down in recumbency must be untied within 30 minutes.

f. If the animal is tied down within the wings of the trap, helicopter drive trapping within the wings will cease until the tied-down animal is removed.

g. Sleds, slide boards, or slip sheets must be placed underneath the animal's body to move and/or load recumbent WH&Bs.

h. Halters and ropes tied to a WH&B may be used to roll, turn, and position or load a recumbent animal, but a WH&B must not be dragged across the ground by a halter or rope attached to its body while in a recumbent position.

i. All animals captured by roping must be marked at the trap site by the contractor for evaluation by the on-site/on-call veterinarian within four hours after capture, and re-evaluation periodically as deemed necessary by the on-site/on-call veterinarian.

HANDLING

Willful Acts of Abuse

The following are prohibited:

a. Hitting, kicking, striking, or beating any WH&B in an abusive manner.

b. Dragging a recumbent WH&B across the ground without a sled, slide board or slip sheet. Ropes used for moving the recumbent animal must be attached to the sled, slide board or slip sheet unless being loaded as specified in Section C 9.2.h

c. Deliberate driving of WH&Bs into other animals, closed gates, panels, or other equipment.

d. Deliberate slamming of gates and doors on WH&Bs.

e. Excessive noise (e.g., constant yelling) or sudden activity causing WH&Bs to become unnecessarily flighty, disturbed or agitated.

General Handling
a. All sorting, loading or unloading of WH&Bs during gathers must be performed during daylight hours except when unforeseen circumstances develop and the LCOR/COR/PI approves the use of supplemental light.

b. WH&Bs should be handled to enter runways or chutes in a forward direction.

c. WH&Bs should not remain in single-file alleyways, runways, or chutes longer than 30 minutes.

d. With the exception of helicopters, equipment should be operated in a manner to minimize flighty behavior and injury to WH&Bs.

Handling Aids
a. Handling aids such as flags and shaker paddles are the primary tools for driving and moving WH&Bs during handling and transport procedures. Contact of the flag or paddle end with a WH&B is allowed. Ropes looped around the hindquarters may be used from horseback or on foot to assist in moving an animal forward or during loading.

b. Routine use of electric prods as a driving aid or handling tool is prohibited. Electric prods may be used in limited circumstances only if the following guidelines are followed:

1. Electric prods must only be a commercially available make and model that uses DC battery power and batteries should be fully charged at all times.
2. The electric prod device must never be disguised or concealed.
3. Electric prods must only be used after three attempts using other handling aids (flag, shaker paddle, voice or body position) have been tried unsuccessfully to move the WH&Bs.
4. Electric prods must only be picked up when intended to deliver a stimulus; these devices must not be constantly carried by the handlers.
5. Space in front of an animal must be available to move the WH&B forward prior to application of the electric prod. 000230 Antelope and Triple B Complexes Gather Plan EA
Chapter 8. Appendix III 9
6. Electric prods must never be applied to the face, genitals, anus, or underside of the tail of a WH&B.
7. Electric prods must not be applied to any one WH&B more than three times during a procedure (e.g., sorting, loading) except in extreme cases with approval of the LCOR/COR/PI. Each exception must be approved at the time by the LCOR/COR/PI.
8. Any electric prod use that may be necessary must be documented daily by the LCOR/COR/PI including time of day, circumstances, handler, location (trap site or temporary holding facility), and any injuries (to WH&B or human)

MOTORIZED EQUIPMENT

Loading and Unloading Areas
a. Facilities in areas for loading and unloading WH&B's at the trap site or temporary holding facility must be maintained in a safe and proper working condition, including gates that swing freely and latch or tie easily.

b. The side panels of the loading chute must be a minimum of 6 feet high and fully covered with materials such as plywood or metal without holes that may cause injury.

c. There must be no holes, gaps or openings, protruding surfaces, or sharp edges present in fence panels or other structures that may cause escape or possible injury.

d. All gates and doors must open and close properly and latch securely.

e. Loading and unloading ramps must have a non-slip surface and be maintained in a safe and proper working condition to prevent slips and falls**.** Examples of non-slip flooring would include, but not be limited to, rubber mats, sand, shavings, and steel reinforcement rods built into ramp. There must be no holes in the flooring or items that can cause an animal to trip.

f. Trailers must be properly aligned with loading and unloading chutes and panels such that no gaps exist between the chute/panel and floor or sides of the trailer creating a situation where a WH&B could injure itself.

g. Stock trailers shall be positioned for loading or unloading such that there is no more than 12" clearance between the ground and floor of the trailer for burros and 18" for horses. . If animals refuse to load, it may be necessary to dig a tire track hole where the trailer level is closer to ground level.

TRANSPORTATION

A. General
1. All sorting, loading, or unloading of WH&Bs during gathers must be performed during daylight hours except when unforeseen circumstances develop and the LCOR/COR/PI approves the use of supplemental light.

2. WH&Bs identified for removal should be shipped from the temporary holding facility to a BLM facility within 48 hours.

3. Shipping delays for animals that are being held for release to range or potential on-site adoption must be approved by the LCOR/COR/PI.

4. Shipping should occur in the following order of priority; 1) debilitated animals, 2) pairs, 3) weanlings, 4) dry mares and 5) studs.

5. Total planned transport time to the BLM preparation facility from the trap site or temporary holding facility must not exceed 10 hours.

6. WH&Bs should not wait in stock trailers and/or semi-trailers at a standstill for more than a combined period of three hours during the entire journey.

B. Vehicles
1. All motorized equipment employed in the transportation of captured animals shall be in compliance with appropriate State and Federal laws and regulations applicable to the humane transportation of animals. The Contractor shall provide the CO annually, with a current safety inspection (less than one year old) for all motorized equipment and tractor-trailers used to transport animals to final destination.

2. Only tractor-trailers or stock trailers with a covered top or overhead bars shall be allowed for transporting animals from trap site(s) to temporary holding facilities, and from temporary holding facilities to final destination(s). Sides or stock racks of all trailers used for transporting animals shall be a minimum height of 6 feet 6 inches from the floor. Single deck tractor-trailers 40 feet or longer shall have two (2) partition gates providing three (3) compartments within the trailer to separate animals. Tractor-trailers less than 40 feet shall have at least one partition gate providing two (2) compartments within the trailer to separate the animals. Compartments in all tractor-trailers shall be of equal size plus or minus 10 percent. Each partition shall be a minimum of 6 feet high and shall have a minimum 5 foot wide swinging gate. The use of double deck tractor-trailers is prohibited. Only straight deck trailers and stock trailers are to be used for transporting WH&B's.

3. WH&B's must have adequate headroom during loading and unloading and must be able to maintain a normal posture with all four feet on the floor during transport without contacting the roof or overhead bars.

4. The width and height of all gates and doors must allow WH&B's to move through freely.

5. All gates and doors must open and close easily and be able to be secured in a closed position.

6. The rear door(s) of stock trailers must be capable of opening the full width of the trailer.

7. Loading and unloading ramps must have a non-slip surface and be maintained in proper working condition to prevent slips and falls.

8. All partitions and panels inside of trailers must be free of sharp edges or holes that could cause injury to WH&B's.

9. The inner lining of all trailers must be strong enough to withstand failure by kicking that would lead to injuries.

10. Partition gates in transport vehicles shall be used to distribute the load into compartments during travel.

11. Surfaces and floors of trailers must be cleaned of dirt, manure and other organic matter prior to the beginning of a gather.

12. Surfaces and floors of trailers shall have non-slip surface, use of shavings, dirt, and floor mates.

C. Care of WH&B's during Transport Procedures

1. WH&B's that are loaded and transported from the temporary holding facility to the BLM preparation facility must be fit to endure travel per direction of LCOR/COR/PI following consultation with on-site/on-call veterinarian.

2. WH&B's that are non-ambulatory, blind in both eyes, or severely injured must not be loaded and shipped unless it is to receive immediate veterinary care or euthanasia.

3. WH&B's that are weak or debilitated must not be transported without approval of the LCOR/COR/PI in consultation with the on-site veterinarian. Appropriate actions for their care during transport must be taken according to direction of the LCOR/COR/PI.

4. WH&B’s shall be sorted prior to transport to ensure compatibility and minimize aggressive behavior that may cause injury.

5. Trailers must be loaded using the minimum space allowance in all compartments as follows:

a. For a 6.8 foot wide; 24 foot long stock trailer 12 to 14 adult horses;
b. For a 6.8 foot wide; 24 foot long stock trailer 18 to 21 adult burros
c. For a 6.8 foot wide; 20 foot long stock trailer 10 to 12 adult horses can be loaded
d. For a 6.8 foot wide; 20 foot long stock trailer 15 to 18 adult burros

For a semi-trailer:
a. 12 square feet per adult horse.
bi. 6.0 square feet per dependent horse foal.
c. 8.0 square feet per adult burro.
d. 4.0 square feet per dependent burro foal

6. Considering the condition of the animals, prevailing weather, travel distance and other factors or if animals are going down on trailers or arriving at their destination down or with injuries or a condition suggesting they may have been down, additional space or footing provisions may be necessary and will be required if directed by the LCOR/COR.

7. The LCOR/COR/PI, in consultation with the receiving Facility Manager, must document any WH&B that is recumbent or dead upon arrival at the destination. Non-ambulatory or recumbent WH&B’s must be evaluated on the trailer and either euthanized or removed from the trailers using a sled, slide board or slip sheet.

8. Saddle horses must not be transported in the same compartment with WH&B’s.

EUTHANASIA or DEATH

Euthanasia Procedure during Gather Operations

1. An authorized, properly trained, and experienced person as well as a firearm appropriate for the circumstances must be available at all times during gather operations. When the travel time between the trap site and temporary holding facility exceeds one hour or if radio or cellular communication is not reliable, provisions for euthanasia must be in place at both the trap site and temporary holding facility during the gather operation.

2. Euthanasia must be performed according to American Veterinary Medical Association euthanasia guidelines (2013) using methods of gunshot or injection of an approved euthanasia agent.

3. The decision to euthanize and method of euthanasia must be directed by the LCOR/COR/PI who must be on site and may consult with the on-site/on-call veterinarian. In event and rare circumstance that the LCOR/COR/PI is not available, the contractor if properly trained may euthanize an animal as an act of mercy.

4. All carcasses will be disposed of in accordance with state and local laws and as directed by the LCORCOR/PI.

5. Carcasses left on the range should not be placed in washes or riparian areas where future runoff may carry debris into ponds or waterways. Trenches or holes for buried animals should be dug so the bottom

of the hole is at least 6 feet above the water table and 4-6 feet of level earth covers the top of the carcass with additional dirt mounded on top where possible.

COMMUNICATIONS

a. The Contractor shall have the means to communicate with the LCOR/COR/PI and all contractor personnel engaged in the capture of wild horses and burros utilizing a VHF/FM Transceiver or VHF/FM portable Two-Way radio.

b. The Contractor shall obtain the necessary FCC licenses for the radio system.

SAFETY AND SECURITY

a. All accidents involving animals or people that occur during the performance of any task order shall be immediately reported to the LCOR/COR/PI.

b. It is the responsibility of the Contractor to provide security to prevent unauthorized release, injury or death of captured animals until delivery to final destination.

c. The contractor must comply with all applicable federal, state and local regulations.

d. Fueling operations shall not take place within 1,000 feet of animals or personnel and equipment other than the refueling truck and equipment.

e. Children under the age of 12 shall not be allowed within the gather's working areas which include near the chute when working animals at the temporary holding facility, or near the pens at the trap site when working and loading of animals. Children under the age of 12 in the non-working area must be accompanied by an adult at either location at all times.

BIOSECURITY

A. Health records for all saddle and pilot horses used on WH&B gathers must be provided to the LCOR during the BLM/Contractor pre-work meeting, including:

1. Certificate of Veterinary Inspection (Health Certificate, within 30 days).
2. Proof of:
    a. A negative test for equine infectious anemia (Coggins or EIA ELISA test) within 12 months.
    b. Vaccination for tetanus, eastern and western equine encephalomyelitis, West Nile virus, equine herpes virus, influenza, *Streptococcus equi*, and rabies within 12 months.

B. Saddle horses and pilot horses must not be removed from the gather operation (such as for an equestrian event) and allowed to return unless they have been observed to be free from signs of infectious disease for a period of at least three weeks and a new Certificate of Veterinary Inspection is obtained after three weeks and prior to returning to the gather.

C. WH&B's, saddle horses, and pilot horses showing signs of infectious disease must be examined by the on-site/on-call veterinarian.

1. Any saddle or pilot horses showing signs of infectious disease (fever, nasal discharge or illness) must be removed from service and isolated from other animals on the gather until such time as the horse is free from signs of infectious disease and approved by the on-site/on-call veterinarian to return to the gather.

2. WH&B's showing signs of infectious disease will normally not be mixed with groups of healthy WH&B's at the temporary holding facility, or during transport..

PUBLIC AND MEDIA INTERACTION

a. Due to heightened public interest in wild horse and burro gathers, the BLM expects an increasing number of requests from the public and media to view the operation. All requests received by the Contractor to view gather operation shall be forwarded to the BLM, who will provide a person with the expertise necessary to escort the public and media. The safety of the WHB's, BLM employees, Contractor crew, Contractor's private animals, and the media and public will be the first priority in determining whether a viewing opportunity will be provided, and if so, the time, location, and conditions associated with the viewing opportunity.

b. Assuming the BLM determines that providing a viewing opportunity for the media and the public is appropriate, the Contractor will establish the viewing area in accordance with instructions from the LCOR/COR/PI and current wild horse and burro program policy and guidance. BLM's observation policy will be discussed with the contractor during the pre-work meeting.

c. Member(s) of the viewing public or media whose conduct interferes with the gather operation in a way that threatens the safety of the WH&B's, BLM employees, contractor crew (including animals), the media, or the public will be warned once to terminate the conduct. If the conduct persists, the offending individual(s) will be asked to leave the viewing area and the gather operation. The LCOR/COR/PI may direct the Contractor to temporarily shut down the gather operation until the situation is resolved.

d. Under no circumstances will the public or any media or media equipment be allowed in or on the gather helicopter or on the trap or holding equipment. The public, media, and media equipment must be at least 500 feet away from the trap during the trapping operation.

e. The public and media may be escorted closer than 500 feet to the trap site if approved by the LCOR/COR and in consultation with the Contractor during the time between gather runs or before or after the gather operation.

f. The Contractor shall not release any information to the news media or the public regarding the activities being conducted under this contract. All communications regarding BLM WH&B management, including but not limited to media, public and local stakeholders, are to come from the BLM unless it expressly authorizes the Contractor to give interviews, etc.

CONTRACTOR-FURNISHED PROPERTY

a. As specified herein, it is the contractor's responsibility to provide all necessary support equipment and vehicles including weed seed free hay and water for the captured animals and any other items, personnel, vehicles (which shall include good condition trucks and stock trailers to haul horses and burros from the trap site to the holding facility and two tractor trailers in good condition to haul horses from the holding facility to the preparation facility), saddle horses, etc. to support the humane and compassionate capture, care, feeding, transportation, treatment, and as appropriate, release of WHB's. Other equipment includes but is not limited to, a minimum 2,500 linear feet of 72-inch high (minimum height) panels for horses or 60-inch high (minimum height) for burros for traps and holding facilities. Separate water troughs shall be provided at each pen where animals are being held meeting the standards in section C.6. Water troughs shall be constructed of such material (e.g., rubber, galvanized metal with rolled edges, rubber over metal) so as to avoid injury to the animals.

b. The Contractor shall provide a radio transceiver to insure communications are maintained with the BLM project PI when driving or transporting the wild horses/burros. The contractor needs to insure communications can be made with the BLM and be capable of operating in the 150 MHz to 174 MHz frequency band, frequency synthesized, CTCSS 32 sub-audible tone capable, operator programmable, 5kHz channel increment, minimum 5 watts carrier power.

c. The Contractor shall provide water and weed seed free hay.

d. The proper operation, service and maintenance of all contractor furnished property is the responsibility of the Contractor.

BLM ROLES AND RESPONSIBILITIES

a. Veterinarian
1. On-site veterinary support must be provided for all helicopter gathers.

2. Veterinary support will be under the direction of the LCOR/COR/PI. Upon request, the on-site/on-call veterinarian will consult with the LCOR/COR/PI on matters related to WH&B health, handling, welfare and euthanasia. All final decisions regarding medical treatment or euthanasia will be made by the on-site LCOR/COR/PI based on recommendations from the on-site veterinarian.

b. Transportation
1. The LCOR/COR/PI shall consider the condition and size of the animals, weather conditions, distance to be transported to the final destination or release, recommendations from the contractor and on-site veterinarian and other factors when planning for the movement of captured animals. The LCOR/COR/PI shall provide for any brand inspection services required for the movement of captured animals to BLM prep facilities. If animals are to be transported over state lines the LCOR will be responsible for obtaining a waiver from the receiving State Veterinarian.

2. If the LCOR/COR/PI determines that conditions are such that the animals could be endangered during transportation, the Contractor will be instructed to adjust speed or delay transportation until conditions improve.

GOVERNMENT FURNISHED EQUIPMENT/SUPPLIES/MATERIALS
a. The government will provide:

1. A portable restraining chute for each contractor to be used for the purpose of restraining animals to determine the age of specific individuals or other similar procedures. The contractor will be responsible for the maintenance of the portable restraining chute during the gather season.
2. All inoculate syringes, freezemarking equipment, and all related equipment for fertility control treatments.
3. A boat to transport burros as appropriate.
4. Sleds, slide boards, or slip sheets for loading of recumbent animals.

b. The Contractor shall be responsible for the security of all Government Furnished Property.

SITE CLEARANCES
a. Prior to setting up a trap or temporary holding facility, BLM will conduct all necessary legal reviews and clearances (NEPA, ARPA, NHPA, etc.). All proposed site(s) must be inspected by a government archaeologist. Once archaeological clearance has been obtained, the trap or temporary holding facility

may be set up. Said clearance shall be coordinated and arranged for by the COR/ PI, or other BLM employees.

Water and Bait Trapping Standard Operating Procedures

The work consists of the capture, handling, care, feeding, daily rate and transportation of wild horses and/or burros from the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah and Wyoming. The method of capture will be with the use of bait and/or water traps in accordance with the standards identified in the Comprehensive Animal Welfare Program (CAWP) for Wild horse and Burro Gathers, Bureau of Land Management (BLM) Instruction Memorandum 2015-151 (Attachment 1). Items listed in the sections of the Statement of Work (SOW) either are not covered or deviate from the CAWP, the SOW takes precedence over the CAWP when there is conflicting information. Extended care, handling and animal restraint for purposes of population growth suppression treatments may be required for some trapping operations. The contractor shall furnish all labor, supplies, transportation and equipment necessary to accomplish the individual task order requirements with the exception of a Government provided restraint fly chute, as needed for population growth suppression. The work shall be accomplished in a safe and humane manner and be in accordance with the provisions of 43 CFR Part 4700, the CAWP, the specifications and provisions included in this SOW, and any subsequent SOW documents issued with individual task orders. The primary concern of the contractor shall be the safety of all personnel involved and the humane capture and handling of all wild horses and burros. It is the responsibility of the contractor to provide appropriate safety and security measures to prevent loss, injury or death of captured wild horses and burros.

Any reference to hay in this SOW or subsequent SOW documents issued with individual task orders will be implied as certified weed-free hay (grass or alfalfa). The contractor will be responsible for providing certifications upon request from the Government. The COR/PI’s will observe a minimum of at least 25% of the trapping activity. BLM reserves the right to place game cameras or other cameras in the capture area to document animal activity and response, capture techniques and procedures, and humane care during trapping. No private/non-BLM camera will be placed within the capture areas.

Trapping activities would be on the HA/HMA/WHBT or outside areas specified in the task order. However, trapping could be required on adjacent land, federal, state, tribal, military, or private property. If trapping operations include work on military and/or other restricted areas, the BLM will coordinate all necessary clearances, such as background checks, to conduct operations for equipment and personnel.

The permissions to use private/state/tribal lands during task order performance will be coordinated by the BLM, contractor, and landowner. The need for these permissions will be identified in the Task Order SOW and will be obtained in writing.

Prior to any gathering operation, the BLM will provide for a pre-capture evaluation of existing conditions in the gather area(s). The evaluation will include animal conditions, prevailing temperatures, drought conditions, soil conditions, road conditions, and preparation of a topographic map with wilderness boundaries, the location of fences, other physical barriers, and acceptable gather site locations in relation to animal distribution. The evaluation will determine whether the proposed activities will necessitate the presence of a veterinarian during operations. If it is determined that capture operations necessitate the services of a veterinarian, one would be obtained before the capture would proceed. The contractor will be apprised of all conditions and will be given instructions regarding the capture and handling of animals to ensure their health and welfare is protected.

Gather sites and temporary holding sites will be located to reduce the likelihood of undue injury and stress to the animals, and to minimize potential damage to the natural and cultural resources of the area. Temporary holding sites would be located on or near existing roads.

Bait Trapping - Facility Design (Temporary Holding Facility Area and Traps)
All trap and temporary holding facility areas locations must be approved by the COR and/or the Project Inspector (PI) prior to construction and/or operation. The contractor may also be required to change or move trap locations as determined by the COR/PI. All traps and temporary holding facilities not located on public land must have prior written approval of the landowner or other management agency.

Facility design to include traps, wings, alleys, handling pens, finger gates, and temporary holding facilities, etc. shall be constructed, maintained and operated to handle the wild horses and burros in a safe and humane manner in accordance with the standards identified in the Comprehensive Animal Welfare Program (CAWP) for Wild Horse and Burro Gathers, Bureau of Land Management (BLM) Instruction Memorandum 2015-151 (Attachment 1).

Some gather operations will require the construction of an off-site temporary holding facility as identified in specific individual task orders for extended care and handling for purposes of slow trapping conditions or management activities such as research, population growth suppression treatments, etc.

No modification of existing fences will be made without authorization from the COR/PI. The contractor shall be responsible for restoring any fences that are modified back to the original condition.

Temporary holding and sorting pens shall be of sufficient size to prevent injury due to fighting and trampling. These pens shall also allow for captured horses and burros to move freely and have adequate access to water and feed.

All pens will be capable of expansion when requested by the COR/PI.

Separate water troughs shall be provided for each pen where wild horses and burros are being held. Water troughs shall be constructed of such material (e.g., rubber, plastic, fiberglass, galvanized metal with rolled edges, and rubber over metal) so as to avoid injury to the wild horses and burros.

Any changes or substitutions to trigger and/or trip devices previously approved for use by the Government must be approved by the COR prior to use.

Bait Trapping, Animal Care, and Handling
If water is to be used as the bait agent and the Government determines that cutting off other water sources is the best action to take under the individual task order, elimination of other water sources shall not last longer than a period of time approved by the COR/PI.

Hazing/Driving of wild horses and burros for the purpose of trapping the animals will not be allowed for the purposes of fulfilling individual task orders. Roping will be utilized only as directed by the COR.

Darting of wild horses and burros for trapping purposes will not be allowed.

No barbed wire material shall be used in the construction of any traps or used in new construction to exclude horses or burros from water sources.

Captured wild horses and burros shall be sorted into separate pens (i.e. by age, gender, animal health/condition, population growth suppression, etc.).

A temporary holding facility area will be required away from the trap site for any wild horses and burros that are being held for more than 24 hours.

The contractor shall assure that captured mares/jennies and their dependent foals shall not be separated for more than 4 hours, unless the COR/PI determines it necessary.

The contractor shall provide a saddle horse on site that is available to assist with the pairing up of mares/jennies with their dependent foals and other tasks as needed.

Contractor will report any injuries/deaths that resulted from trapping operations as well as preexisting conditions to the COR/PI within 12 hours of capture and will be included in daily gather activity report to the COR.

The COR/PI may utilize contractor constructed facilities when necessary in the performance of individual task orders for such management actions as population growth suppression, and/or selecting animals to return to the range.

In performance of individual task orders, the contractor may be directed by the COR to transport and release wild horses or burros back to the range.

At the discretion of the COR/PI the contractor may be required to delay shipment of horses until the COR/PI inspects the wild horses and burros at the trap site and/or the temporary holding facility prior to transporting them to the designated facility.

Wild Horse and Burro Care and Biosecurity

The contractor shall restrain sick or injured wild horses and burros if treatment is necessary in consultation with the COR/PI and/or veterinarian.

Any saddle or pilot horses used by the contractor will be vaccinated within 12 months of use (EWT, West Nile, Flu/rhino, strangles).

Transportation and Animal Care

The contractor, following coordination with the COR, shall schedule shipments of wild horses and burros to arrive during the normal operating hours of the designated facility unless prior approval has been obtained from the designated facility manager by the COR. Shipments scheduled to arrive at designated facilities on a Sunday or a Federal holiday requires prior facility personnel approval.

All motorized equipment employed in the transportation of captured wild horses and burros shall be incompliance with appropriate State and Federal laws and regulations.

Sides or dividers of all trailers used for transporting wild horses and burros shall be a minimum height of 6 feet 6 inches from the floor. A minimum of one full height partition is required in each stock trailer. All trailers shall be covered with solid material or bars to prevent horses from jumping out.

The contractor shall consider the condition and size of the wild horses and burros, weather conditions, distance to be transported, or other factors when planning for the movement of captured wild horses and burros.

The Government shall provide for any brand and/or veterinary inspection services required for captured wild horses and burros. Prior to shipping across state lines the Government will be responsible for coordinating with the receiving state veterinarian to transport the animals without a health certificate or coggins test. If the receiving state does not agree to grant entry to animals without a current health certificate or coggins test, the Government will obtain them prior to shipment.

When transporting wild horses and burros, drivers shall inspect for downed animals a minimum of every two hours when travelling on gravel roads or when leaving gravel roads onto paved roads and a minimum of every four hours when travelling on paved roads. a)

Euthanasia or Death

The COR/PI will determine if a wild horse or burro must be euthanized and will/may direct the contractor to destroy the animal in accordance with the BLM Animal Health, Maintenance, Evaluation, and Response Instruction Memorandum, 2015-070 (Attachment 2). Any contractor personnel performing this task shall be trained as described in this Memorandum.

Pursuant to the IM 2015-070 the contractor may be directed by the Authorized Officer and/or COR to humanely euthanize wild horses and burros in the field and to dispose of the carcasses in accordance with state and local laws.

Safety and Communication

The nature of work performed under this contract may involve inherently hazardous situations. The primary concern of the contractor shall be the safety of all personnel involved and the humane handling of all wild horses and burros. It is the responsibility of the contractor to provide appropriate safety and security measures to prevent loss, injury or death of captured wild horses and burros until delivery to the final destination.

The BLM reserves the right to remove from service immediately any contractor personnel or contractor furnished equipment which, in the opinion of the COR and/or CO violate contract rules, are unsafe or otherwise unsatisfactory. In this event, BLM will notify the contractor to furnish replacement personnel or equipment within 24 hours of notification. All such replacements must be approved in advance by the COR and/or CO.

Contractor personnel who utilize firearms for purposes of euthanasia will be required to possess proof of completing a State or National Rifle Association firearm safety certification or equivalent (conceal carry, hunter safety, etc.).

All accidents involving wild horses and burros or people that occur during the performance of any task order shall be immediately reported to the COR/PI.

The contractor shall have the means to communicate with the COR/PI and all contractor personnel engaged in the capture of wild horses and burros utilizing a cell/satellite phone or radio at all times during the trapping operations. The Contractor will be responsible for furnishing all communication equipment for contractor use. BLM will provide the frequency for radio communications.

The contractor will provide daily gather activity reports to the COR/PI if they are not present.

Public and Media

Due to increased public interest in the Wild Horse and Burro Gathers, any media or visitation requests received by the contractor shall be forwarded to the COR immediately. Only the COR or CO can approve these requests.

The Contractor shall not post any information or images to social media networks or release any information to the news media or the public regarding the activities conducted under this contract.

If the public or media interfere in any way with the trapping operation, such that the health and well-being of the crew, or horses and burros are threatened, the contractor will immediately report the incident to the COR and trapping operations will be suspended until the situation is resolved as directed by the COR.

1. All motorized equipment employed in the transportation of captured animals shall be in compliance with appropriate State and Federal laws and regulations applicable to the humane transportation of animals. The Contractor shall provide the COR/PI with a current safety inspection (less than one year old) for all motorized equipment and tractor-trailers used to transport animals to final destination.

2. All motorized equipment, tractor-trailers, and stock trailers shall be in good repair, of adequate rated capacity, and operated so as to ensure that captured animals are transported without undue risk or injury.

3. Only tractor-trailers or stock trailers with a covered top shall be allowed for transporting animals from gather site(s) to temporary holding facilities and from temporary holding facilities to final destination(s). Sides or stock racks of all trailers used for transporting animals shall be a minimum height of 6 feet 6 inches from the floor. Single deck tractor-trailers 40 feet or longer shall have two (2) partition gates providing three (3) compartments within the trailer to separate animals. Tractor-trailers less than 40 feet shall have at least one partition gate providing two (2) compartments within the trailer to separate the animals. Compartments in all tractor-trailers shall be of equal size plus or minus 10 percent. Each partition shall be a minimum of 6 feet high and shall have a minimum 5 foot wide swinging gate. The use of double deck tractor-trailers is unacceptable and shall not be allowed.

4. All tractor-trailers used to transport animals to final destination(s) shall be equipped with at least one (1) door at the rear end of the trailer which is capable of sliding either horizontally or vertically. The rear door(s) of tractor- trailers and stock trailers must be capable of opening the full width of the trailer. Panels facing the inside of all trailers must be free of sharp edges or holes that could cause injury to the animals. The material facing the inside of all trailers must be strong enough so that the animals cannot push their hooves through the side. Final approval of tractor-trailers and stock trailers used to transport animals shall be held by the COR/PI.

5. Floors of tractor-trailers, stock trailers and loading chutes shall be covered and maintained with wood shavings to prevent the animals from slipping.

6. Animals to be loaded and transported in any trailer shall be as directed by the COR/PI and may include limitations on numbers according to age, size, sex, temperament and animal condition. The following minimum square feet per animal shall be allowed in all trailers:

a. 11 square feet per adult horse (1.4 linear foot in an 8 foot wide trailer);
b. 8 square feet per adult burro (1.0 linear foot in an 8 foot wide trailer);
c. 6 square feet per horse foal (.75 linear foot in an 8 foot wide trailer);
d. 4 square feet per burro foal (.50 linear feet in an 8 foot wide trailer).

7. The COR/PI shall consider the condition and size of the animals, weather conditions, distance to be transported, or other factors when planning for the movement of captured animals. The COR/PI shall provide for anybrand and/or inspection services required for the captured animals.
8. If the COR/PI determines that dust conditions are such that the animals could be endangered during transportation, the Contractor will be instructed to adjust speed.

Safety and Communications
1. The Contractor shall have the means to communicate with the COR/PI and all contractor personnel engaged in the capture of wild horses and burros utilizing a VHF/FM Transceiver or VHF/FM portable Two-Way radio. If communications are ineffective the government will take steps necessary to protect the welfare of the animals.

a. The proper operation, service and maintenance of all contractor furnished property are the responsibility of the Contractor. The BLM reserves the right to remove from service any contractor personnel or contractor furnished equipment which, in the opinion of the contracting officer or COR/PI violate contract rules, are unsafe or otherwise unsatisfactory. In this event, the Contractor will be notified in writing to furnish replacement personnel or equipment within 48 hours of notification. All such replacements must be approved in advance of operation by the Contracting Officer or his/her representative.

b. The Contractor shall obtain the necessary FCC licenses for the radio system

c. All accidents occurring during the performance of any task order shall be immediately reported to the COR/PI.

Public and Media
Due to heightened public interest in wild horse and burro gathers, the BLM/Contractor may expect an increasing number of requests from the public and media to view the operation.

1. Due to this type of operation (luring wild horses and burros to bait) spectators and viewers will be prohibited as it will have impacts on the ability to capture wild horses and burros. Only essential personnel (COR/PI, veterinarian, contractor, contractor employees, etc.) will be allowed at the trap site during operations.

2. Public viewing of the wild horses and burros trapped may be provided at the staging area and/or the BLM preparation facility by appointment.

3. The Contractor agrees that there shall be no release of information to the news media regarding the removal or remedial activities conducted under this contract.

4. All information will be released to the news media by the assigned government public affairs officer.

5. If the public or media interfere in any way with the trapping operation, such that the health and wellbeing of the crew, horses and burros is threatened, the trapping operation will be suspended until the situation is resolved.

COR/PI Responsibilities
a. In emergency situations, the COR/PI will implement procedures to protect animals as rehab is initiated, i.e. rationed feeding and watering at trap and or staging area.

b. The COR/PI will authorize the contractor to euthanize any wild horse or burros as an act of mercy.

c. The COR/PI will ensure wild horses or burros with pre-existing conditions are euthanized in the field according to BLM policy.

d. Prior to setting up a trap or staging area on public land, the BLM and/or Forest Service will conduct all necessary clearances (archaeological, T&E, etc.). All proposed sites must be inspected by a government archaeologist or equivalent. Once archaeological clearance has been obtained, the trap or staging area may be set up. Said clearances shall be arranged for by the COR/PI.

e. The COR/PI will provide the contractor with all pertinent information on the areas and wild horses and burros to be trapped.

f. The COR/PI will be responsible to establish the frequency of communicating with the contractor.

g. The COR/PI shall inspect trap operation prior to Contractor initiating trapping.

h. The Contractor shall make all efforts to allow the COR/PI to observe a minimum of at least 25% of the trapping activity.

i. The COR/PI is responsible to arrange for a brand inspector and/or veterinarian to inspect all wild horses and burros prior to transporting to a BLM preparation facility when legally required.

j. The COR/PI will be responsible for the establishing a holding area for administering PZP, gelding of stallions, holding animals in poor condition until they are ready of shipment, holding for EIA testing, etc.

k. The COR/PI will ensure the trailers are cleaned and disinfected before WH&B's are transported. This will help prevent transmission of disease into our populations at a BLM Preparation Facility.

Responsibility and Lines of Communication
The Wild Horse Specialist (COR) or delegate has direct responsibility to ensure human and animal safety. The Field Manager will take an active role to ensure that appropriate lines of communication are established between the field, field office, state office, national program office, and BLM holding facility offices.

All employees involved in the gathering operations will keep the best interests of the animals at the forefront at all times.

All publicity and public contact and inquiries will be handled through the Office of Communications. These individuals will be the primary contact and will coordinate with the COR on any inquiries.

The BLM delegate will coordinate with the corrals to ensure animals are being transported from the capture site in a safe and humane manner and are arriving in good condition.

The BLM require humane treatment and care of the animals during removal operations. These specifications are designed to minimize the risk of injury and death during and after capture of the animals. The specifications will be vigorously enforced.

Resource Protection
Gather sites and holding facilities would be located in previously disturbed areas whenever possible to minimize potential damage to the natural and cultural resources.

Gather sites and temporary holding facilities would not be constructed on wetlands or riparian zones.

Prior to implementation of gather operations, gather sites and temporary holding facilities would be evaluated to determine their potential for containing cultural resources. All gather facilities (including gather sites, gather run- ways, blinds, holding facilities, camp locations, parking areas, staging areas, etc.) that would be located partially or totally in new locations (i.e. not at previously used gather locations) or in previously undisturbed areas would be inventoried by a BLM archaeologist or district archaeological technician before initiation of the gather. A buffer of at least 50 meters would be maintained between gather facilities and any identified cultural resources.

Gather sites and holding facilities would not be placed in known areas of Native American concern.

The contractor would not disturb, alter, injure or destroy any scientifically important paleontological remains; any historical or archaeological site, structure, building, grave, object or artifact; or any location having Native American traditional or spiritual significance within the project area or surrounding lands. The contractor would be responsible for ensuring that its employees, subcontractors or any others associated with the project do not collect artifacts and fossils, or damage or vandalize archaeological, historical or paleontological sites or the artifacts within them.

Should damage to cultural or paleontological resources occur during the period of gather due to the unauthorized, inadvertent or negligent actions of the contractor or any other project personnel, the contractor would be responsible for costs of rehabilitation or mitigation. Individuals involved in illegal activities may be subject to penalties under the Archaeological Resources Protection

Appendix C. Win Equus Population Modeling Results

To complete the population modeling for the Nevada Wild Horse Range HMA, version 1.40 of the WinEquus program, created April 10, 2020, was utilized.

Objectives of Population Modeling

Review of the data output for each of the simulations provided many use full comparisons of the possible outcomes for each alternative. Some of the questions that need to be answered through the modeling include:

- ***Do any of the Alternatives "crash" the population?***
  - None of the alternatives indicate that a "crash" is likely to occur to the population. There is no expectation that the number of animals in the wild horse or wild burro herds would decline to zero. Minimum population levels and growth rates are all within reasonable levels, and adverse impacts to the population are not likely. In combination with the potential to bring in additional breeding animals if genetic monitoring indicates a level of observed heterozygosity that is cause for concern, the lowest minimum population size of potentially breeding animals for each alternative is expected to lead to loss of observed heterozygosity at levels of less than 1% per generation.

- ***What effect do fertility control methods have on population growth rate?***
  - The expected effects of fertility control methods (vaccines and / or IUDs) in mares is analyzed in detail in this EA, as are effects of mare sterilization. It is expected that the use of fertility control methods will lead to a slightly lower population growth rate than management without the use of fertility control. The specific annual growth rates realized will depend on the number of females that are successfully treated, as a fraction of the total number of females. However, the use of fertility control would not reduce the population to AML without removal of wild horses from the range.

- ***What effect do the different alternatives have on the average population size?***
  - The level to which the population is gathered appears to be more of an influence to average population size than fertility control. Fertility control methods applied to females are expected to reduce growth rates between gathers. Alternatives without removal of wild horses are expected to result in the highest average population.

- ***What effects do the different alternatives have on the genetic health of the herd?***
  - The minimum population levels and growth rates are all within reasonable levels for each alternative; therefore, unacceptable impacts to the genetic diversity of the herds are not likely to occur. Repeated use of immunocontraceptives can lead to long-term infertility for some treated mares. However, the majority of vaccine injections are expected to take place during gathers, so it is likely that there will be gaps in time between vaccine treatments when treated mares could return to fertility. Even if a relatively large number of mares were to f genetic diversity monitoring reveals that there are causes for concern about the levels of observed heterozygosity in the herd, BLM can introduce additional wild horses from a different HMA, to augment genetic diversity within the NWHR HMA.

Population Data, Criteria, and Parameters utilized for Population Modeling

All simulations used the survival probabilities, foaling rates, and sex ratio at birth that was supplied with the Winn Equus population for the Garfield HMA.

Sex ratio at Birth:
42% Females
58% Males

The following percent effectiveness of Population growth suppression was utilized in the population modeling for Alternative I: Year 1: 94%

The following table displays the contraception parameters utilized in the population model for Proposed Alternative:

<u>Contraception Criteria</u>

Age	Percentages for Fertility Treatment
1	100%
2	100%
3	100%
4	100%
5	100%
6	100%
7	100%
8	100%
9	100%
10-14	100%
15-19	100%
20+	100%

<u>Population Modeling Criteria</u>

The following summarizes the population modeling criteria that are common to the Proposed Action and all alternatives:

- Starting year: 2020
- Initial Gather Year: 2020
- Gather interval: regular interval of three years
- Gather for fertility treatment regardless of population size: Yes
- Continue to gather after reduction to treat females: Yes
- Sex ratio at birth: 58% males
- Percent of the population that can be gathered: 80%
- Minimum age for long term holding facility horses: Not Applicable (Gate Cut)
- Foals are included in the AML
- Simulations were run for 10 years with 100 trials each

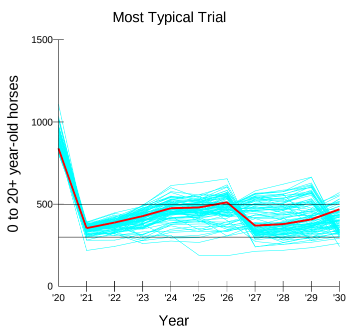
The following table displays the population modeling parameters utilized in the model:

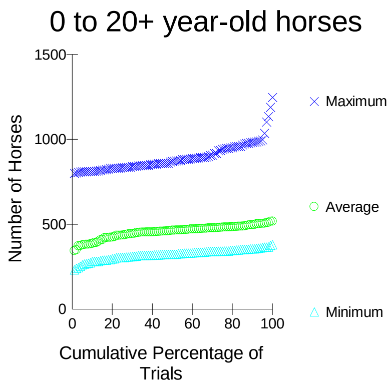
Population Modeling Parameters Modeling Parameter	Alternative 1 & 2: Proposed Action-Gather and Removal of Excess Wild Horses and Application of Population Growth Suppression	Alternative 3: Gather and Removal of Excess Wild Horses without Population Growth Suppression.	Alternative 4: No Action – Continue Existing Management. No Gather and Removal
Management by removal only	No	Yes	No
Threshold Population Size Following Gathers	400	400	N/A
Target Population Size Following gather	400	400	N/A
Gather for Population Growth Suppression regardless of population size	Yes	No	N/A
Gather continue after removals to treat additional females	Yes	Yes	N/A

Effectiveness of Population Growth Suppression: Year 1	94%	N/A	N/A

Results Alternative 1 & 2: Proposed Action –Gather and Removal of Excess Wild Horses and Application of Population Growth Suppression.

Population Size

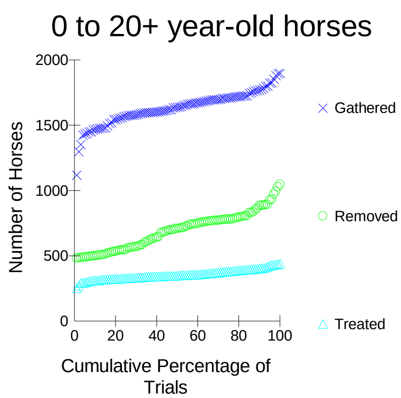




	Population Sizes in 11 Years*		
	Minimum	Average	Maximum
Lowest Trial	232	345	801
10th Percentile	282	390	812
25th Percentile	305	437	834
Median Trial	324	465	872
75th Percentile	342	483	944
90th Percentile	356	498	984
Highest Trial	380	518	1248

* 0 to 20+ year-old horses

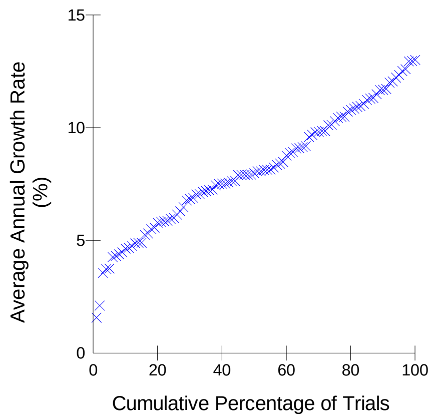
In 11 years and 100 trials, the lowest number of 0 to 20+ year old horses ever obtained was 232 and the highest was 1248. In half the trials, the minimum population size in 11 years was less than 324 and the maximum was less than 872. The average population size across 11 years ranged from 345 to 518.



Totals in 11 Years*

	Gathered	Removed	Treated
Lowest Trial	1119	481	252
10th Percentile	1472	502	312
25th Percentile	1573	555	330
Median Trial	1640	711	350
75th Percentile	1711	781	381
90th Percentile	1774	886	404
Highest Trial	1898	1048	441

* 0 to 20+ year-old horses

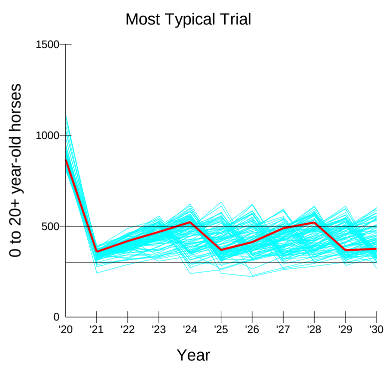


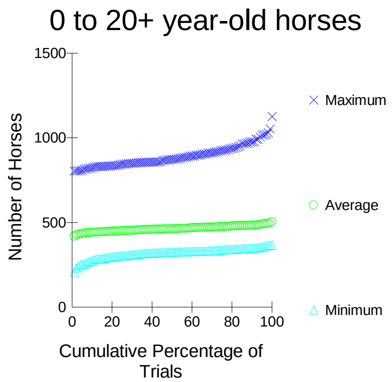
Average Growth Rate in 10 Years

Lowest Trial	1.6
10th Percentile	4.7
25th Percentile	6.1
Median Trial	8.0
75th Percentile	10.4
90th Percentile	11.7
Highest Trial	13.0

Results Alternative 3: Gather and Removal of Excess Wild Horses without Population Growth Suppression

Population Size

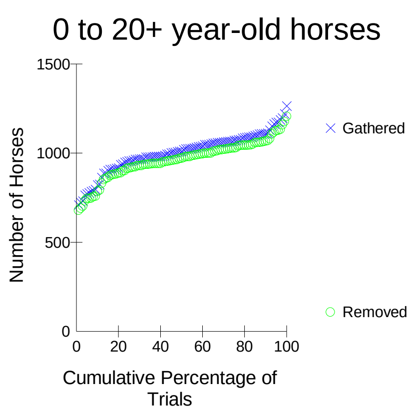




	Population Sizes in 11 Years*		
	Minimum	Average	Maximum
Lowest Trial	205	419	805
10th Percentile	278	442	827
25th Percentile	304	451	846
Median Trial	326	463	874
75th Percentile	339	476	927
90th Percentile	350	484	978
Highest Trial	368	504	1127

* 0 to 20+ year-old horses

In 11 years and 100 trials, the lowest number of 0 to 20+ horses ever obtained was 205 and the highest was 1127. In half the trials, the minimum population size in 11 years was less than 326 and the maximum was less than 874. The average population size across 11 years ranged from 419 to 504.

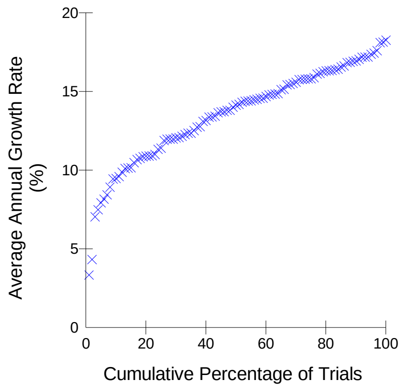


Totals in 11 Years*

Gathered Removed

Lowest Trial	710	679
10th Percentile	824	788
25th Percentile	957	918
Median Trial	1016	973
75th Percentile	1072	1030
90th Percentile	1112	1068
Highest Trial	1265	1206

* 0 to 20+ year-old horses

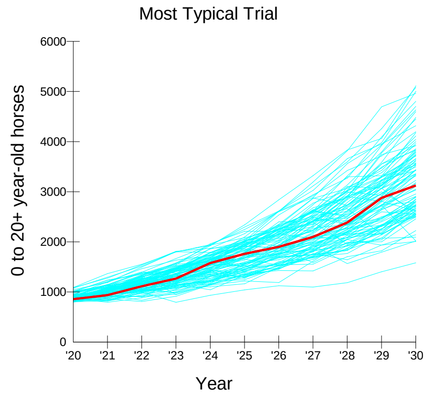


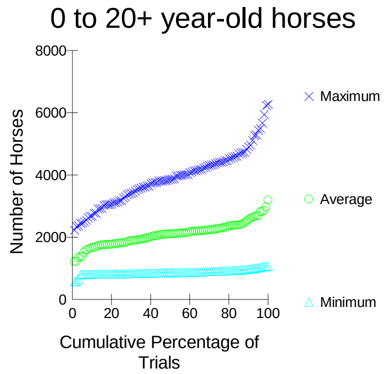
Average Growth Rate in 10 Years

Lowest Trial	3.3
10th Percentile	9.5
25th Percentile	11.7
Median Trial	14.2
75th Percentile	15.9
90th Percentile	17.0
Highest Trial	18.3

Alternative 4: No Action – No Gather, Removal or use of Population Growth Suppression

Population Size



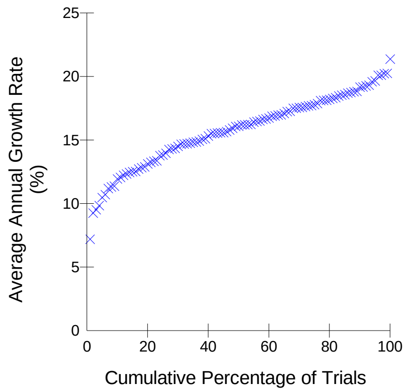


Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	573	1221	2230
10th Percentile	813	1666	2727
25th Percentile	832	1817	3222
Median Trial	864	2105	3868
75th Percentile	918	2286	4418
90th Percentile	982	2587	4934
Highest Trial	1080	3195	6275

* 0 to 20+ year-old horses

In 11 years and 100 trials the lowest number of 0 to 20+ year old horses ever obtained was 579 and the highest was 5512. In half the trials, the minimum population size in 11 years was less than 876 and the maximum was less than 3394. The average population size across 11 years ranged from 910-2835.



Average Growth Rate in 10 Years

Lowest Trial	7.2
10th Percentile	12.0
25th Percentile	13.9
Median Trial	16.2
75th Percentile	17.8
90th Percentile	19.2
Highest Trial	21.4

Appendix D. PZP, GonaCon, Spay, Geld, and IUD Literature Reviews

BLM's Use of Contraception in Wild Horse Management

Expanding the use of population growth suppression (PGS) to slow population growth rates and reducing the number of animals removed from the range and sent to off-range pastures (ORPs) is a BLM priority. The WFRHBA of 1971 specifically provides sterilization (section 3.b.1). No finding of excess determination is required for BLM to pursue contraception in wild horses or wild burros only. Contraception has been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used with other techniques, to reduce horse population size (Bartholow 2004, de Seve and Boyles-Griffin 2013). All fertility control methods in wild animals are associated with potential risks and benefits, including effects of handling, frequency of handling, physiological effects, behavioral effects, and reduced population growth rates (Hampton et al. 2015). Contraception by itself does not remove excess horses from an HMA's population, so if a wild horse population is in excess of AML, then contraception alone would result in some continuing environmental effects of horse overpopulation. Successful contraception reduces future reproduction. Limiting future population increases of horses could limit increases in environmental damage from higher densities of horses than currently exist. Horses are long-lived, potentially reaching 20 years of age or more in the wild and, if the population is above AML, treated horses returned to the NWHR may continue exerting negative environmental effects, as described above, throughout their life span. In contrast, if horses above AML are removed when horses are gathered, that leads to an immediate decrease in the severity of ongoing detrimental environmental effects.

Successful contraception would be expected to reduce the effects of frequent horse gather activities on the environment, as well as wild horse management costs to taxpayers. Bartholow (2007) concluded that the application of 2 or 3-year contraceptives to wild mares could reduce operational costs in a project area by 12-20%, or up to 30% in carefully planned population management programs. He also concluded that contraceptive treatment would likely reduce the number of horses that must be removed in total, with associated cost reductions in the number of adoptions and total holding costs. If applying contraception to horses requires capturing and handling horses, the risks and costs associated with capture and handling of horses may be comparable to those of gathering for removal, but adoption and long-term holding costs would be lower. Selectively applying contraception to older animals and returning them to the NWHR could reduce long-term holding costs for such horses, which are difficult to adopt, and could reduce the compensatory reproduction that often follows removals (Kirkpatrick and Turner 1991). On the other hand, selectively applying contraception to younger animals can slow the rate of genetic diversity loss – a process that tends to be slow in a long-lived animal with high levels of genetic diversity – and could reduce growth rates further by delaying the age of first parturition (Gross 2000). Although contraceptive treatments are associated with a number of potential physiological, behavioral, demographic, and genetic effects, detailed in Section 4, Environmental Effects, those concerns do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013). The Proposed Action reflects proposed management strategies that are consistent with the WFRHBA, which allows for sterilization as a means of population control as well as consistent with recommendations from the National Academy of Science.

Porcine Zona Pellucida (PZP) Vaccine

PZP vaccines have been used on dozens of horse herds by the National Park Service, US Forest Service, Bureau of Land Management, and Native American tribes and its use is approved by the EPA for free-ranging wild horses. Taking into consideration available literature on the subject, the National Research Council concluded in their 2013 report that PZP was one of the preferable available methods for contraception in wild horses and burros (NRC 2013). PZP use can reduce the need for gathers and removals (Turner et al. 1997). PZP vaccines meet most of the criteria that the National Research Council (2013) used to identify promising fertility control methods, in terms of delivery method, availability, efficacy, and side effects. It has been used extensively in wild horses (NRC 2013), and in feral burros on Caribbean islands (Turner et al. 1996, French et al. 2017). PZP is relatively inexpensive, meets BLM requirements for safety to mares and the environment, and is produced as ZonaStat-H, an EPA-registered commercial product (EPA 2012, SCC 2015), or as PZP-22, which is a formulation of PZP in polymer pellets that can lead to a longer immune response (Turner et al. 2002, Rutberg et al. 2017). 'Native' PZP proteins can be purified from pig ovaries (Liu et al. 1989). Recombinant ZP proteins may be produced with molecular techniques (Gupta and Minhas 2017, Joonè et al. 2017a). It can easily be remotely administered in the field in cases where mares are relatively approachable. Use of remotely delivered (dart-delivered) vaccine is generally limited to populations where individual animals can be accurately identified and repeatedly approached within 50 m (BLM 2010).

The BLM currently uses two PZP formulations for fertility control of wild horse mares, ZonaStat-H (PZP Native) and PZP-22. As other formulations are approved for use by BLM, they may be applied through future gathers or darting activities. For the purpose of this management plan, field or remote darting refers to applying the vaccine using a dart. Darting can be implemented when animals are gathered into corrals or opportunistically by applicators near water sources or along main WH&B trails out on the range. Blinds may be used to camouflage applicators to allow efficient treatment of as many mares as possible. PZP can also be applied via hand injections using plastic syringes when animals are gathered into corrals and chutes. In keeping with the EPA registration for ZonaStat-H (EPA 2012; reg. no. 86833-1), certification through the Science and Conservation Center in Billings Montana is required to apply that vaccine to equids.

When applying native PZP (i.e., ZonaStat-H), first the primer with modified Freund's Complete adjuvant is given and then the booster with Freund's Incomplete adjuvant is given 2-6 weeks later. Preferably, the timing of the booster dose is at least 1-2 weeks prior to the onset of breeding activity. Following the initial 2 inoculations, annual boosters are required to maintain contraception. For maximum effectiveness, PZP would be administered within the December to February timeframe. The procedures to be followed for application of PZP are detailed in Appendix E, *Standard Operating Procedures for Population-level Porcine Zona Pellucida Fertility control treatments*.

For the PZP-22 formulation administered during gathers, each released mare would receive a single dose of the PZP-22 contraceptive vaccine pellets at the same time as a dose of the liquid PZP vaccine with modified Freund's Complete adjuvant. The pellets are applied to the mare with a large gauge needle and jab-stick into the hip. Although PZP-22 pellets have been delivered via darting in trial studies (Rutberg et al 2017), BLM does not plan to use darting for PZP-22 delivery in this HMA until there is more demonstration that PZP-22 can be reliably delivered via dart. Therefore, WH&Bs must be gathered for each application of this formulation.

PZP Direct Effects

The historically accepted hypothesis explaining PZP vaccine effectiveness posits that when injected as an antigen in vaccines, PZP causes the mare's immune system to produce antibodies that are specific to zona pellucida proteins on the surface of that mare's eggs. The antibodies bind to the mare's eggs surface proteins (Liu et al. 1989), and effectively block sperm binding and fertilization (Zoo Montana, 2000). Because treated mares do not become pregnant but other ovarian functions remain generally unchanged, PZP can cause a mare to continue having regular estrus cycles throughout the breeding season. More recent observations support a complementary hypothesis, which posits that PZP vaccination causes reductions in ovary size and function (Mask et al. 2015, Joonè et al. 2017b, Joonè et al. 2017c). Antibodies specific to PZP protein do not crossreact with tissues outside of the reproductive system (Barber and Fayrer-Hosken 2000).

Research has demonstrated that contraceptive efficacy of an injected liquid PZP vaccine, such as ZonaStat-H, is approximately 90 percent or more for mares treated twice in one year (Turner and Kirkpatrick 2002, Turner et al. 2008). The highest success for fertility control has been reported when the vaccine has been applied November through February. High contraceptive rates of 90 percent or more can be maintained in horses that are boostered annually (Kirkpatrick et al. 1992). Approximately 60 percent to 85 percent of mares are successfully contracepted for one year when treated simultaneously with a liquid primer and PZP-22 pellets (Rutberg et al. 2017). Application of PZP for fertility control would reduce fertility in a large percentage of mares for at least one year (Ransom et al. 2011).

The contraceptive result for a single application of the liquid PZP vaccine primer dose along with PZP vaccine pellets (PZP-22), based on winter applications, can be expected to fall in the approximate efficacy ranges as follows (based on figure 2 in Rutberg et al. 2017). Below, the approximate efficacy is measured as the relative decrease in foaling rate for treated mares, compared to control mares:

Year 1	Year 2	Year 3
0 (developing fetuses come to term)	~30-75 percent	~20-50 percent

If mares that have been treated with PZP-22 vaccine pellets subsequently receive a booster dose of either the liquid PZP vaccine or the PZP-22 vaccine pellets, the subsequent contraceptive effect is apparently more pronounced and long-lasting. The approximate efficacy following a booster dose can be expected to be in the following ranges (based on figure 3 in Rutberg et al. 2017).

Year 1	Year 2	Year 3	Year 4
0 (developing fetuses come to term)	~50-90 percent	~55-75 percent	~40-75 percent

The efficacies noted above, which are based on results in Rutberg et al. (2017), call into question population and economic models that assume PZP-22 can have an 85 percent efficacy in years 2 and 3 after immunization, such as Fonner and Bohara (2017).

The fraction of mares treated in a herd can have a large effect on the realized change in growth rate due to PZP contraception, with an extremely high portion of mares required to be treated to lead prevent population-level growth (e.g., Turner and Kirkpatrick 2002). Gather efficiency would likely not exceed 85 percent via helicopter, and may be less with bait and water trapping, so there would be a portion of the female population uncaptured that is not treated in any given year. Additionally, some mares may not respond to the fertility control vaccine, but instead may continue to foal normally.

Reversibility and Effects on Ovaries

In most cases, PZP contraception appears to be temporary and reversible, with most treated mares returning to fertility over time (Kirkpatrick and Turner 2002). The NRC (2013) criterion by which PZP is not optimal for wild horse contraception was duration. The ZonaStat-H formulation of the vaccine tends to confer only one year of efficacy per dose. Some studies have found that a PZP vaccine in long-lasting pellets (PZP-22) can confer multiple years of contraception (Turner et al. 2007), particularly when boostered with subsequent PZP vaccination (Rutberg et al. 2017). Other trial data, though, indicate that the pelleted vaccine may only be effective for one year (J. Turner, University of Toledo, Personal Communication).

The purpose of applying PZP treatment is to prevent mares from conceiving foals, but BLM acknowledges that long-term infertility, or permanent sterility, could be a result for some number of wild horses receiving PZP vaccinations. The rate of long-term or permanent sterility following vaccinations with PZP is hard to predict for individual horses, but that outcome appears to increase in likelihood as the number of doses increases (Kirkpatrick and Turner 2002). Permanent sterility for mares treated consecutively 5-7 years was observed by Nuñez et al. (2010, 2017). In a graduate thesis, Knight (2014) suggested that repeated treatment with as few as three to four years of PZP treatment may lead to longer-term sterility, and that sterility may result from PZP treatment before puberty. Repeated treatment with PZP led long-term infertility in Przewalski's horses receiving as few as one PZP booster dose (Feh 2012). However, even if some number of mares become sterile as a result of PZP treatment, that potential result would be consistent with the contraceptive purpose that motivates BLM's potential use of the vaccine.

In some mares, PZP vaccination may cause direct effects on ovaries (Gray and Cameron 2010, Joonè et al. 2017b, Joonè et al. 2017c, Joonè et al. 2017d). Joonè et al. (2017a) noted reversible effects on ovaries in mares treated with one primer dose and booster dose. Joonè et al. (2017c) documented decreased anti-Mullerian hormone (AMH) levels in mares treated with native or recombinant PZP vaccines; AMH levels are thought to be an indicator of ovarian function. Bechert et al. (2013) found that ovarian function was affected by the SpayVac PZP vaccination, but that there were no effects on other organ systems. Mask et al. (2015) demonstrated that equine antibodies that resulted from SpayVac immunization could bind to oocytes, ZP proteins, follicular tissues, and ovarian tissues. It is possible that result is specific to the immune response to SpayVac, which may have lower PZP purity than ZonaStat or PZP-22 (Hall et al. 2016). However, in studies with native ZP proteins and recombinant ZP proteins, Joonè et al. (2017a) found transient effects on ovaries after PZP vaccination in some treated mares; normal estrus cycling had resumed 10 months after the last treatment. SpayVac is a patented formulation of PZP in liposomes that led to multiple years of infertility in some breeding trials (Killian et al. 2008, Roelle et al. 2017, Bechert and Fraker 2018), but unacceptably poor efficacy in a subsequent trial (Kane 2018). Kirkpatrick et al. (1992) noted effects on horse ovaries after three years of treatment with PZP. Observations at Assateague Island National Seashore indicate that the more times a mare is consecutively treated, the longer the time lag before fertility returns, but that even mares treated 7 consecutive years did eventually return to ovulation (Kirkpatrick and Turner 2002). Other studies have reported that continued applications of PZP may result in decreased estrogen levels (Kirkpatrick et al. 1992) but that decrease was not biologically significant, as ovulation remained similar between treated and untreated mares (Powell and Monfort 2001). Permanent sterility for mares treated consecutively 5-7 years was observed by Nuñez et al. (2010, 2017). Bagavant et al. (2003) demonstrated T-cell clusters on ovaries, but no loss of ovarian function after ZP protein immunization in macaques. Skinner et al. (1984) raised concerns about PZP effects on ovaries, based on their study in laboratory rabbits, as did Kaur and Prabha (2014), though neither paper was a study of PZP effects in equids.

Effects on Existing Pregnancies, Foals, and Birth Phenology
If a mare is already pregnant, the PZP vaccine has not been shown to affect normal development of the fetus or foal, or the hormonal health of the mare with relation to pregnancy (Kirkpatrick and Turner 2003). It is possible that there may be transitory effects on foals born to mares or jennies treated with PZP. In mice, Sacco et al. (1981) found that antibodies specific to PZP can pass from mother mouse to pup via the placenta or colostrum, but that did not apparently cause any innate immune response in the offspring: the level of those antibodies were undetectable by 116 days after birth. There was no indication

in that study that the fertility or ovarian function of those mouse pups was compromised, nor is BLM aware of any such results in horses or burros. Unsubstantiated speculative connections between PZP treatment and foal stealing has not been published in a peer-reviewed study and thus cannot be verified. Similarly, although Nettles (1997) noted reported stillbirths after PZP treatments in cynomolgus monkeys, those results have not been observed in equids despite extensive use.

On-range observations from 20 years of application to wild horses indicate that PZP vaccine use in wild mares does not generally cause mares to give birth to foals out of season or late in the year (Kirkpatrick and Turner 2003). Nuñez's (2010) research showed that a small number of mares that had previously been treated with PZP foaled later than untreated mares and expressed the concern that this late foaling "may" impact foal survivorship and decrease band stability, or that higher levels of attention from stallions on PZP-treated mares might harm those mares. However, that paper provided no evidence that such impacts on foal survival or mare well-being actually occurred. Rubenstein (1981) called attention to a number of unique ecological features of horse herds on Atlantic barrier islands, which calls into question whether inferences drawn from island herds can be applied to western wild horse herds. Ransom et al. (2013), though, identified a potential shift in reproductive timing as a possible drawback to prolonged treatment with PZP, stating that treated mares foaled on average 31 days later than non-treated mares. Results from Ransom et al. (2013), however, showed that over 81percent of the documented births in this study were between March 1 and June 21, i.e., within the normal, peak, spring foaling season. Ransom et al. (2013) pointedly advised that managers should consider carefully before using PZP in small refugia or rare species. Wild horses and burros managed by BLM do not generally occur in isolated refugia, nor are they rare species. Moreover, an effect of shifting birth phenology was not observed uniformly: in two of three PZP-treated wild horse populations studied by Ransom et al. (2013), foaling season of treated mares extended three weeks and 3.5 months, respectively, beyond that of untreated mares. In the other population, the treated mares foaled within the same time period as the untreated mares. Furthermore, Ransom et al. (2013) found no negative impacts on foal survival even with an extended birthing season. If there are shifts in birth phenology, though, it is reasonable to assume that some negative effects on foal survival might result from particularly severe weather events (Nuñez et al. 2018).

Effects of Marking and Injection

Standard practices for PZP treatment require that immunocontraceptive-treated animals be readily identifiable, either via brand marks or unique coloration (BLM 2010). BLM has instituted guidelines to reduce the sources of handling stress in captured animals (BLM 2015). Some level of transient stress is likely to result in newly captured mares that do not have markings associated with previous fertility control treatments. It is difficult to compare that level of temporary stress with long-term stress that can result from food and water limitation on the range (e.g., Creel et al. 2013). Handling may include freeze-marking, for the purpose of identifying that mare and identifying her PZP vaccine treatment history. Under past management practices, captured mares experienced increased stress levels from handling (Ashley and Holcombe 2001). Markings may also be used into the future to determine the approximate fraction of mares in a herd that have been previously treated, and could provide additional insight regarding gather efficiency.

Most mares recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from the fertility control injections, other than the direct consequence of becoming temporarily infertile. Injection site reactions associated with fertility control treatments are possible in treated mares (Roelle and Ransom 2009, Bechert et al. 2013, French et al. 2017), but swelling or local reactions at the injection site are expected to be minor in nature. Roelle and Ransom (2009) found that the most time-efficient method for applying PZP is by hand-delivered injection of 2-year pellets when horses are gathered. They observed only two instances of swelling from that technique. Use of remotely delivered, 1-year PZP is generally limited to populations where individual animals can be accurately identified and repeatedly approached. The dart-delivered formulation produced injection-site reactions of varying intensity, though none of the observed reactions appeared debilitating to the animals (Roelle and Ransom 2009). Joonè et al. (2017a) found that injection site reactions had healed in most mares within 3 months after the booster dose, and that they did not affect movement or cause fever. The longer term nodules observed did not appear to change any animal's range of movement or locomotor patterns and in most cases did not appear to differ in magnitude from naturally occurring injuries or scars.

Indirect Effects
One expected long-term, indirect effect on wild horses treated with fertility control would be an improvement in their overall health (Turner and Kirkpatrick 2002). Many treated mares would not experience the biological stress of reproduction, foaling and lactation as frequently as untreated mares. The observable measure of improved health is higher body condition scores (Nuñez et al. 2010). After a treated mare returns to fertility, her future foals would be expected to be healthier overall, and would benefit from improved nutritional quality in the mare's milk. This is particularly to be expected if there is an improvement in rangeland forage quality at the same time, due to reduced wild horse population size. Past application of fertility control has shown that mares' overall health and body condition remains improved even after fertility resumes. PZP treatment may increase mare survival rates, leading to longer potential lifespan (Turner and Kirkpatrick 2002, Ransom et al. 2014a). To the extent that this happens, changes in lifespan and decreased foaling rates could combine to cause changes in overall age structure in a treated herd (i.e., Turner and Kirkpatrick 2002, Roelle et al. 2010), with a greater prevalence of older mares in the herd (Gross 2000). Observations of mares treated in past gathers showed that many of the treated mares were larger than, maintained higher body condition than, and had larger healthy foals than untreated mares.

Following resumption of fertility, the proportion of mares that conceive and foal could be increased due to their increased fitness; this has been called a 'rebound effect.' Elevated fertility rates have been observed after horse gathers and removals (Kirkpatrick and Turner 1991). More research is needed to document and quantify these hypothesized effects in PZP-treated herds. If repeated contraceptive treatment leads to a prolonged contraceptive effect, then that may minimize or delay the hypothesized rebound effect. Selectively applying contraception to older animals and returning them to the HMA could reduce long-term holding costs for such horses, which are difficult to adopt, and may reduce the compensatory reproduction that often follows removals (Kirkpatrick and Turner 1991).

Because successful fertility control would reduce foaling rates and population growth rates, another indirect effect should be to reduce the number of wild horses that have to be removed over time to achieve and maintain the established AML. Contraception would be expected to lead to a relative increase in the fraction of older animals in the herd. Reducing the numbers of wild horses that would have to be removed in future gathers could allow for removal of younger, more easily adoptable excess wild horses, and thereby could eliminate the need to send additional excess horses from this area to off-range holding corrals or pastures for long-term holding. Among mares in the herd that remain fertile, a high level of physical health and future reproductive success would be expected because reduced population sizes should lead to more availability of water and forage resources per capita.

Reduced population growth rates and smaller population sizes could also allow for continued and increased environmental improvements to range conditions within the project area, which would have long-term benefits to wild horse habitat quality. As the population nears or is maintained at the level necessary to achieve a thriving natural ecological balance, vegetation resources would be expected to recover, improving the forage available to wild horses and wildlife throughout the HMA. With rangeland conditions more closely approaching a thriving natural ecological balance, and with a less concentrated distribution of wild horses across the HMA, there should also be less trailing and concentrated use of water sources. Lower population density would be expected to lead to reduced competition among wild horses using the water sources, and less fighting among horses accessing water sources. Water quality and quantity would continue to improve to the benefit of all rangeland users including wild horses. Wild horses would also have to travel less distance back and forth between water and desirable foraging areas. Should PZP booster treatment continue into the future, there may be fewer instances of overpopulation and large gathers and removals, but instead a consistent cycle of balance and stability would ensue, resulting in continued improvement of overall habitat conditions and animal health. While it is conceivable that widespread and continued treatment with PZP could reduce the birth rates of the population to such a point that birth is consistently below mortality, that outcome is not likely unless a very high fraction of the mares present are all treated in almost every year.

Behavioral Effects
The NRC report (2013) noted that all fertility suppression has effects on mare behavior, mostly as a result of the lack of pregnancy and foaling, and concluded that PZP was a good choice for use in the program. The result that PZP-treated mares may continue estrus cycles throughout the breeding season can lead to behavioral differences (as discussed below), when compared to mares that are fertile. Such behavioral differences should be considered as potential consequences of successful contraception.

Ransom and Cade (2009) delineate behaviors that can be used to test for quantitative differences due to treatments. Ransom et al. (2010) found no differences in how PZP-treated and untreated mares allocated their time between feeding, resting, travel, maintenance, and most social behaviors in three populations of wild horses, which is consistent with Powell's (1999) findings in another population. Likewise, body condition of PZP-treated and control mares did not differ between treatment groups in Ransom et al.'s (2010) study. Nuñez (2010) found that PZP-treated mares had higher body condition than control mares in another population, presumably because energy expenditure was reduced by the absence of pregnancy and lactation. Knight (2014) found that PZP-treated mares had better body condition, lived longer and switched harems more frequently, while mares that foaled spent more time concentrating on grazing and lactation and had lower overall body condition. Studies on Assateague Island (Kirkpatrick and Turner 2002) showed that once fillies (female foals) that were born to mares treated with PZP during pregnancy eventually breed, they produce healthy, viable foals.

In two studies involving a total of four wild horse populations, both Nuñez et al. (2009) and Ransom et al. (2010) found that PZP-treated mares were involved in reproductive interactions with stallions more often than control mares, which is not surprising given the evidence that PZP-treated females of other mammal species can regularly demonstrate estrus behavior while contracepted (Shumake and Killian 1997, Heilmann et al. 1998, Curtis et al. 2001, Duncan et al. 2017). There was no evidence, though, that mare welfare was affected by the increased level of herding by stallions noted in Ransom et al. (2010). Nuñez's later analysis (2017) noted no difference in mare reproductive behavior as a function of contraception history.

Ransom et al. (2010) found that control mares were herded by stallions more frequently than PZP-treated mares, and Nuñez et al. (2009, 2014, 2017, 2018) found that PZP-treated mares exhibited higher infidelity to their band stallion during the non-breeding season than control mares. Madosky et al. (2010) and Knight (2014) found this infidelity was also evident during the breeding season in the same population that Nuñez et al. (2009, 2010, 2014, 2017, 2018) studied. Nuñez et al. (2014, 2017, 2018) concluded that PZP-treated mares changing bands more frequently than control mares could lead to band instability. Nuñez et al. (2009), though, cautioned against generalizing from that island population to other herds. Nuñez et al. (2014) found elevated levels of fecal cortisol, a marker of physiological stress, in mares that changed bands. The research is inconclusive as to whether all the mares' movements between bands were related to the PZP treatments themselves or the fact that the mares were not nursing a foal, and did not demonstrate any long-term negative consequence of the transiently elevated cortisol levels. Nuñez et al. 2014 wrote that these effects "…may be of limited concern when population reduction is an urgent priority." Nuñez (2018) noted (based on unpublished results) that band stallions of mares that have received PZP treatment can exhibit changes in behavior and physiology. Nuñez (2018) cautioned that PZP use may limit the ability of mares to return to fertility, but also noted that, "such aggressive treatments may be necessary when rapid reductions in animal numbers are of paramount importance…If the primary management goal is to reduce population size, it is unlikely (and perhaps less important) that managers achieve a balance between population control and the maintenance of more typical feral horse behavior and physiology."

In contrast to transient stresses, Creel et al. (2013) highlight that variation in population density is one of the most well-established causal factors of chronic activation of the hypothalamic-pituitary-adrenal axis, which mediates stress hormones; high population densities and competition for resources can cause chronic stress. Creel et al. (2013) also state that "…there is little consistent evidence for a negative association between elevated baseline glucocorticoids and fitness." Band fidelity is not an aspect of wild horse biology that is specifically protected by the WFRHBA of 1971. It is also notable that Ransom et al. (2014b) found higher group fidelity after a herd had been gathered and treated with a contraceptive vaccine; in that case, the researchers postulated that higher fidelity may have been facilitated by the decreased competition for forage after excess horses were removed. At the population level, available research does not provide evidence of the loss of harem structure among any herds treated with PZP. Long-term implications of these changes in social behavior are currently unknown, but no negative impacts on the overall animals or populations overall, long-term welfare or well-being have been established in these studies.

The National Research Council (2013) found that harem changing was not likely to result in serious adverse effects for treated mares:

> "The studies on Shackleford Banks (Nuñez et al., 2009; Madosky et al., 2010) suggest that there is an interaction between pregnancy and social cohesion. The importance of harem stability to mare well-being is not clear, but considering the relatively large number of free-ranging mares that have been treated with liquid PZP in a variety of ecological settings, the likelihood of serious adverse effects seem low."

Nuñez (2010) stated that not all populations will respond similarly to PZP treatment. Differences in habitat, resource availability, and demography among conspecific populations will undoubtedly affect their physiological and behavioral responses to PZP contraception, and need to be considered. Kirkpatrick et al. (2010) concluded that: "the larger question is, even if subtle alterations in behavior may occur, this is still far better than the alternative," and that the "…other victory for horses is that every mare prevented from being removed, by virtue of contraception, is a mare that will only be delaying her reproduction rather than being eliminated permanently from the range. This preserves herd genetics, while gathers and adoption do not."

The NRC report (2013) provides a comprehensive review of the literature on the behavioral effects of contraception that puts research up to that date by Nuñez et al. (2009, 2010) into the broader context of all of the available scientific literature, and cautions, based on its extensive review of the literature that:

> ". . . in no case can the committee conclude from the published research that the behavior differences observed are due to a particular compound rather than to the fact that treated animals had no offspring during the study. That must be borne in mind particularly in interpreting long-term impacts of contraception (e.g., repeated years of reproductive "failure" due to

contraception)."

Genetic Effects of PZP Vaccination
In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NRC report (2013) recommended that single HMAs should not be considered as isolated genetic populations. Rather, managed herds of wild horses should be considered as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviate potential inbreeding concerns (BLM 2010).

In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, such that most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NRC 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result would be expected to slow the rate of genetic diversity loss (Hailer et al. 2006). Based on a population model, Gross (2000) found that a strategy to preferentially treat young animals with a contraceptive led to more genetic diversity being retained than either a strategy that preferentially treats older animals, or a strategy with periodic gathers and removals.

Even if it is the case that repeated treatment with PZP may lead to prolonged infertility, or even sterility in some mares, most HMAs have only a low risk of loss of genetic diversity if logistically realistic rates of contraception are applied to mares. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses. As such, the existing genetic diversity in the majority of HMAs does not contain unique or historically unusual genetic markers. Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e., human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition. Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in case where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5percent per year), and very large fractions of the female population are permanently sterilized.

It is worth noting that, although maintenance of genetic diversity at the scale of the overall population of wild horses is an intuitive management goal, there are no existing laws or policies that require BLM to maintain genetic diversity at the scale of the individual herd management area or complex. Also, there is no Bureau-wide policy that requires BLM to allow each female in a herd to reproduce before she is treated with contraceptives.

One concern that has been raised with regards to genetic diversity is that treatment with immunocontraceptives could possibly lead to an evolutionary increase in the frequency of individuals whose genetic composition fosters weak immune responses (Cooper and Larson 2006, Ransom et al. 2014a).Many factors influence the strength of a vaccinated individual's immune response, potentially including genetics, but also nutrition, body condition, and prior immune responses to pathogens or other antigens (Powers et al. 2013). This premise is based on an assumption that lack of response to PZP is a heritable trait, and that the frequency of that trait will increase over time in a population of PZP-treated animals. Cooper and Herbert (2001) reviewed the topic, in the context of concerns about the long-term effectiveness of immunocontraceptives as a control agent for exotic species in Australia. They argue that imunocontraception could be a strong selective pressure, and that selecting for reproduction in individuals with poor immune response could lead to a general decline in immune function in populations where such evolution takes place. Other authors have also speculated that differences in antibody titer responses could be partially due to genetic differences between animals (Curtis et al. 2001, Herbert and Trigg 2005). However, Magiafolou et al. (2013) clarify that if the variation in immune response is due to environmental factors (i.e., body condition, social rank) and not due to genetic factors, then there will be no expected effect of the immune phenotype on future generations. It is possible that general health, as measured by body condition, can have a causal role in determining immune response, with animals in poor condition demonstrating poor immune reactions (NRC 2013).

Correlations between physical factors and immune response would not preclude, though, that there could also be a heritable response to immunocontraception. In studies not directly related to immunocontraception, immune response has been shown to be heritable (Kean et al. 1994, Sarker et al. 1999). Unfortunately, predictions about the long-term, population-level evolutionary response to immunocontraceptive treatments are speculative at this point, with results likely to depend on several factors, including: the strength of the genetic predisposition to not respond to PZP; the heritability of that gene or genes; the initial prevalence of that gene or genes; the number of mares treated with a primer dose of PZP (which generally has a short-acting effect); the number of mares treated with multiple booster doses of PZP; and the actual size of the genetically-interacting metapopulation of horses within which the PZP treatment takes place.

BLM is not aware of any studies that have quantified the heritability of a lack of response to immunocontraception such as PZP vaccine or GonaCon-Equine in horses. At this point there are no studies available from which one could make conclusions about the long-term effects of sustained and widespread immunocontraception treatments on population-wide immune function. Although a few, generally isolated, feral horse populations have been treated with high fractions of mares receiving PZP immunocontraception for long-term population control (e.g., Assateague Island and Pryor Mountains), no studies have tested for changes in immune competence in those areas. Relative to the large number of free-roaming feral horses in the western United States, immunocontraception has not been used in the type of widespread or prolonged manner that might be required to cause a detectable evolutionary response.
Although this topic may merit further study, lack of clarity should not preclude the use of immunocontraceptives to help stabilize extremely rapidly growing herds.

Gonadotropin Releasing Hormone (GnRH) Vaccine (GonaCon)

This literature review is intended to summarize what is known and what is not known about potential effects of treating mares with GonaCon. As noted below, some negative consequences of vaccination are possible. Anti-GnRH vaccines can be administered to either sex, but this analysis is limited to effects on females, except where inferences can be made to females, based on studies that have used the vaccine in males.

Whether to use or not use this method to reduce population growth rates in wild horses is a decision that must be made considering those effects as well as the potential effects of inaction, such as continued overpopulation and rangeland health degradation.

Reference in this text to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement, recommendation, or favoring by the Department of the Interior.

Registration and safety of GonaCon-Equine

Taking into consideration available literature on the subject, the National Research Council concluded in their 2013 report that GonaCon-B (which is produced under the trade name GonaCon-Equine for use in feral horses and burros) was one of the most preferable available methods for contraception in wild horses and burros (NRC 2013), in terms of delivery method, availability, efficacy, and side effects. GonaCon-Equine is approved for use by authorized federal, state, tribal, public and private personnel, for application to wild and feral equids in the United States (EPA 2013, 2015). Its use is appropriate for free-ranging wild horse herds. GonaCon-Equine has been used on feral horses in Theodore Roosevelt National Park and on wild horses by BLM (BLM 2015). GonaCon-Equine can be remotely administered in the field in cases where mares are relatively approachable, using a customized pneumatic dart (McCann et al. 2017). Use of remotely delivered (dart-delivered) vaccine is generally limited to populations where individual animals can be accurately identified and repeatedly approached within 50 m (BLM 2010).

GonaCon is an immunocontraceptive vaccine which has been shown to provide multiple years of infertility in several wild ungulate species, including horses (Killian et al., 2008; Gray et al., 2010). GonaCon uses the gonadotropin-releasing hormone (GnRH), a small neuropeptide that performs an obligatory role in mammalian reproduction, as the vaccine antigen. When combined with an adjuvant, the GnRH vaccine stimulates a persistent immune response resulting in prolonged antibody production against GnRH, the carrier protein, and the adjuvant (Miller et al., 2008). The most direct result of successful GnRH vaccination is that it has the effect of decreasing the level of GnRH signaling in the body, as evidenced by a drop in luteinizing hormone levels, and a cessation of ovulation. The lack of estrus cycling that results from successful GonaCon vaccination has been compared to typical winter period of anoestrus in open mares. As anti-GnRH antibodies decline over time, concentrations of available endogenous GnRH increase and treated animals usually regain fertility (Power et al., 2011).

As with other contraceptives applied to wild horses, the long-term goal of GonaCon-Equine use is to reduce or eliminate the need for gathers and removals (NRC 2013). GonaCon-Equine vaccine is an EPA-approved pesticide (EPA 2009a) that is relatively inexpensive, meets BLM requirements for safety to mares and the environment, and is produced in a USDA-APHIS laboratory. The intended effect of the vaccine is as a contraceptive. GonaCon is produced as a pharmaceutical-grade vaccine, including aseptic manufacturing technique to deliver a sterile vaccine product (Miller et al. 2013). If stored at 4° C, the shelf life is 6 months (Miller et al 2013).

Miller et al. (2013) reviewed the vaccine environmental safety and toxicity. When advisories on the product label (EPA 2015) are followed, the product is safe for users and the environment (EPA 2009b).

EPA waived a number of tests prior to registering the vaccine, because GonaCon was deemed to pose low risks to the environment, so long as the product label is followed (Wang-Cahill et al., *in press*).

Under the Proposed Action, the BLM would return to the HMA as needed to re-apply GonaCon-Equine and initiate new treatments in order to maintain contraceptive effectiveness in controlling population growth rates. GonaCon-Equine can safely be reapplied as necessary to control the population growth rate; booster dose effects may lead to increased effectiveness of contraception, which is generally the intent. Even with one booster treatment of GonaCon-Equine, it is expected that most, if not all, mares would return to fertility at some point, although the average duration of effect after booster doses has not yet been quantified. Although it is unknown what would be the expected rate for the return to fertility rate in mares boosted more than once with GonaCon-Equine, a prolonged return to fertility would be consistent with the desired effect of using GonaCon (e.g., effective contraception). Once the herd size in the project area is at AML and population growth seems to be stabilized, BLM could make a determination as to the required frequency of new mare treatments and mare re-treatments with GonaCon, to maintain the number of horses within AML.

GnRH Vaccine Direct Effects
GonaCon-Equine is one of several vaccines that have been engineered to create an immune response to the gonadotropin releasing hormone peptide (GnRH). GnRH is a small peptide that plays an important role in signaling the production of other hormones involved in reproduction in both sexes. GnRH is highly conserved across mammalian taxa, so some inferences about the mechanism and effects of GonaCon-Equine in horses can be made from studies that used different anti-GnRH vaccines, in horses and other taxa. Other commercially available anti-GnRH vaccines include: Improvac (Imboden et al. 2006, Botha et al. 2008, Janett et al. 2009a, Janett et al. 2009b, Schulman et al. 2013, Dalmau et al. 2015), made in South Africa; Equity (Elhay et al. 2007), made in Australia; Improvest, for use in swine (Bohrer et al. 2014); Repro-BLOC (Boedeker et al. 2011); and Bopriva, for use in cows (Balet et al. 2014). Of these, GonaCon-Equine, Improvac, and Equity are specifically intended for horses. Other anti-GnRH vaccine formulations have also been tested, but did not become trademarked products (e.g., Goodloe 1991, Dalin et al 2002, Stout et al. 2003, Donovan et al. 2013, Schaut et al. 2018, Yao et al. 2018). The effectiveness and side-effects of these various anti-GnRH vaccines may not be the same as would be expected from GonaCon-Equine use in horses. Results could differ as a result of differences in the preparation of the GnRH antigen, and the choice of adjuvant used to stimulate the immune response. While GonaCon-Equine can be administered as a single dose, most other anti-GnRH vaccines require a primer dose and at least one booster dose to be effective.

GonaCon has been produced by USDA-APHIS (Fort Collins, Colorado) in several different formulations, the history of which is reviewed by Miller et al. (2013). In any vaccine, the antigen is the stimulant to which the body responds by making antigen-specific antibodies. Those antibodies then signal to the body that a foreign molecule is present, initiating an immune response that removes the molecule or cell. GonaCon vaccines present the recipient with hundreds of copies of GnRH as peptides on the surface of a linked protein that is naturally antigenic because it comes from invertebrate hemocyanin (Miller et al 2013). Early GonaCon formulations linked many copies of GnRH to a protein from the keyhole limpet (GonaCon-KHL), but more recently produced formulations where the GnRH antigen is linked to a protein from the blue mussel (GonaCon-B) proved less expensive and more effective (Miller et al. 2008). GonaCon-Equine is in the category of GonaCon-B vaccines.

Adjuvants are included in vaccines to elevate the level of immune response, inciting recruitment of lymphocytes and other immune cells which foster a long-lasting immune response that is specific to the antigen. For some formulations of anti-GnRH vaccines, a booster dose is required to elicit a contraceptive response, though GonaCon can cause short-term contraception in a fraction of treated animals from one dose (Powers et al. 2011, Gionfriddo et al. 2011a, Baker et al. 2013, Miller et al 2013). The adjuvant used in GonaCon, Adjuvac, generally leads to a milder reaction than Freund's Complete Adjuvant (Powers et al. 2011). Adjuvac contains a small number of killed *Mycobacterium avium* cells (Miller et al. 2008, Miller et al. 2013). The antigen and adjuvant are emulsified in mineral oil, such that they are not all presented to the immune system right after injection It is thought that the mineral oil emulsion leads to a 'depot effect' that is associated with slow or sustained release of the antigen, and a resulting longer-lasting immune response (Miller et al. 2013). Miller et al. (2008, 2013) have speculated that, in cases where memory-B leukocytes are protected in immune complexes in the lymphatic system, it can lead to years of immune response. Increased doses of vaccine may lead to stronger immune reactions, but only to a certain point; when Yoder and Miller (2010) tested varying doses of GonaCon in prairie dogs, antibody responses to the 200µg and 400µg doses were equal to each other but were both higher than in response to a 100µg dose.

The most direct result of successful GnRH vaccination is that it has the effect of decreasing the level of GnRH signaling in the body, as evidenced by a drop in luteinizing hormone levels, and a cessation of ovulation. Antibody titer measurements are proximate measures of the antibody concentration in the blood specific to a given antigen. Anti-GnRH titers generally correlate with a suppressed reproduction system (Gionfriddo et al. 2011a, Powers et al. 2011). Various studies have attempted to identify a relationship between anti-GnRH titer levels and infertility, but that relationship has not been universally predictable or consistent. The time length that titer levels stay high appears to correlate with the length of suppressed reproduction (Dalin et al. 2002, Levy et al. 2011, Donovan et al. 2013, Powers et al. 2011). For example, Goodloe (1991) noted that mares did produce elevated titers and had suppressed follicular development for 11-13 weeks after treatment, but that all treated mares ovulated after the titer levels declined. Similarly, Elhay (2007) found that high initial titers correlated with longer-lasting ovarian and behavioral anoestrus. However, Powers et al. (2011) did not identify a threshold level of titer that was consistently indicative of suppressed reproduction despite seeing a strong correlation between antibody concentration and infertility, nor did Schulman et al. (2013) find a clear relationship between titer levels and mare acyclicity.

In many cases, young animals appear to have higher immune responses, and stronger contraceptive effects of anti-GnRH vaccines than older animals (Brown et al. 1994, Curtis et al. 2001, Stout et al. 2003, Schulman et al. 2013). Vaccinating with GonaCon at too young an age, though, may prevent effectiveness; Gionfriddo et al. (2011a) observed weak effects in 3-4 month old fawns. It has not been possible to predict which individuals of a given age class will have long-lasting immune responses to the GonaCon vaccine. Gray (2010) noted that mares in poor body condition tended to have lower contraceptive efficacy in response to GonaCon-B. Miller et al. (2013) suggested that higher parasite loads might have explained a lower immune response in free-roaming horses than had been observed in a captive trial. At this time it is unclear what the most important factors affecting efficacy are.

Females that are successfully contracepted by GnRH vaccination enter a state similar to anestrus, have a lack of or incomplete follicle maturation, and no ovarian cycling (Botha et al. 2008). A leading hypothesis is that anti-GnRH antibodies bind GnRH in the hypothalamus – pituitary 'portal vessels,' preventing GnRH from binding to GnRH-specific binding sites on gonadotroph cells in the pituitary, thereby limiting the production of gonadotropin hormones, particularly luteinizing hormone (LH) and, to a lesser degree, follicle-stimulating hormone (FSH) (Powers et al. 2011, NRC 2013). This reduction in LH (and FSH), and a corresponding lack of ovulation, has been measured in response to treatment with anti-GnRH vaccines (Boedeker et al. 2011, Garza et al. 1986).

Females successfully treated with anti-GnRH vaccines have reduced progesterone levels (Garza et al. 1986, Stout et al. 2003, Imboden et al. 2006, Elhay 2007, Botha et al. 2008, Killian et al. 2008, Miller et al. 2008, Janett et al. 2009, Schulman et al. 2013, Balet et al 2014, Dalmau et al. 2015) and β-17 estradiol levels (Elhay et al. 2007), but no great decrease in estrogen levels (Balet et al. 2014). Reductions in progesterone do not occur immediately after the primer dose, but can take several weeks or months to develop (Elhay et al. 2007, Botha et al. 2008, Schulman et al. 2013, Dalmau et al. 2015). This indicates that ovulation is not occurring and corpora lutea, formed from post-ovulation follicular tissue, are not being established.

Changes in hormones associated with anti-GnRH vaccination lead to measurable changes in ovarian structure and function. The volume of ovaries reduced in response to treatment (Garza et al. 1986, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Botha et al. 2008, Gionfriddo 2011a, Dalmau et al. 2015). Treatment with an anti-GnRH vaccine changes follicle development (Garza et al. 1986, Stout et al. 2003, Imboden et al. 2006, Elhay et al. 2007, Donovan et al. 2013, Powers et al. 2011, Balet et al. 2014), with the result that ovulation does not occur. A related result is that the ovaries can exhibit less activity and cycle with less regularity or not at all in anti-GnRH vaccine treated females (Goodloe 1991, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Janett et al. 2009a, Powers et al. 2011, Donovan et al. 2013). In studies where the vaccine required a booster, hormonal and associated results were generally observed within several weeks after delivery of the booster dose.

GnRH Vaccine Contraceptive Effects
The NRC (2013) review pointed out that single doses of GonaCon-Equine do not lead to high rates of initial effectiveness, or long duration. Initial effectiveness of one dose of GonaCon-Equine vaccine appears to be lower than for a combined primer plus booster dose of the PZP vaccine Zonastat-H (Kirkpatrick et al. 2011), and the initial effect of a single GonaCon dose can be limited to as little as one breeding season. However, preliminary results on the effects of boostered doses of GonaCon-Equine indicate that it can have high efficacy and longer-lasting effects in free-roaming horses (Baker et al. 2018) than the one-year effect that is generally expected from a single booster of Zonastat-H.

GonaCon and other anti-GnRH vaccines can be injected while a female is pregnant (Miller et al. 2000, Powers et al. 2011, Baker et al. 2013) – in such a case, a successfully contracepted mare will be expected to give birth during the following foaling season, but to be infertile during the same year's breeding season. Thus, a mare injected in November of 2018 would not show the contraceptive effect (i.e., no new foal) until spring of 2020.

Too few studies have reported on the various formulations of anti-GnRH vaccines to make generalizations about differences between products, but GonaCon formulations were consistently good at causing loss of fertility in a statistically significant fraction of treated mares for at least one year (Killian et al. 2009, Gray et al. 2010, Baker et al. 2013, 2017). With few exceptions (e.g., Goodloe 1991), anti-GnRH treated mares gave birth to fewer foals in the first season when there would be an expected contraceptive effect (Botha et al. 2008, Killian et al. 2009, Gray et al. 2010, Baker et al. 2013). Goodloe (1991) used an anti-GnRH-KHL vaccine with a triple adjuvant, in some cases attempting to deliver the vaccine to horses with a hollow-tipped 'biobullet,'but concluded that the vaccine was not an effective immunocontraceptive in that study.

Not all mares should be expected to respond to the GonaCon-equine vaccine; some number should be expected to continue to become pregnant and give birth to foals. In studies where mares were exposed to stallions, the fraction of treated mares that are effectively contracepted in the year after anti-GnRH vaccination varied from study to study, ranging from ~50 percent (Baker et al. 2017), to 61 percent (Gray et al. 2010), to ~90 percent (Killian et al. 2006, 2008, 2009). Miller et al. (2013) noted lower effectiveness in free-ranging mares (Gray et al. 2010) than captive mares (Killian et al. 2009). Some of these rates are lower than the high rate of effectiveness typically reported for the first year after PZP vaccine treatment

(Kirkpatrick et al. 2011). In the one study that tested for a difference, darts and hand-injected GonaCon doses were equally effective in terms of fertility outcome (McCann et al. 2017).

In studies where mares were not exposed to stallions, the duration of effectiveness also varied. A primer and booster dose of Equity led to anoestrus for at least 3 months (Elhay et al. 2007). A primer and booster dose of Improvac also led to loss of ovarian cycling for all mares in the short term (Imboden et al. 2006). It is worth repeating that those vaccines do not have the same formulation as GonaCon.

Results from horses (Baker et al. 2017) and other species (Curtis et al. 2001) suggest that providing a booster dose of GonaCon-Equine will increase the fraction of temporarily infertile animals to higher levels than would a single vaccine dose alone.

Longer-term infertility has been observed in some mares treated with anti-GnRH vaccines, including GonaCon-Equine. In a single-dose mare captive trial with an initial year effectiveness of 94 percent, Killian et al. (2008) noted infertility rates of 64 percent, 57 percent, and 43 percent in treated mares during the following three years, while control mares in those years had infertility rates of 25 percent, 12 percent, and 0 percent in those years. GonaCon effectiveness in free-roaming populations was lower, with infertility rates consistently near 60 percent for three years after a single dose in one study (Gray et al. 2010) and annual infertility rates decreasing over time from 55 percent to 30 percent to 0 percent in another study with one dose (Baker et al. 2017). Similarly, gradually increasing fertility rates were observed after single dose treatment with GonaCon in elk (Powers et al. 2011) and deer (Gionfriddo et al. 2011a).

Baker et al. (2017) observed a return to fertility over 4 years in mares treated once with GonaCon, but then noted extremely low fertility rates of 0 percent and 16 percent in the two years after the same mares were given a booster dose four years after the primer dose. These are extremely promising preliminary results from that study in free-roaming horses; a third year of post-booster monitoring is ongoing in summer 2017, and researchers on that project are currently determining whether the same high-effectiveness, long-term response is observed after boosting with GonaCon after 6 months, 1 year, 2 years, or 4 years after the primer dose. Four of nine mares treated with primer and booster doses of Improvac did not return to ovulation within 2 years of the primer dose (Imboden et al. 2006), though one should probably not make conclusions about the long-term effects of GonaCon-Equine based on results from Improvac.

It is difficult to predict which females will exhibit strong or long-term immune responses to anti-GnRH vaccines (Killian et al. 2006, Miller et al. 2008, Levy et al. 2011). A number of factors may influence responses to vaccination, including age, body condition, nutrition, prior immune responses, and genetics (Cooper and Herbert 2001, Curtis et al. 2001, Powers et al. 2011). One apparent trend is that animals that are treated at a younger age, especially before puberty, may have stronger and longer-lasting responses (Brown et al. 1994, Curtis et al. 2001, Stout et al. 2003, Schulman et al. 2013). It is plausible that giving ConaGon-Equine to prepubertal mares will lead to long-lasting infertility, but that has not yet been tested.

To date, short term evaluation of anti-GnRH vaccines, show contraception appears to be temporary and reversible. Killian et al. noted long-term effects of GonaCon in some captive mares (2009). However, Baker et al. (2017) observed horses treated with GonaCon-B return to fertility after they were treated with a single primer dose; after four years, the fertility rate was indistinguishable between treated and control mares. It appears that a single dose of GonaCon results in reversible infertility. Although it is unknown whether long-term treatment would result in permanent infertility, such permanent infertility fertility would be consistent with the desired effect of using GonaCon (e.g., effective contraception).

Other anti-GnRH vaccines also have had reversible effects in mares. Elhay (2007) noted a return to ovary functioning over the course of 34 weeks for 10 of 16 mares treated with Equity. That study ended at 34 weeks, so it is not clear when the other six mares would have returned to fertility. Donovan et al. (2013) found that half of mares treated with an anti-GnRH vaccine intended for dogs had returned to fertility after 40 weeks, at which point the study ended. In a study of mares treated with a primer and booster dose of Improvac, 47 of 51 treated mares had returned to ovarian cyclicity within 2 years; younger mares appeared to have longer-lasting effects than older mares (Schulman et al. 2013). Joonè et al. (2017c) analyzed samples from the Schulman et al. (2013) study, and found no significant decrease in anti-Mullerian hormone (AMH) levels in mares treated with GnRH vaccine. AMH levels are thought to be an indicator of ovarian function, so results from Joonè et al. (2017c) support the general view that the anoestrus resulting from GnRH vaccination is physiologically similar to typical winter anoestrus. In a small study with a non-commercial anti-GnRH vaccine (Stout et al. 2003), three of seven treated mares had returned to cyclicity within 8 weeks after delivery of the primer dose, while four others were still suppressed for 12 or more weeks. In elk, Powers et al. (2011) noted that contraception after one dose of GonaCon was reversible. In white-tailed deer, single doses of GonaCon appeared to confer two years of contraception (Miller et al. 2000). Ten of 30 domestic cows treated became pregnant within 30 weeks after the first dose of Bopriva (Balet et al. 2014).

Permanent sterility as a result of single-dose or boostered GonaCon-Equine vaccine, or other anti-GnRH vaccines, has not been recorded, but that may be because no long-term studies have tested for that effect. It is conceivable that some fraction of mares could become sterile after receiving one or more booster doses of GonaCon-Equine, but the rate at which that could be expected to occur is currently unknown. If some fraction of mares treated with GonaCon-Equine were to become sterile, though, that result would be consistent with text of the WFRHBA of 1971, as amended, which allows for sterilization to achieve population goals.

In summary, based on the above results related to fertility effects of GonaCon and other anti-GnRH vaccines, application of a single dose of GonaCon-Equine to gathered or remotely-darted wild horses could be expected to prevent pregnancy in perhaps 30percent-60percent of mares for one year. Some smaller number of wild mares should be expected to have persistent contraception for a second year, and less still for a third year. Applying one booster dose of GonaCon to previously-treated mares should lead to two or more years with relatively high rates (80+percent) of additional infertility expected, with the potential that some as-yet-unknown fraction of boostered mares may be infertile for several to many years. There is no data to support speculation regarding efficacy of multiple boosters of GonaCon-Equine; however, given it is formulated as a highly immunogenic long-lasting vaccine, it is reasonable to hypothesize that additional boosters would increase the effectiveness and duration of the vaccine.

GonaCon-Equine only affects the fertility of treated animals; untreated animals will still be expected to give birth. Even under favorable circumstances for population growth suppression, gather efficiency might not exceed 85percent via helicopter, and may be less with bait and water trapping. Similarly, not all animals may be approachable for darting. The uncaptured or undarted portion of the female population would still be expected to have normally high fertility rates in any given year, though those rates could go up slightly if contraception in other mares increases forage and water availability.

GnRH Vaccine Effects on Other Organ Systems

BLM requires individually identifiable marks for immunocontraceptive treatment; this may require handling and marking. Mares that receive any vaccine as part of a gather operation would experience slightly increased stress levels associated with handling while being vaccinated and freeze-marked, and potentially microchipped. Newly captured mares that do not have markings associated with previous fertility control treatments would be marked with a new freeze-mark for the purpose of identifying that mare, and identifying her vaccine treatment history. This information would also be used to determine the number of mares captured that were not previously treated, and could provide additional insight regarding gather efficiency, and the timing of treatments required into the future. Most mares recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from the fertility control injections, other than the direct consequence of becoming temporarily infertile.

Injection site reactions associated with immunocontraceptive treatments are possible in treated mares (Roelle and Ransom 2009). Whether injection is by hand or via darting, GonaCon-Equine is associated with some degree of inflammation, swelling, and the potential for abscesses at the injection site (Baker et al. 2013). Swelling or local reactions at the injection site are generally expected to be minor in nature, but some may develop into draining abscesses. When PZP vaccine was delivered via dart it led to more severe swelling and injection site reactions (Roelle and Ransom 2009), but that was not observed with dart-delivered GonaCon (McCann et al. 2017). Mares treated with one formulation of GnRH-KHL vaccine developed pyogenic abscesses (Goodloe 1991). Miller et al. (2008) noted that the water and oil emulsion in GonaCon will often cause cysts, granulomas, or sterile abscesses at injection sites; in some cases, a sterile abscess may develop into a draining abscess. In elk treated with GonaCon, Powers et al. (2011) noted up to 35 percent of treated elk had an abscess form, despite the injection sites first being clipped and swabbed with alcohol. Even in studies where swelling and visible abscesses followed GonaCon immunization, the longer term nodules observed did not appear to change any animal’s range of movement or locomotor patterns (Powers et al. 2013, Baker et al. 2017).

The result that other formulations of anti-GnRH vaccine may be associated with less notable injection site reactions in horses may indicate that the adjuvant formulation in GonaCon leads a single dose to cause a stronger immune reaction than the adjuvants used in other anti-GnRH vaccines. Despite that, a booster dose of GonaCon-Equine appears to be more effective than a primer dose alone (Baker et al. 2017). Horses injected in the hip with Improvac showed only transient reactions that disappeared within 6 days in one study (Botha et al. 2008), but stiffness and swelling that lasted 5 days were noted in another study where horses received Improvac in the neck (Imboden et al. 2006). Equity led to transient reactions that resolved within a week in some treated animals (Elhay et al. 2007). Donovan et al. noted no reactions to the canine anti-GnRH vaccine (2013). In cows treated with Bopriva there was a mildly elevated body temperature and mild swelling at injection sites that subsided within 2 weeks (Balet et al. 2014).

Several studies have monitored animal health after immunization against GnRH. GonaCon treated mares did not have any measurable difference in uterine edema (Killian 2006, 2008). Powers et al. (2011, 2013) noted no differences in blood chemistry except a mildly elevated fibrinogen level in some GonaCon treated elk. In that study, one sham-treated elk and one GonaCon treated elk each developed leukocytosis, suggesting that there may have been a causal link between the adjuvant and the effect. Curtis et al. (2008) found persistent granulomas at GonaCon-KHL injection sites three years after injection, and reduced ovary weights in treated females. Yoder and Miller (2010) found no difference in blood chemistry between GonaCon treated and control prairie dogs. One of 15 GonaCon treated cats died without explanation, and with no determination about cause of death possible based on necropsy or histology (Levy et al. 2011). Other anti-GnRH vaccine formulations have led to no detectable adverse effects (in elephants; Boedeker et al. 2011), though Imboden et al. (2006) speculated that young treated animals might conceivably have impaired hypothalamic or pituitary function.

Kirkpatrick et al. (2011) raised concerns that anti-GnRH vaccines could lead to adverse effects in other organ systems outside the reproductive system. GnRH receptors have been identified in tissues outside of the pituitary system, including in the testes and placenta (Khodr and Siler-Khodr 1980), ovary (Hsueh and Erickson 1979), bladder (Coit et al. 2009), heart (Dong et al. 2011), and central nervous system, so it is plausible that reductions in circulating GnRH levels could inhibit physiological processes in those organ systems. Kirkpatrick et al. (2011) noted elevated cardiological risks to human patients taking GnRH agonists (such as leuprolide), but the National Academy of Sciences (2013) concluded that the mechanism and results of GnRH agonists would be expected to be different from that of anti-GnRH antibodies; the former flood GnRH receptors, while the latter deprive receptors of GnRH.

GnRH Vaccine Effects on Fetus and Foal
Although fetuses are not explicitly protected under the WFRHBA of 1971, as amended, it is prudent to analyze the potential effects of GonaCon-Equine or other anti-GnRH vaccines on developing fetuses and foals. GonaCon had no apparent effect on pregnancies in progress, foaling success, or the health of offspring, in horses that were immunized in October (Baker et al. 2013), elk immunized 80-100 days into gestation (Powers et al. 2011, 2013), or deer immunized in February (Miller et al. 2000). Kirkpatrick et al. (2011) noted that anti-GnRH immunization is not expected to cause hormonal changes that would lead to abortion in the horse, but this may not be true for the first 6 weeks of pregnancy (NRC 2013). Curtis et al. (2011) noted that GonaCon-KHL treated white tailed deer had lower twinning rates than controls, but speculated that the difference could be due to poorer sperm quality late in the breeding season, when the treated does did become pregnant. Goodloe (1991) found no difference in foal production between treated and control animals.

Offspring of anti-GnRH vaccine treated mothers could exhibit an immune response to GnRH (Khodr and Siler-Khodr 1980), as antibodies from the mother could pass to the offspring through the placenta or colostrum. In the most extensive study of long-term effects of GonaCon immunization on offspring, Powers et al. (2012) monitored 15 elk fawns born to GonaCon treated cows. Of those, 5 had low titers at birth and 10 had high titer levels at birth. All 15 were of normal weight at birth, and developed normal endocrine profiles, hypothalamic GnRH content, pituitary gonadotropin content, gonad structure, and gametogenesis. All the females became pregnant in their second reproductive season, as is typical. All males showed normal development of secondary sexual characteristics. Powers et al. (2012) concluded that suppressing GnRH in the neonatal period did not alter long-term reproductive function in either male or female offspring. Miller et al. (2013) report elevated anti-GnRH antibody titers in fawns born to treated white tailed deer, but those dropped to normal levels in 11 of 12 of those fawns, which came into breeding condition; the remaining fawn was infertile for three years.

Direct effects on foal survival are equivocal in the literature. Goodloe (1991), reported lower foal survival for a small sample of foals born to anti-GnRH treated mares, but she did not assess other possible explanatory factors such as mare social status, age, body condition, or habitat in her analysis (NRC 2013). Gray et al. (2010) found no difference in foal survival in foals born to free-roaming mares treated with GonaCon.

There is little empirical information available to evaluate the effects of GnRH vaccination on foaling phenology. It is possible that immunocontracepted mares returning to fertility late in the breeding season could give birth to foals at a time that is out of the normal range (Nuñez et al. 2010, Ransom et al 2013). Curtis et al. (2001) did observe a slightly later fawning date for GonaCon treated deer in the second year after treatment, when some does regained fertility late in the breeding season. In anti-GnRH vaccine trials in free-roaming horses, there were no published differences in mean date of foal production (Goodloe 1991, Gray et al. 2010). Unpublished results from an ongoing study of GonaCon treated free-roaming mares indicate that some degree of aseasonal foaling is possible (D. Baker, Colorado State University, personal communication to Paul Griffin, BLM WH&B Research Coordinator). Because of the concern that contraception could lead to shifts in the timing of parturitions for some treated animals, Ransom et al. (2013) advised that managers should consider carefully before using PZP immunocontraception in small refugia or rare species; the same considerations could be advised for use of GonaCon, but wild horses and burros in most areas do not generally occur in isolated refugia, they are not a rare species at the regional, national, or international level, and genetically they represent descendants of domestic livestock with most populations containing few if any unique alleles (NRC 2013). Moreover, in PZP-treated horses that did have some degree of parturition date shift, Ransom et al. (2013) found no negative impacts on foal survival even with an extended birthing season; however, this may be more related to stochastic, inclement weather events than extended foaling seasons. If there were to be a shift in foaling date for some treated mares, the effect on foal survival may depend on weather severity and local conditions; for example, Ransom et al. (2013) did not find consistent effects across study sites.

Indirect Effects of GnRH Vaccination
One expected long-term, indirect effect on wild horses treated with fertility control would be an improvement in their overall health. Many treated mares would not experience the biological stress of reproduction, foaling and lactation as frequently as untreated mares, and their better health is expected to be reflected in higher body condition scores. After a treated mare returns to fertility, her future foals would be expected to be healthier overall, and would benefit from improved nutritional quality in the mares' milk. This is particularly to be expected if there is an improvement in rangeland forage quality at the same time, due to reduced wild horse population size. Past application of fertility control has shown that mares' overall health and body condition can remain improved even after fertility resumes. Anecdotal, subjective observations of mares treated with a different immunocontraceptive, PZP, in past gathers showed that many of the treated mares were larger, maintained better body condition, and had larger healthy foals than untreated mares.

Body condition of anti-GnRH-treated females was equal to or better than that of control females in published studies. Ransom et al. (2014b) observed no difference in mean body condition between GonaCon-B treated mares and controls. Goodloe (1991) found that GnRH-KHL treated mares had higher survival rates than untreated controls. In other species, treated deer had better body condition than controls (Gionfriddo et al. 2011b), treated cats gained more weight than controls (Levy et al. 2011), as did treated young female pigs (Bohrer et al. 2014).

Following resumption of fertility, the proportion of mares that conceive and foal could be increased due to their increased fitness; this has been called by some a 'rebound effect.' Elevated fertility rates have been observed after horse gathers and removals (Kirkpatrick and Turner 1991). More research is needed to document and quantify these hypothesized effects. If repeated contraceptive treatment leads to a prolonged contraceptive effect, then that may minimize or delay the hypothesized rebound effect. Selectively applying contraception to older animals and returning them to the HMA could reduce long-term holding costs for such horses, which are difficult to adopt, and could negate the compensatory reproduction that can follow removals (Kirkpatrick and Turner 1991).

Because successful fertility control would reduce foaling rates and population growth rates, another indirect effect would be to reduce the number of wild horses that have to be removed over time to achieve and maintain the established AML. Contraception would be expected to lead to a relative increase in the fraction of older animals in the herd. Reducing the numbers of wild horses that would have to be removed in future gathers could allow for removal of younger, more easily adoptable excess wild horses, and thereby could eliminate the need to send additional excess horses from this area to off-range holding corrals or pastures for long-term holding. Among mares in the herd that remain fertile, a high level of physical health and future reproductive success would be expected because reduced population sizes should lead to more availability of water and forage resources per capita.

Reduced population growth rates and smaller population sizes could also allow for continued and increased environmental improvements to range conditions within the project area, which would have long-term benefits to wild horse habitat quality. As the local horse abundance nears or is maintained at the level necessary to achieve a thriving natural ecological balance, vegetation resources would be expected to recover, improving the forage available to wild horses and wildlife throughout the HMA or HMAs. With rangeland conditions more closely approaching a thriving natural ecological balance, and with a less concentrated distribution of wild horses across the HMA, there should also be less trailing and concentrated use of water sources. Lower population density would be expected to lead to reduced competition among wild horses using the water sources, and less fighting among horses accessing water sources. Water quality and quantity would continue to improve to the benefit of all rangeland users including wild horses. Wild horses would also have to travel less distance back and forth between water and desirable foraging areas. Should GonaCon-Equine treatment, including booster doses, continue into the future, with treatments given on a schedule to maintain a lowered level of fertility in the herd, there may be less frequent need for large gathers and removals, but instead a consistent abundance of wild horses could be maintained, resulting in continued improvement of overall habitat conditions and animal health. While it is conceivable that widespread and continued treatment with GonaCon-Equine could reduce the birth rates of the population to such a point that birth is consistently below mortality, that outcome is not likely unless a very high fraction of the mares present are all treated with primer and booster doses, and perhaps repeated booster doses.

Behavioral Effects of GnRH Vaccination
Behavioral differences should be considered as potential consequences of contraception with GonaCon. The NRC (2013) noted that all successful fertility suppression has effects on mare behavior, mostly as a result of the lack of pregnancy and foaling, and concluded that GonaCon was a good choice for use in the program. The result that GonaCon treated mares may have suppressed estrous cycles throughout the breeding season can lead treated mares to behave in ways that are functionally similar to pregnant mares or mares in seasonal anoestrus.

While successful in mares, GonaCon and other anti-GnRH vaccines are expected to induce fewer estrous cycles when compared to non-pregnant control mares. This has been observed in many studies (Garza et al. 1986, Curtis et al. 2001, Dalin et al. 2002, Killian et al. 2006, Dalmau et al. 2015). In contrast, PZP vaccine is generally expected to lead mares to have more estrous cycles per breeding season, as they continue to be receptive to mating while not pregnant. Females treated with GonaCon had fewer estrous cycles than control or PZP-treated mares (Killian et al. 2006) or deer (Curtis et al. 2001). Thus, concerns about PZP treated mares receiving more courting and breeding behaviors from stallions (Nuñez et al. 2009, Ransom et al. 2010) are not generally expected to be a concern for mares treated with anti-GnRH vaccines (Botha et al. 2008).

Ransom et al. (2014b) found that GonaCon treated mares had similar rates of reproductive behaviors that were similar to those of pregnant mares. Among other potential causes, the reduction in progesterone levels in treated females may lead to a reduction in behaviors associated with reproduction. Despite this, some females treated with GonaCon or other anti-GnRH vaccines did continue to exhibit reproductive behaviors, albeit at irregular intervals and durations (Dalin et al. 2002, Stout et al. 2003, Imboden et al. 2006), which is a result that is similar to spayed (ovariectomized) mares (Asa et al. 1980). Gray et al. (2009) found no difference in sexual behaviors in mares treated with GonaCon and untreated mares. When progesterone levels are low, small changes in estradiol concentration can foster reproductive estrous behaviors (Imboden et al. 2006). Owners of anti-GnRH vaccine treated mares reported a reduced number of estrous-related behaviors under saddle (Donovan et al. 2013). Treated mares may refrain from reproductive behavior even after ovaries return to cyclicity (Elhay et al. 2007). Studies in elk found that GonaCon treated cows had equal levels of precopulatory behaviors as controls (Powers et al. 2011), though bull elk paid more attention to treated cows late in the breeding season, after control cows were already pregnant (Powers et al. 2011).

Stallion herding of mares, and harem switching by mares are two behaviors related to reproduction that might change as a result of contraception. Ransom et al. (2014b) observed a 50 percent decrease in herding behavior by stallions after the free-roaming horse population at Theodore Roosevelt National Park was reduced via a gather, and mares there were treated with GonaCon-B. The increased harem tending behaviors by stallions were directed to both treated and control mores. It is difficult to separate any effect of GonaCon in this study from changes in horse density and forage following horse removals.

Mares in untreated free-roaming populations change bands; some have raised concerns over effects of PZP vaccination on band structure (Nuñez et al. 2009), with rates of band fidelity being suggested as a measure of social stability. With respect to treatment with GonaCon or other anti-GnRH vaccines, it is probably less likely that treated mares will switch harems at higher rates than untreated animals, because treated mares are similar to pregnant mares in their behaviors (Ransom et al. 2014b). Indeed, Gray et al. (2009) found no difference in band fidelity in a free-roaming population of horses with GonaCon treated mares, despite differences in foal production between treated and untreated mares. Ransom et al. (2014b) actually found increased levels of band fidelity after treatment, though this may have been partially a result of changes in overall horse density and forage availability.

Even in cases where there may be changes in band fidelity, the National Research Council (2013) found that harem changing was not likely to result in serious adverse effects for treated mares:

> "The studies on Shackleford Banks (Nuñez et al., 2009; Madosky et al., 2010) suggest that there is an interaction between pregnancy and social cohesion. The importance of harem stability to mare well-being is not clear, but considering the relatively large number of free-ranging mares that have been treated with liquid PZP in a variety of ecological settings, the likelihood of serious adverse effects seem low."

Kirkpatrick et al. (2010) concluded that "the larger question is, even if subtle alterations in behavior may occur, this is still far better than the alternative."

The NRC (2013) provides a comprehensive review of the literature on the behavioral effects of contraception that puts Nuñez's (2009, 2010) research into the broader context of all of the available scientific literature, and cautions, based on its extensive review of the literature that:

> ". . . in no case can the committee conclude from the published research that the behavior differences observed are due to a particular compound rather than to the fact that treated animals had no offspring during the study. That must be borne in mind particularly in interpreting long-term impacts of contraception (e.g., repeated years of reproductive "failure" due to contraception)."

Gray et al. (2009) and Ransom et al. (2014b) monitored non-reproductive behaviors in GonaCon treated populations of free-roaming horses. Gray et al. (2009) found no difference between treated and untreated mares in terms of activity budget, sexual behavior, proximity of mares to stallions, or aggression. Ransom et al. (2014b) found only minimal differences between treated and untreated mare time budgets, but those differences were consistent with differences in the metabolic demands of pregnancy and lactation in untreated mares, as opposed to non-pregnant treated mares.

Genetic Effects of GnRH Vaccination

In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NRC (2013) recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, such that most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NRC 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result which would be expected to slow the rate of genetic diversity loss (Hailer et al., 2006). Based on a population model, Gross (2000) found that an effective way to retain genetic diversity in a population treated with fertility control is to preferentially treat young animals, such that the older animals (which contain all the existing genetic diversity available) continue to have offspring. Conversely, Gross (2000) found that preferentially treating older animals (preferentially allowing young animals to breed) leads to a more rapid expected loss of genetic diversity over time.

Even if it is the case that booster treatment with GonaCon may lead to prolonged infertility, or even sterility in some mares, most HMAs have only a low risk of loss of genetic diversity if logistically realistic rates of contraception are applied to mares. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses. As such, the existing genetic diversity in the majority of HMAs does not contain genetic markers that have been identified as unique or historically unusual (NRC 2013). Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e. human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition. Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in cases where all four of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, intrinsic population growth rate is low (5percent per year), and very large fractions of the female population are permanently sterilized.

Many factors influence the strength of a vaccinated individual’s immune response, potentially including genetics, but also nutrition, body condition, and prior immune responses to pathogens or other antigens (Powers et al 2013). One concern that has been raised with regards to genetic diversity is that treatment with immunocontraceptives could possibly lead to an evolutionary increase in the frequency of individuals whose genetic composition fosters weak immune responses (Cooper and Larson 2006, Ransom et al. 2014a). This premise is based on a hypothesis that lack of response to immunocontraceptives could be a heritable trait, and that the frequency of that trait will increase over time in a population of treated animals. Cooper and Herbert (2001) reviewed the topic, in the context of concerns about the long-term effectiveness of immunocontraceptives as a control agent for exotic species in Australia. They argue that immunocontraception could be a strong selective pressure, and that selecting for reproduction in individuals with poor immune response could lead to a general decline in immune function in populations where such evolution takes place. Other authors have also speculated that differences in antibody titer responses could be partially due to genetic differences between animals (Curtis et al. 2001, Herbert and Trigg 2005).

BLM is not aware of any studies that have quantified the heritability of a lack of response to immunocontraception such as PZP vaccine or GonaCon-Equine in horses. At this point there are no studies available from which one could make conclusions about the long-term effects of sustained and widespread immunocontraception treatments on population-wide immune function. Although a few, generally isolated, feral horse populations have been treated with high fractions of mares receiving PZP immunocontraception for long-term population control (e.g., Assateague Island and Pryor Mountains), no studies have tested for changes in immune competence in those areas. Relative to the large number of free-roaming feral horses in the western United States, immunocontraception has not been used in the type of widespread or prolonged manner that might be required to cause a detectable evolutionary response at a large scale.

Magiafolou et al. (2013) clarify that if the variation in immune response is due to environmental factors (i.e., body condition, social rank) and not due to genetic factors, then there will be no expected effect of the immune phenotype on future generations. Correlations between immune response and physical factors such as age and body condition have been documented; it remains untested whether or not those factors play a larger role in determining immune response to immunocontraceptives than heritable traits. Several studies discussed above noted a relationship between the strength of individuals' immune responses after treatment with GonaCon or other anti-GnRH vaccines, and factors related to body condition. For example, age at immunization was a primary factor associated with different measures of immune response, with young animals tending to have stronger and longer-lasting responses (Stout et al. 2003, Schulman et al. 2013). It is also possible that general health, as measured by body condition, can have a causal role in determining immune response, with animals in poor condition demonstrating poor immune reactions (Gray 2009, NRC 2013). Miller et al. (2013) speculated that animals with high parasite loads also may have weaker immune reactions to GonaCon.

Correlations between such physical factors and immune response would not preclude, though, that there could also be a heritable response to immunocontraception. In studies not directly related to immunocontraception, immune response has been shown to be heritable (Kean et al. 1994, Sarker et al. 1999). Unfortunately, predictions about the long-term, population-level evolutionary response to immunocontraceptive treatments would be speculative at this point, with results likely to depend on several factors, including: the strength of the genetic predisposition to not respond to GonaCon-Equine; the heritability of that gene or genes; the initial prevalence of that gene or genes; the number of mares treated with a primer dose of GonaCon-Equine (which generally has a short-acting effect, if any); the number of mares treated with a booster dose of GonaCon-Equine (which appears to cause a longer-lasting effect); and the actual size of the genetically-interacting metapopulation of horses within which the GonaCon treatment takes place.

Effects of Spaying

Current Methods

This literature review of spay impacts focuses on 2 methods: flank laparoscopy, and colpotomy. The anticipated effects of the spay treatment are both physical and behavioral. Physical effects would be due to post-surgical healing and the possibility for complications.

Anticipated Effects of Surgery on a Pregnancy

The average mare gestation period ranges from 335 to 340 days (Evans et al. 1977, p. 373). There are few peer reviewed studies documenting the effects of ovariectomy on the success of pregnancy in a mare. A National Research Council (NRC) committee that reviewed research proposals in 2015 explained, "The mare's ovaries and their production of progesterone are required during the first 70 days of pregnancy to maintain the pregnancy" (NRC 2015). In female mammals, less progesterone is produced when ovaries are removed, but production does not cease (Webley and Johnson 1982). In 1977, Evans et al. stated that by 200 days, the secretion of progesterone by the corpora lutea is insignificant because removal of the ovaries does not result in abortion (p. 376). "If this procedure were performed in the first 120 days of pregnancy, the fetus would be resorbed or aborted by the mother. If performed after 120 days, the pregnancy should be maintained. The effect of ovary removal on a pregnancy at 90–120 days of gestation is unpredictable because it is during this stage of gestation that the transition from corpus luteum to placental support typically occurs" (NRC Proposal Review 2015). In 1979, Holtan et al. evaluated the effects of bilateral ovariectomy at selected times between 25 and 210 days of gestation on 50 mature pony mares. Their results show that abortion (resorption) of the conceptus (fetus) occurred in all 14 mares ovariectomized before day 50 of gestation, that pregnancy was maintained in 11 of 20 mares after ovariectomy between days 50 and 70, and that pregnancy was not interrupted in any of 12 mares ovariectomized on days 140 to 210. Those results are similar to the suggestions of the NRC committee (2015).

For those pregnancies that are maintained following the procedure, likely those past approximately 120 days, the development of the foal is not expected to be affected. However, because this procedure is not commonly conducted on pregnant mares the rate of complications to the fetus has not yet been quantified. There is the possibility that entry to the abdominal cavity could cause premature births related to inflammation. However, after five months the placenta should hormonally support the pregnancy regardless of the presence or absence of ovaries. Gestation length was similar between ovariectomized and control mares (Holtan et al. 1979).

Anticipated Complication and Mortality Rates Associated with Ovariectomy via Colpotomy

Between 2009 and 2011, the Sheldon NWR in Nevada conducted ovariectomy via colpotomy surgeries (August through October) on 114 feral mares and released them back to the range with a mixture of sterilized stallions and untreated mares and stallions (Collins and Kasbohm 2016). Gestational stage was not recorded, but a majority of the mares were pregnant (Gail Collins, US Fish and Wildlife Service (USFWS), pers. comm.). Only a small number of mares were very close to full term. Those mares with late term pregnancies did not receive surgery as the veterinarian could not get good access to the ovaries due to the position of the foal (Gail Collins, USFWS, pers. comm.). After holding the mares for an average of 8 days after surgery for observation, they were returned to the range with other treated and untreated mares and stallions (Collins and Kasbohm 2016). During holding the only complications were observed within 2 days of surgery. The observed mortality rate for ovariectomized mares following the procedure was less than 2 percent (Collins and Kasbohm 2016, Pielstick pers. comm.).

During the Sheldon NWR ovariectomy study, mares generally walked out of the chute and started to eat; some would raise their tail and act as if they were defecating; however, in most mares one could not notice signs of discomfort (Bowen 2015). In their discussion of ovariectomy via colpotomy, McKinnon and Vasey (2007) considered the procedure safe and efficacious in many instances, able to be performed expediently by personnel experienced with examination of the female reproductive tract, and associated with a complication rate that is similar to or less than male castration. Nevertheless, all surgery is associated with some risk. Loesch et al. (2003) lists that following potential risks with colpotomy: pain and discomfort; injuries to the cervix, bladder, or a segment of bowel; delayed vaginal healing; eventration of the bowel; incisional site hematoma; intraabdominal adhesions to the vagina; and chronic lumbar or bilateral hind limb pain. Most horses, however, tolerate ovariectomy via colpotomy with very few complications, including feral horses (Collins and Kasbohm 2016). Evisceration is also a possibility, but these complications are considered rare (Prado and Schumacher, 2017). Mortality due to surgery or post-surgical complications is not anticipated, but it is a possibility and therefore every effort would be made to mitigate risks.

In September 2015, the BLM solicited the USGS to convene a panel of veterinary experts to assess the relative merits and drawbacks of several surgical ovariectomy techniques that are commonly used in domestic horses for potential application in wild horses. A table summarizing the various methods was sent to the BLM (Bowen 2015) and provides a concise comparison of several methods. Of these, ovariectomy via colpotomy was found to be relatively safe when practiced by an experienced surgeon and was associated with the shortest duration of potential complications after the operation. The panel discussed the potential for evisceration through the vaginal incision with this procedure. In marked contrast to a suggestion by the NRC Review (2013), this panel of veterinarians identified evisceration as not being a probable risk associated with ovariectomy via colpotomy and "none of the panel participants had had this occur nor had heard of it actually occurring" (Bowen 2015).

Most spay surgeries on mares have low morbidity[4] and with the help of medications, pain and discomfort can be mitigated. Pain management is an important aspect of any ovariectomy (Rowland et al. 2018); according to surgical protocols that would be used, a long-lasting direct anesthetic would be applied to the ovarian pedicle, and systemic analgesics in the form of butorphanol and flunixin meglumine would be administered, as is compatible with accepted animal husbandry practices. In a study of the effects of bilateral ovariectomy via colpotomy on 23 mares, Hooper and others (1993) reported that post-operative problems were minimal (1 in 23, or 4%).   Hooper et al. (1993) noted that four other mares were reported by owners as having some problems after surgery, but that evidence as to the role the surgery played in those subsequent problems was inconclusive. In contrast Röcken et al. (2011) noted a morbidity of 10.8% for mares that were ovariectomized via a flank laparoscopy. "Although 5 mares in our study had problems (repeated colic in 2 mares, signs of lumbar pain in 1 mare, signs of bilateral hind limb pain in 1 mare, and clinical signs of peritonitis in 1 mare) after surgery, evidence is inconclusive in each as to the role played by surgery" (Hooper et al. 1993). A recent study showed a 2.5% complication rate where one mare of 39 showed signs of moderate colic after laparoscopic ovariectomy (Devick 2018 personal communication).

Anticipated Effects on Mare Health and Behavior on the Range

No fertility control method exists that does not affect physiology or behavior of a mare (NRC Review 2013). Any action taken to alter the reproductive capacity of an individual has the potential to affect hormone production and therefore behavioral interactions and ultimately population dynamics in unforeseen ways (Ransom et al. 2014). The health and behavioral effects of spaying wild horse mares that live with other fertile and infertile wild horses has not been well documented, but the literature review below can be used to make reasonable inferences about their likely behaviors.

Horses are anovulatory (do not ovulate/express estrous behavior) during the short days of late fall and early winter, beginning to ovulate as days lengthen and then cycling roughly every 21 days during the warmer months, with about 5 days of estrus (Asa et al. 1979, Crowell-Davis 2007). Estrus in mares is shown by increased frequency of proceptive behaviors: approaching and following the stallion, urinating, presenting the rear end, clitoral winking, and raising the tail towards the stallion (Asa et al. 1979, Crowell-Davis 2007). In most mammal species other thanprimates estrus behavior is not shown during the anovulatory period, and reproductive behavior is considered extinguished following spaying (Hart and Eckstein 1997). However mares may continue to demonstrate estrus behavior during the anovulatory period (Asa et al. 1980). Similarly, ovariectomized mares may also continue to exhibit estrous behavior (Scott and Kunze 1977, Kamm and Hendrickson 2007, Crabtree 2016), with one study finding that 30% of mares showed estrus signs at least once after surgery (Roessner et al 2015) and only 60 percent of ovariectomized mares cease estrous behavior following surgery (Loesch and Rodgerson 2003). Mares continue to show reproductive behavior following ovariectomy due to non-endocrine support of estrus

[4] Morbidity is defined as the frequency of the appearance of complications following a surgical procedure or other treatment. In contrast, mortality is defined as an outcome of death due to the procedure.

behavior, specifically steroids from the adrenal cortex. Continuation of this behavior during the non-breeding season has the function of maintaining social cohesion within a horse group (Asa et al. 1980, Asa et al. 1984, NRC Review 2013). This may be a unique response of the horse (Bertin et al. 2013), as spaying usually greatly reduces female sexual behavior in companion animals (Hart and Eckstein 1997). In six ponies, mean monthly plasma luteinizing hormone[5] levels in ovariectomized mares were similar to intact mares during the anestrous season, and during the breeding season were similar to levels in intact mares at mid-estrus (Garcia and Ginther 1976).

The likely effects of spaying on mares' social interactions and group membership can be inferred from available literature, even though wild horses have rarely been spayed and released back into the wild, resulting in few studies that have investigated their behavior in free-roaming populations. Wild horses and burros are instinctually herd-bound and this behavior is expected to continue. However, no study has documented the rate at which spayed mares will continue to remain with the stallion and band from which the mare was most recently attached. Overall the BLM anticipates that some spayed mares may continue to exhibit estrus behavior which could foster band cohesion. If free-ranging ovariectomized mares show estrous behavior and occasionally allow copulation, interest of the stallion may be maintained, which could foster band cohesion (NRC Review 2013). This last statement could be validated by the observations of group associations on the Sheldon NWR where feral mares were ovariectomized via colpotomy and released back on to the range with untreated horses of both sexes (Collins and Kasbohm 2016). No data were collected on inter- or intra-band behavior (e.g. estrous display, increased tending by stallions, etc.), during multiple aerial surveys in years following treatment, all treated individuals appeared to maintain group associations, and there were no groups consisting only of treated males or only of treated females (Collins and Kasbohm 2016). In addition, of solitary animals documented during surveys, there were no observations of solitary treated females (Collins and Kasbohm 2016). These data help support the expectation that ovariectomized mares would not lose interest in or be cast out of the social dynamics of a wild horse herd. As noted by the NRC Review (2013), the ideal fertility control method would not eliminate sexual behavior or change social structure substantially.

A study conducted for 15 days in January 1978 (Asa et al. 1980), compared the sexual behavior in ovariectomized and seasonally anovulatory (intact) pony mares and found that there were no statistical differences between the two conditions for any measure of proceptivity or copulatory behavior, or days in estrous. This may explain why treated mares at Sheldon NWR continued to be accepted into harem bands; they may have been acting the same as a non-pregnant mare. Five to ten percent of pregnant mares exhibit estrous behavior (Crowell-Davis 2007). Although the physiological cause of this phenomenon is not fully understood (Crowell-Davis 2007), it is thought to be a bonding mechanism that assists in the maintenance of stable social groups of horses year round (Ransom et al. 2014b). The complexity of social behaviors among free-roaming horses is not entirely centered on reproductive receptivity, and fertility control treatments that suppress the reproductive system and reproductive behaviors should contribute to minimal changes to social behavior (Ransom et al. 2014b, Collins and Kasbohm 2016).

BLM expects that wild horse family structures would continue to exist under the proposed action because fertile mares, stallions, and their foals would continue to be a component of the herd. It is not expected that spaying a subset of mares would significantly change the social structure or herd demographics (age and sex ratios) of fertile wild horses.

'Foal stealing,' where a near-term pregnant mare steals a neonate foal from a weaker mare, is unlikely to be a common behavioral result of including spayed mares in a wild horse herd. McDonnell (2012) noted that "foal stealing is rarely observed in horses, except under crowded conditions and synchronization of

[5] Luteinizing hormone (LH) is a glycoprotein hormone produced in the pituitary gland. In females, a sharp rise of LH triggers ovulation and development of the corpus luteum. LH concentrations can be measured in blood plasma.

foaling," such as in horse feed lots. Those conditions are not likely in the wild, where pregnant mares will be widely distributed across the landscape, and where the expectation is that parturition dates would be distributed across the normal foaling season.

Movement, Body Condition and Survival of Ovariectomized Mares
The free-roaming behavior of wild horses is not anticipated to be affected by this alternative as the definition of free-roaming is the ability to move without restriction by fences or other barriers within a HMA (BLM H-4700-1, 2010) and there are no permanent physical barriers being proposed. However, the study would document the movement patterns of both herd segments to determine any difference in use areas and distances travelled.

In domestic animals spaying is often associated with weight gain and associated increase in body fat (Fettman et al 1997, Becket et al 2002, Jeusette et al. 2006, Belsito et al 2009, Reichler 2009, Camara et al. 2014). Spayed cats had a decrease in fasting metabolic rate, and spayed dogs had a decreased daily energy requirement, but both had increased appetite (O'Farrell & Peachey 1990, Hart and Eckstein 1997, Fettman et al. 1997, Jeusette et al. 2004). In wild horses, contracepted mares tend to be in better body condition that mares that are pregnant or that are nursing foals (Nuñez et al. 2010); the same improvement in body condition is likely to take place in spayed mares. In horses spaying has the potential to increase risk of equine metabolic syndrome (leading to obesity and laminitis), but both blood glucose and insulin levels were similar in mares before and after ovariectomy over the short-term (Bertin et al. 2013). In wild horses the quality and quantity of forage is unlikely to be sufficient to promote over-eating and obesity.

Coit et al. (2009) demonstrated that spayed dogs have elevated levels of LH-receptor and GnRH-receptor mRNA in the bladder tissue, and lower contractile strength of muscles. They noted that urinary incontinence occurs at elevated levels in spayed dogs and in post-menopausal women. Thus, it is reasonable to suppose that some ovariectomized mares could also suffer from elevated levels of urinary incontinence.

Sterilization had no effect on movements and space use of feral cats or brushtail possums (Ramsey 2007, Guttilla & Stapp 2010), or greyhound racing performance (Payne 2013). Rice field rats (*Rattus argentiventer*) tend to have a smaller home range in the breeding season, as they remain close to their litters to protect and nurse them. When surgically sterilized, rice field rats had larger home ranges and moved further from their burrows than hormonally sterilized or fertile rats (Jacob et al. 2004). Spayed possums and foxes (*Vulpes vulpes*) had a similar core range area after spay surgery compared to before, and were no more likely to shift their range than intact females (Saunders et al. 2002, Ramsey 2007).

The likely effects of spaying on mares' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). It is unlikely that spayed mares will change their spatial ecology, but being emancipated from constraints of lactation may mean they can spend more time away from water sources and increase their home range size. Lactating mares need to drink every day, but during the winter when snow can fulfill water needs or when not lactating, horses can traverse a wider area (Feist & McCullough 1976, Salter 1979). During multiple aerial surveys in years following the mare ovariectomy study at the Sheldon NWR, it was documented that all treated individuals appeared to maintain group associations, no groups consisted only of treated females, and none of the solitary animals observed were treated females (Collins and Kasbohm 2016). Since treated females maintained group associations, this indicates that their movement patterns and distances may be unchanged.

Spaying wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether spayed mares would continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that spayed mares would continue to roam unhindered in the Warm Springs HMA where this action would take place. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a spayed animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that spaying wild horses will cause them to lose their free-roaming nature.

In this sense, a spayed wild mare would be just as much 'wild' as defined by the WFRHBA as any fertile wild mare, even if her patterns of movement differ slightly. Congress specified that sterilization is an acceptable management action (16 USC §1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC §1333.2.C.d). Any opinions based on a semantic and subjective definition of what constitutes a 'wild' horse are not legally binding for BLM, which must adhere to the legal definition of what constitutes a wild free-roaming horse[6], based on the WFRHBA (as amended). BLM is not obliged to base management decisions on personal opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Spaying is not expected to reduce mare survival rates. Individuals receiving fertility control often have reduced mortality and increased longevity due to being released from the costs of reproduction (Kirkpatrick and Turner 2008). Similar to contraception studies, in other wildlife species a common trend has been higher survival of sterilized females (Twigg et al. 2000, Saunders et al. 2002, Ramsey 2005, Jacob et al. 2008, Seidler and Gese 2012). Observations from the Sheldon NWR provide some insight into long-term effects of ovariectomy on feral horse survival rates. The Sheldon NWR ovariectomized mares were returned to the range along with untreated mares. Between 2007 and 2014, mares were captured, a portion treated, and then recaptured. There was a minimum of 1 year between treatment and recapture; some mares were recaptured a year later and some were recaptured several years later. The long-term survival rate of treated wild mares appears to be the same as that of untreated mares (Collins and Kasbohm 2016). Recapture rates for released mares were similar for treated mares and untreated mares.

Bone Histology

The BLM knows of no scientific, peer-reviewed literature that documents bone density loss in mares following ovariectomy. A concern has been raised in an opinion article (Nock 2013) that ovary removal in mares could lead to bone density loss. That paper was not peer reviewed nor was it based on research in wild or domestic horses, so it does not meet the BLM's standard for "best available science" on which to base decisions (Kitchell et al. 2015). Hypotheses that are forwarded in Nock (2013) appear to be based on analogies from modern humans leading sedentary lives. Post-menopausal women have a greater chance of osteoporosis (Scholz-Ahrens et al. 1996), but BLM is not aware of any research examining bone loss in horses following ovariectomy. Bone loss in humans has been linked to reduced circulating estrogen. There have been conflicting results when researchers have attempted to test for an effect of reduced estrogen on animal bone loss ratesin animal models; all experiments have been on laboratory animals, rather than free-ranging wild animals. While some studies found changes in bone cell activity after ovariectomy leading to decreased bone strength (Jerome et al. 1997, Baldock et al. 1998, Huang et

[6] "wild free-roaming horses and burros" means all unbranded and unclaimed horses and burros on public lands of the United States.

al. 2002, Sigrist et al. 2007), others found that changes were moderate and transient or minimal (Scholz-Ahrens et al. 1996, Lundon et al. 1994, Zhang et al. 2007), and even returned to normal after 4 months (Sigrist et al. 2007).

Consistent and strenuous use of bones, for instance using jaw bones by eating hard feed, or using leg bones by travelling large distances, may limit the negative effects of estrogen deficiency on micro-architecture (Mavropoulos et al. 2014). The effect of exercise on bone strength in animals has been known for many years and has been shown experimentally (Rubin et al. 2001). Dr. Simon Turner, Professor Emeritus of the Small Ruminant Comparative Orthopaedic Laboratory at Colorado State University, conducted extensive bone density studies on ovariectomized sheep, as a model for human osteoporosis. During these studies, he did observe bone density loss on ovariectomized sheep, but those sheep were confined in captive conditions, fed twice a day, had shelter from inclement weather, and had very little distance to travel to get food and water (Simon Turner, Colorado State University Emeritus, written comm., 2015). Dr. Turner indicated that an estrogen deficiency (no ovaries) could potentially affect a horse's bone metabolism, just as it does in sheep and human females when they lead a sedentary lifestyle, but indicated that the constant weight bearing exercise, coupled with high exposure to sunlight ensuring high vitamin D levels, are expected to prevent bone density loss (Simon Turner, Colorado State University Emeritus, written comm., 2015).

Home range size of horses in the wild has been described as 4.2 to 30.2 square miles (Green and Green 1977) and 28.1 to 117 square miles (Miller 1983). A study of distances travelled by feral horses in "outback" Australia shows horses travelling between 5 and 17.5 miles per 24 hour period (Hampson et al. 2010a), travelling about 11 miles a day even in a very large paddock (Hampson et al. 2010b). Thus extensive movement patterns of wild horses are expected to help prevent bone loss. The expected daily movement distance would be far greater in the context of larger pastures typical of BLM long-term holding facilities in off-range pastures. A horse would have to stay on stall rest for years after removal of the ovaries in order to develop osteoporosis (Simon Turner, Colorado State University Emeritus, written comm., 2015) and that condition does not apply to any wild horses turned back to the range or any wild horses that go into off-range pastures.

Physical, Non-surgical Mare Sterilization
This type of procedure would include any physical form of sterilization that does not involve surgery. This could include any form of physical procedure that leads a mare to be unable to become pregnant, or to maintain a pregnancy. For example, one form of physical, non-surgical sterilization causes a long-term blockage of the oviduct, so that fertile eggs cannot go from the ovaries to the uterus. The mare retains her ovaries. The mare would be sterile, although she would continue to have estrus cycles. Because of the retention of estrus cycles, it is expected that behavioral outcomes would be similar to those observed for PZP vaccine treated mares. The procedure is transcervical, so the treated mare cannot have a fetus in the uterus at the time of treatment. Treated mares would need to be screened to ensure they are not pregnant, because transcervical procedures can cause a pregnancy to terminate. Screening could be with transrectal palpation or ultrasonography. Those procedures require restraint and evacuation of the colon, and for a veterinarian to feel across the rectum, or hold an ultrasound probe there, but do not require sedation or analgesia.

One form of oviduct blockage infuses medical-grade N-butyl cyanoacrylate glue into the oviduct to cause long-term blockage (Bigolin et al. 2009). A pilot project used this approach in six domestic mares, and has shown that after three years of breeding by a fertile stallion, all six mares remained infertile (Dr. I. Liu, UC Davis Emeritus Professor, personal communication to BLM). A three person team of experts is required to manipulate and operate an endoscope monitor, insert and hold the endoscope, manipulate and position a fine-tipped catheter into the oviduct, and infuse the fluid into the oviduct. After restraint, sedation and analgesic administration, fecal material is removed from the rectum, the tail is wrapped and suspended, and the vaginal area is cleaned with betadine. An endoscope is inserted through the cervix to the uterotubal junction (which is the entrance to the oviduct). A sterile catheter is inserted into the uterotubal junction. A half mL of N-butyl cyanoacrylate is infused into each oviduct. A new catheter is used for the procedure on the second oviduct. The mares are monitored initially for 10 minutes, but no further pain management is expected to be needed.

It could be expected that mares treated with any form of physical, non-surgical sterilization that leaves the ovaries intact would be expected to have behaviors and behavioral outcomes that are similar to PZP-treated mares with functioning ovaries. .

Effects of Mare Sterilization on Genetic Diversity

It is true that spayed mares are unable to contribute to the genetic diversity of a herd, but that does not lead to an expectation that the NWHR HMA would necessarily experience high levels of inbreeding, because there would continue to be a relatively large core breeding population of mares present, because there was adequately high genetic heterozygosity in the herd at the last measurement, because horses could always be introduced to augment genetic diversity if future monitoring indicates cause for that management action, and because there is an expectation of continued positive growth in the herd. “Fertility control application should achieve a substantial treatment effect while maintaining some long-term population growth to mitigate the effects of environmental catastrophes” (BLM IM 2009-090). This statement applies to all population growth suppression techniques, including spaying. According to the WinEquus population model trials of removal with fertility control (for both trials with PZP treatment and with spay treatments), the health of individual animals or the long-term viability of the herd would not be threatened because between 2020-2030 the lowest possible population growth rate would be 8 percent WinEquus Comparison Table (page 32). The WinEquus trials run for this proposed action include a gather to low AML at 2020 and a proposed gather the next times high AML is achieved. Under this scenario there would be another gather anywhere from 3-4 years, depending on the treatment type chosen, at which time hair samples would be collected and genetic analysis completed to determine if appropriate management changes (such as translocations from a nearby HMA) are needed. Periodic gathers allow BLM to collect DNA samples, closely monitor the genetic variability of the herd, and make appropriate changes (i.e. translocation from other HMAs) when testing deems them necessary.

Although BLM is unable to precisely quantify cumulative effects under the proposed action, the effects of this alternative on present and RFFAs and in wild horse and burro habitat would aid in the long-term maintenance of habitat conditions necessary for a thriving natural ecological balance within the HMA. By maintaining AML and potentially slowing the population growth rate of wild horses, the objectives from the Nevada Wild Horse Range HMAP and the NTTR RMP/ROD (2004) would be achieved and maintained over the long term (at least 10 years). Maintenance of an appropriate wild horse and burro population under this alternative encourages the success of noxious weed treatments and wildfire rehabilitation efforts.

In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NRC Review (2013) recommended that single HMAs should not be considered as isolated genetic populations. Rather, managed herds of wild horses should be considered as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. It is worth noting that, although maintenance of genetic diversity at the scale of the overall population of wild horses is an intuitive management goal, there are no existing laws or policies that require BLM to maintain genetic diversity at the scale of the individual herd management area or complex. Also, there is no Bureau-wide policy that requires BLM to allow each female in a herd to reproduce before she is treated with contraceptives. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010). There would be little concern for effects to genetic variability of the herd because all action alternatives incorporate BLM's management plan for genetic monitoring and maintenance of genetic variability.

In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, including in the NWHR HMA. As a result, most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives on the HMA. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NRC Review 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result would be expected to slow the rate of genetic diversity loss (Hailer et al. 2006). Based on a population model, Gross (2000) found that a strategy to preferentially treat young animals with a contraceptive led to more genetic diversity being retained than either a strategy that preferentially treats older animals, or a strategy with periodic gathers and removals.

The NWHR HMA would have only a low risk of loss of genetic diversity if logistically realistic rates of sterilization or fertility control vaccine contraception are applied to mares. After the initial gather, subsequent sterilization and PZP vaccine treatments there would take place only after gathers. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses, and this is apparently true in NWHR HMA as well. Genetic monitoring did not identify any unique alleles in NWHR HMA (Cothran 2004). Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e., human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition. Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in case where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the female population are permanently sterilized.

Effects of Gelding

Castration (the surgical removal of the testicles, also called gelding or neutering) is a surgical procedure for the horse sterilization that has been used for millenia. The procedure is fairly straight forward and has a relatively low complication rate. As noted in the review of scientific literature that follows, the expected effects of gelding are well understood overall, even though there is some degree of uncertainty about the exact quantitative outcomes for any given individual (as is true for any natural system). Reference in this text to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement, recommendation, or favoring by the Department of the Interior.

Including a portion of geldings in a herd can lead to a reduced population-level per-capita growth rate, by virtue of having fertile mares comprise a lower fraction of the herd. By having a skewed sex ratio with less females than males (stallions and geldings), the result will be that there will be a lower number of breeding females in the population. Including geldings in herd management is not new for BLM and federal land management. Geldings have been released on BLM lands as a part of herd management in the Barren Valley complex in Oregon (BLM 2011), the Challis HMA in Idaho (BLM 2012), and the Conger HMA in Utah (BLM 2016). Geldings were also included in US Fish and Wildlife Service management plans for the Sheldon National Wildlife Refuge that relied on sterilization and removals (Collins and Kasbohm 2016).

The more commonly applied methods for managing population growth of free-roaming wild horses focus largely on suppressing female fertility through contraceptive vaccines (e.g., Ballou et al. 2008, Killian et al. 2008, Turner et al. 2008, Gray et al. 2010, Ransom et al. 2011). Fewer studies have been conducted on techniques for reducing male fertility. Nelson (1980) and Garrott and Siniff (1992) modeled potential efficacy of male-oriented contraception as a population management tool, and both studies agreed that while slowing growth, sterilizing only dominant males (i.e., harem-holding stallions) would result in only marginal reduction in female fertility rates. Eagle et al. (1993) and Asa (1999) tested this hypothesis on herd management areas (HMAs) where dominant males were vasectomized. Their findings agreed with modeling results from previous studies, and they also concluded that sterilizing only dominant males would not provide the desired reduction in female fertility and overall population growth rate, assuming that the numbers of fertile females is not changed. While bands with vasectomized harem stallions tended to have fewer foals, breeding by bachelors and subordinate stallions meant that population growth still occurred – female fertility was not dramatically reduced. Garrott and Siniff (1992) concluded from their modeling that male sterilization would effectively cause there to be zero population growth (the point where births roughly equal deaths) only if a large proportion of males (i.e., >85%) could be sterilized. In cases where the goal of harem stallion sterilization is to reduce population growth rates, success appears to be dependent on a stable group structure, as strong bonds between a stallion and mares reduce the probability of a mare mating an extra-group stallion (Nelson 1980, Garrott and Siniff 1992, Eagle et al. 1993, Asa 1999). Collins and Kasbohm (2016) demonstrated that there was a reduced fertility rate in a feral horse herd with both spayed and vasectomized horses – some geldings were also present in that herd.

Despite these studies, geldings can be used to reduce overall growth rates in a management strategy that does not rely on any expectation that geldings will retain harems or lead to a reduction in per-female fertility rates. In alternatives being considered in this environmental analysis, the primary goal of including geldings in the herd is not necessarily to reduce female fertility. Rather, by including some geldings in a herd that also has fertile mares and stallions, the geldings would take some of the spaces toward AML that would otherwise be taken by fertile females. If the total number of horses is constant but geldings are included in the herd, this can reduce the number of fertile mares, therefore reducing the absolute number of foals produced. Put another way, if geldings occupy spaces toward AML that would otherwise be filled by fertile mares, that will reduce growth rates merely by the fact of causing there to be a lower starting number of fertile mares.

Surgical sterilization techniques, while not reversible, may control horse reproduction without the kind of additional handling or darting that can be needed to administer contraceptive vaccines. In this sense, sterilization surgeries can be used to achieve herd management objectives with a relative minimum level of animal handling and management over the long term. The WFRHBA (as amended) indicates that management should be at the minimum level necessary to achieve management objectives (CFR 4710.4), and if gelding some fraction of a managed population can reduce population growth rates by replacing breeding mares, it then follows that gelding some individuals can lead to a reduced number of handling occasions and removals of excess horses from the range, which is consistent with legal guidelines. Other fertility control options that may be temporarily effective on male horses, such as the injection of GonaCon-Equine immunocontraceptive vaccine, apparently require multiple handling occasions to achieve longer-term male infertility. Similarly, PZP immunocontraception that is currently available for use in wild mares requires handling or darting every year. By some measures, any management activities that require multiple capture operations to treat a given individual would be more intrusive for wild horses and potentially less sustainable than an activity that requires only one handling occasion.

Effects of handling and marking

It is prudent for gelded animals to be readily identifiable, either via freeze brand marks or unique coloration, so that their treatment history is easily recognized (e.g., BLM 2010). Markings may also be useful into the future to determine the approximate fraction of geldings in a herd, and could provide additional insight regarding gather efficiency. BLM has instituted guidelines to reduce the sources of handling stress in captured animals (BLM 2015). Handling may include freeze-marking, for the purpose of identifying an individual. Some level of transient stress is likely to result in newly captured horses that are not previously marked. Under past management practices, captured horses experienced increased, transient stress levels from handling (Ashley and Holcombe 2001). It is difficult to compare that level of temporary stress with long-term stress that can result from food and water limitation on the range (e.g., Creel et al. 2013), which could occur in the absence of herd management.

Most horses recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from gelding, other than the direct consequence of becoming infertile.

Selected stallions would be shipped to the facility, gelded, and returned to the range within 30 days. Gelded animals could be monitored periodically for complications for approximately 7-10 days following release. In the proposed alternatives, gelding is not part of any research study, but additional monitoring on the range could be completed either through aerial recon, if available, or field observations from major roads and trails. It is not anticipated that all the geldings would be observed but if the goal is to detect complications on the range, then this level of casual observation may help BLM determine if they are occurring. Observations of the long term outcomes of gelding could be recorded during routine resource monitoring work. Such observations could include but not be limited to band size, social interactions with other geldings and harem bands, distribution within their habitat, forage utilization and activities around key water sources. Periodic population inventories and future gather statistics could provide additional anecdotal information about how logistically effective it is to manage a portion of the herd as non-breeding animals.

Indirect Effects of Gelding

Castration is not expected to reduce geldings' survival rates. Castration is thought to increase survival as males are released from the cost of reproduction (Jewell 1997). In Soay sheep castrates survived longer than rams in the same cohort (Jewell 1997), and Misaki horse geldings lived longer than intact males (Kaseda et al. 1997, Khalil and Murakami 1999). Moreover, it is unlikely that a reduced testosterone level will compromise gelding survival in the wild, considering that wild mares survive with low levels of testosterone. Consistent with geldings not expending as much energy toward in attempts to obtain or defend a harem, it is expected that wild geldings may have a better body condition that wild, fertile stallions.

Under the proposed action, reproductive stallions would still be a component of the population's age and sex structure. The question of whether or not a given gelding would or would not attempt to maintain a harem is not germane to population-level management. Gelding a subset of stallions in the proposed action would not prevent other stallions and mares from continuing with the typical range of social behaviors for sexually active adults. For fertility control strategies where gelding is intended to reduce growth rates by virtue of sterile males defending harems, the National Academies of Sciences (NRC 2013) suggested that the effectiveness of gelding on overall reproductive rates may depend on the pre-castration social roles of those animals. However, in this decision the alternatives being considered that include gelding would reduce population growth rates by a different means: including geldings as a component of the total horses counted toward AML would effectively reduce the relative number of fertile mares in the herd. Having a post-gather herd with some geldings and a lower fraction of fertile mares necessarily reduces the absolute number of foals born per year, compared to a herd that includes more fertile mares. An additional benefit is that geldings that would otherwise be permanently removed from the range (for adoption, sale or other disposition) may be released back onto the range where they can engage in free-roaming behaviors.

BLM would expect that wild horse family structures will continue to exist under the proposed action within wild horse population, because fertile mares, stallions, and their foals will continue to be a component of the herd. Because the fraction of males gelded is not expected to come anywhere close to the ~85% threshold suggested by Garrott and Siniff (1992) as being necessary to substantially reduce population growth rates, is not expected that gelding a subset of stallions will significantly change the social structure or herd demographics (age and sex ratios) of fertile wild horses, insofar as it is expected that alt females (and their offspring) will continue to be found primarily in groups with only one adult male, or a small number of adult males. It is worth noting, though, that the BLM is not required to manage populations of wild horses in a manner that ensures that any given individual maintains its social standing within any given harem or band.

Behavioral Effects of Gelding

Gelding adult male horses is expected to result in reduced testosterone production, which is expected to directly influence reproductive behaviors (NRC 2013). However, testosterone levels alone are not a predictor of masculine behavior (Line et al. 1985, Schumacher 2006). In domestic geldings, 20-30% continued to show stallion-like behavior, whether castrated pre- or post-puberty (Line et al. 1985). Gelding of domestic horses most commonly takes place before or shortly after sexual maturity, and age-at-gelding can affect the degree to which stallion-like behavior is expressed later in life. In intact stallions, testosterone levels peak increase up to an age of ~4-6 years, and can be higher in harem stallions than bachelors (Khalil et al 1998). It is assumed that free roaming wild horse geldings would generally exhibit reduced aggression toward other horses, and reduced reproductive behaviors (NRC 2013). The behavior of wild horse geldings in the presence of intact stallions has not been well documented, but the literature review below can be used to make reasonable inferences about their likely behaviors.

Despite livestock being managed by castrating males for millenia, there is relatively little published research on castrates' behaviors (Hart and Jones 1975). Stallion behaviors in wild or pasture settings are better documented than gelding behaviors, but it inferences about how the behaviors of geldings will change, how quickly any change will occur after surgery, or what effect gelding an adult stallion and releasing him back in to a wild horse population will have on his behavior and that of the wider population must be surmised from the existing literature. There is an ongoing BLM study in Utah focused on the individual and population-level effects of including some geldings in a free-roaming horse population (BLM 2016), but results from that study are not yet available. However, inferences about likely behavioral outcomes of gelding can be made based on available literature.

Feral horses typically form bands composed of an adult male with 1 to 3 adult females and their immature offspring (Feist and McCullough 1976, Berger 1986, Roelle et al. 2010). In many populations subordinate 'satellite' stallions have been observed associating with the band, although the function of these males continues to be debated (see Feh 1999, and Linklater and Cameron 2000). Juvenile offspring of both sexes leave the band at sexual maturity (normally around two or three years of age (Berger 1986), but adult females may remain with the same band over a span of years. Group stability and cohesion is maintained through positive social interactions and agonistic behaviors among all members, and herding and reproductive behaviors from the stallion (Ransom and Cade 2009). Group movements and consortship of a stallion with mares is advertised to other males through the group stallion marking dung piles as they are encountered, and over-marking mare eliminations as they occur (King and Gurnell 2006).

In horses, males play a variety of roles during their lives (Deniston 1979): after dispersal from their natal band they generally live as bachelors with other young males, before associating with mares and developing their own breeding group as a harem stallion or satellite stallion. In any population of horses not all males will achieve harem stallion status, so all males do not have an equal chance of breeding (Asa 1999). Stallion behavior is thought to be related to androgen levels, with breeding stallions having higher androgen concentrations than bachelors (Angle et al. 1979, Chaudhuri and Ginsberg 1990, Khalil et al. 1998). A bachelor with low libido had lower levels of androgens, and two year old bachelors had higher testosterone levels than two year olds with undescended testicles who remained with their natal band (Angle et al. 1979).

The effect of castration on aggression in horses has not often been quantified. One report has noted that high levels of aggression continued to be observed in domestic horse geldings who also exhibited sexual behaviors (Rios and Houpt 1995). Stallion-like behavior in domestic horse geldings is relatively common (Smith 1974, Schumacher 1996), being shown in 20-33% of cases whether the horse was castrated pre- or post-puberty (Line et al. 1985, Rios and Houpt 1995, Schumacher 2006). While some of these cases may be due to cryptorchidism or incomplete surgery, it appears that horses are less dependent on hormones than other mechanisms for the maintenance of sexual behaviors (Smith 1974). Domestic geldings exhibiting masculine behavior had no difference in testosterone concentrations than other geldings (Line et al. 1985, Schumacher 2006), and in some instances the behavior appeared context dependent (Borsberry 1980, Pearce 1980).

Dogs and cats are commonly neutered, and it is also common for them to continue to exhibit reproductive behaviors several years after castration (Dunbar 1975). Dogs, ferrets, hamsters, and marmosets continued to show sexually motivated behaviors after castration, regardless of whether they had previous experience or not, although in beagles and ferrets there was a reduction in motivation post-operatively (Hart 1968, Dunbar 1975, Dixson 1993, Costantini et al. 2007, Vinke et al. 2008). Ungulates continued to show reproductive behaviors after castration, with goats and llamas continuing to respond to females even a year later in the case of goats, although mating time and the ejaculatory response was reduced (Hart and Jones 1975, Nickolmann et al. 2008).

The likely effects of castration on geldings' social interactions and group membership can be inferred from available literature, even though wild horses are rarely gelded and released back into the wild, resulting in few studies that have investigated their behavior in free-roaming populations. In the western US – where ranges are much larger, intact stallions are present year-round, and population density varies – free-roaming gelding behaviors may differ somewhat from those noted below. In a pasture study of domestic horses, Van Dierendonk et al. (1995) found that social rank among geldings was directly correlated to the age at which the horse was castrated, suggesting that social experiences prior to sterilization may influence behavior afterward. Of the two geldings present in a study of semi-feral horses in England, one was dominant over the mares whereas a younger gelding was subordinate to older mares; stallions were only present in this population during a short breeding season (Tyler 1972). A study of domestic geldings in Iceland held in a large pasture with mares and sub-adults of both sexes, but no mature stallions, found that geldings and sub-adults formed associations amongst each other that included interactions such as allo-grooming and play, and were defined by close proximity (Sigurjónsdóttir et al. 2003). These geldings and sub-adults tended to remain in a separate group from mares with foals, similar to castrated Soay sheep rams (Ovis aries) behaving like bachelors and grouping together, or remaining in their mother's group (Jewell 1997). In Japan, Kaseda et al. (1997) reported that young males dispersing from their natal harem and geldings moved to a different area than stallions and mares during the non-breeding season. Although the situation in Japan may be the equivalent of a bachelor group in natural populations, in Iceland this division between mares and the rest of the horses in the herd contradicts the dynamics typically observed in a population containing mature stallions. Sigurjónsdóttir et al. (2003) also noted that in the absence of a stallion, allo-grooming between adult females increased drastically. Other findings included increased social interaction among yearlings, display of stallion-like behaviors such as mounting by the adult females, and decreased association between females and their yearling offspring (Sigurjónsdóttir et al. 2003). In the same population in Iceland Van Dierendonck et al. (2004) concluded that the presence of geldings did not appear to affect the social behavior of mares or negatively influence parturition, mare-foal bonding, or subsequent maternal activities. Additionally, the welfare of broodmares and their foals was not affected by the presence of geldings in the herd (Van Dierendonck et al. 2004). These findings are important because treated geldings will be returned to the range in the presence of pregnant mares and mares with foals of the year.

The likely effects of castration on geldings' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). By comparison, bachelor groups tend to be more transient, and can potentially use areas of good forage further from water sources, as they are not constrained by the needs of lactating mares in a group. The number of observations of gelded wild stallion behavior are still too few to make general predictions about whether a particular gelded stallion individuals will behave like a harem stallion, a bachelor, or form a group with geldings that may forage and water differently from fertile wild horses.

Gelding wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether geldings will continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that geldings would continue to roam unhindered in the HMA where this action would take place. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a gelded animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that gelding wild horses will cause them to lose their free-roaming nature. It is worth noting that individual choices in wild horse group membership, home range, and habitat use are not protected under the WFRHBA. BLM acknowledges that geldings may exhibit some behavioral differences after surgery, compared to intact stallions, but those differences are not be expected to remove the geldings' rebellious and feisty nature, or their defiance of man. While it may be that a gelded horse could have a different set of behavioral priorities than an intact stallion, the expectation is that geldings will choose to act upon their behavioral priorities in an unhindered way, just as is the case for an intact stallion. In this sense, a gelded male would be just as much 'wild' as defined by the WFRHBA as any intact stallion, even if his patterns of movement differ from those of an intact stallion. Congress specified that sterilization is an acceptable management action (16 USC §1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC §1333.2.C.d). Several academics have offered their opinions about whether gelding a given stallion would lead to that individual effectively losing its status as a wild horse (Rutberg 2011, Kirkpatrick 2012, Nock 2017). Those opinions are based on a semantic and subjective definition of 'wild,' while BLM must adhere to the legal definition of what constitutes a wild horse, based on the WFRHBA (as amended). Those individuals have not conducted any studies that would test the speculative opinion that gelding wild stallions will cause them to become docile. BLM is not obliged to base management decisions on such opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Genetic Effects of Gelding

It is true that geldings are unable to contribute to the genetic diversity of the herd, but that does not lead to an expectation that the HMA would necessarily experience high levels of inbreeding, because there would be a core breeding population of stallions consistent with low end AML. Existing levels of genetic diversity were above the critical threshold in this area when last measured (Cothran 2004), and expectations are that heterozygosity levels are even higher now, because the population has continued to grow exponentially in the recent past, and most likely has received animals immigrating in from other nearby herds, such as in Stone Cabin HMA and Reveille HMA. In addition, many of the stallions that would be gelded would have already had a chance to breed, passing on genetic material to their offspring. BLM is not obligated to ensure that any given individual in a herd has the chance to sire a foal and pass on genetic material. The herd in which the proposed action is to take place are not at immediate or future risk of catastrophic loss of genetic diversity, nor does the genetic diversity in this herd represent unique genetic information. This action does not prevent BLM from augmenting genetic diversity in the treated herd in the future, if future genetic monitoring indicates that would be necessary.

It is not expected that genetic health would be affected by the Proposed Action. Available indications are that these populations contain adequate levels of genetic diversity at this time. More information about the genetic diversity in these populations will become available as a result of genetic monitoring under Alternatives 1-3. The AML range of 300-500 on the NWHR HMA should lead to low rates of loss in observed heterozygosity (well below 1% per generation). If at any time in the future the genetic diversity in either HMA is determined to be relatively low, then a large number of other HMAs could be used as sources for fertile wild horses that could be translocated into the HMA of concern (BLM 2010).

The NWHR HMA is located such that wild horses can enter the population from neighboring areas (adjacent and nearby HMAs). As such, there is the potential for some additional genetic information to continually enter this population. The BLM allows for the possibility that, if future genetic testing indicates that there is a critically low genetic diversity in the NWHR HMA herd and other herds that interact with it genetically, future management of the herd in the NWHR HMA could include genetic augmentation, by bringing in additional stallions, mares, or both. The NRC report (2013) recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010).

Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Although those results are specific to mares, some inferences about potential effects of stallion sterilization may be made from their results. Roelle and Oyler-McCance (2015) showed that the risk of the loss of genetic heterozygosity is extremely low except in cases where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the population are permanently sterilized.

BLM acknowledges that if the management goal was to sterilize >85% of males in a population, that could lead to genetic consequences of reduced heterozygosity and increased inbreeding coefficients, as it would potentially allow a very small group of males to dominate the breeding (e.g., Saltz et al. 2000). Such genetic consequences could be mitigated by natural movements or human-facilitated translocations (BLM 2010). However, the question of how >85% gelded males in a population would interact with intact stallions and mares and with their habitat is not relevant to this decision because that level of castration is not being considered as an alternative in this decision. Garrott and Siniff's (1992) model predicts that gelding 50-80% of mature males in the population would result in reduced, but not halted, mare fertility rates. However, within a few years after any male sterilization treatment, a number of fertile male colts would become sexually mature stallions who could contribute genetically to the herd.

Effects of Intra-Uterine Devices (IUDs)

Up through the present time, BLM has not used IUDs to control fertility as a wild horse and burro fertility control method on the range. The BLM has supported and continues to support research into the development and testing of effective and safe IUDs for use in wild horse mares (Baldrighi et al. 2017). However, existing literature on the use of IUDs in horses allows for inferences about expected effects of any management alternatives that might include use of IUDs.

IUDs are considered a temporary fertility control method that does not generally cause future sterility (Daels and Hughes 1995). Use of IUDs is an effective fertility control method in women, and IUDs have historically been used in livestock management, including in domestic horses. Insertion of an IUD can be a very rapid procedure, but it does require the mare to be temporarily restrained, such as in a squeeze chute. IUDs in mares may cause physiological effects including discomfort, infection, perforation of the uterus if the IUD is hard and angular, endometritis, uterine edema (Killian et al. 2008), and pyometra (Klabnik-Bradford et al. 2013). In women, deaths attributable to IUD use may be as low as 1.06 per million (Daels and Hughes 1995).

The exact mechanism by which IUDs prevent pregnancy is uncertain (Daels and Hughes 1995), but the presence of an IUD in the uterus may, like a pregnancy, prevent the mare from coming back into estrus (Turner et al. 2015). However, some domestic mares did exhibit repeated estrus cycles during the time when they had IUDs (Killian et al. 2008). The main cause for an IUD to not be effective at contraception is its failure to stay in the uterus (Daels and Hughes 1995). As a result, one of the major challenges to using IUDs to control fertility in mares on the range is preventing the IUD from being dislodged or otherwise ejected over the course of daily activities, which could include, at times, frequent breeding.

At this time, it is thought that any IUD inserted into a pregnant mare may cause the pregnancy to terminate, which may also cause the IUD to be expelled. For that reason, it is expected that IUDs would only be inserted in non-pregnant (open) mares. Some method of testing for pregnancy status, such as palpation or ultrasound examination, could be used as a precursor to determining whether a given mare is a candidate for IUD use. It is expected that mares identified as candidates for IUD application would first be screened via transrectal palpation or transrectal ultrasound. The mare would be restrained in a squeeze chute that allows safe access for a veterinarian or other qualified person. Fecal material would be removed from the rectum before the procedure. Mares found to be non-pregnant (open) would have an IUD inserted by means of a narrow applicator passed through the cervix. Mares receiving IUDs may or may not receive a small dose of progesterone, for the purpose of discouraging copulation for a short time after IUD insertion. Total time in restraint may be on the order of 2-5 minutes. If a mare has a zygote or very small, early phase embryo, it is possible that it will fail to develop further, but without causing the expulsion of the IUD.

Using metallic or glass marbles as IUDs may prevent pregnancy in horses (Nie et al. 2003), but can pose health risks to domestic mares (Turner et al. 2015, Freeman and Lyle 2015). Marbles may break into shards (Turner et al. 2015), and uterine irritation that results from marble IUDs may cause chronic, intermittent colic (Freeman and Lyle 2015). Metallic IUDs may cause severe infection (Klabnik-Bradford et al. 2013).

In domestic ponies, Killian et al. (2008) explored the use of three different IUD configurations, including a silastic polymer O-ring with copper clamps, and the “380 Copper T” and “GyneFix” IUDs designed for women. The longest retention time for the three IUD models was seen in the “T” device, which stayed in the uterus of several mares for 3-5 years. Reported contraception rates for IUD-treated mares were 80%, 29%, 14%, and 0% in years 1-4, respectively. They surmised that pregnancy resulted after IUD fell out of the uterus. Killian et al. (2008) reported high levels of progesterone in non-pregnant, IUD-treated ponies.

Soft IUDs may cause relatively less discomfort than hard IUDs (Daels and Hughes 1995). Daels and Hughes (1995) tested the use of a flexible O-ring IUD, made of silastic, surgical-grade polymer, measuring 40 mm in diameter; in five of six breeding domestic mares tested, the IUD was reported to have stayed in the mare for at least 10 months. In mares with IUDs, Daels and Hughes (1995) reported some level of uterine irritation but surmised that the level of irritation was not enough to interfere with a return to fertility after IUD removal.

More recently, several types of IUDs have been tested for use in breeding mares. When researchers attempted to replicate the O-ring study (Daels and Hughes 1995) in an USGS / Oklahoma State University (OSU) study with breeding domestic mares, using various configurations of silicone O-ring IUDs, the IUDs fell out at unacceptably high rates over time scales of less than 2 months (Baldrighi et al. 2017). Subsequently, the USGS / OSU researchers tested a Y-shaped IUD to determine retention rates and assess effects on uterine health; retention rates were greater than 75% for an 18-month period, and mares returned to good uterine health and reproductive capacity after removal of the IUDs (Holyoak et al., unpublished results). The University of Massachusetts has developed a magnetic IUD that has been effective at preventing estrus in non-breeding domestic mares (Gradil 2019). After insertion in the uterus, the three subunits of the device are held together by magnetic forces as a flexible triangle. A metal detector can be used to determine whether the device is still present in the mare. In an early trial, two sizes of those magnetic IUDs fell out of breeding domestic mares at high rates (Holyoak et al., unpublished results). In 2019, the magnetic IUD was used in two trials where mares were exposed to stallions, and in one where mares were artificially inseminated; in all cases, the IUDs were reported to stay in the mares without any pregnancy (Gradil, unpublished results).

Sex Ratio Manipulation

Skewing the sex ratio of a herd so that there are more males than females is an established BLM management technique for reducing population growth rates. As part of a wild horse and burro gather process, the number of animals returned to the range may include more males, the number removed from the range may include more females, or both. By reducing the proportion of breeding females in a population (as a fraction of the total number of animals present), the technique leads to fewer foals being born, relative to the total herd size.

Sex ratio is typically adjusted in such a way that 60 percent of the horses are male. In the absence of other fertility control treatments, this 60:40 sex ratio can temporarily reduce population growth rates from approximately 20% to approximately 15% (Bartholow 2004). While such a decrease in growth rate may not appear to be large or long-lasting, the net result can be that fewer foals being born, at least for a few years – this can extend the time between gathers, and reduce impacts on-range, and costs off-range. Any impacts of sex ratio manipulation are expected to be temporary because the sex ratio of wild horse and burro foals at birth is approximately equal between males and females (NRC 2013), and it is common for female foals to reproduce by their second year (NRC 2013). Thus, within a few years after a gather and selective removal that leads to more males than females, the sex ratio of reproducing wild horses and burros will be returning toward a 50:50 ratio.

Having a larger number of males than females is expected to lead to several demographic and behavioral changes as noted in the NAS report (NRC 2013), including the following. Having more fertile males than females should not alter the fecundity of fertile females. Wild mares may be distributed in a larger number of smaller harems. Competition and aggression between males may cause a decline in male body condition. Female foraging may be somewhat disrupted by elevated male-male aggression. With a greater number of males available to choose from, females may have opportunities to select more genetically fit sires. There would also be an increase the genetic effective population size because more stallions would be breeding and existing females would be distributed among many more small harems. This last beneficial impact is one reason that skewing the sex ratio to favor males is listed in the BLM wild horse and burro handbook (BLM 2010) as a method to consider in herds where there may be concern about the loss of genetic diversity; having more males fosters a greater retention of genetic diversity.

Infanticide is a natural behavior that has been observed in wild equids (Feh and Munktuya 2008, Gray 2009), but there are no published accounts of infanticide rates increasing as a result of having a skewed sex ratio in wild horse or wild burro herds. Any comment that implies such an impact would be speculative.

The BLM wild horse and burro management handbook (BLM 2010) discusses this method. The handbook acknowledges that there may be some behavioral impacts of having more males than females. The handbook includes guidelines for when the method should be applied, specifying that this method should be considered where the low end of the AML is 150 animals or greater, and with the result that males comprise 60-70 percent of the herd. Having more than 70 percent males may result in unacceptable impacts in terms of elevated male-male aggression. In NEPA analyses, BLM has chosen to follow these guidelines in some cases, for example:

- In the 2015 Cold Springs HMA Population Management Plan EA (DOI-BLM-V040-2015-022), the low end of AML was 75. Under the preferred alternative, 37 mares and 38 stallions would remain on the HMA. This is well below the 150 head threshold noted above.

- In the 2017 Hog Creek HMA Population Management Plan EA (DOI-BLM-ORWA-V000-2017-0026-EA), BLM clearly identified that maintaining a 50:50 sex ratio was appropriate because the herd size at the low end of AML was only 30 animals.

It is relatively straightforward to speed the return of skewed sex ratios back to a 50:50 ratio. The BLM wild horse and burro handbook (BLM 2010) specifies that, if post-treatment monitoring reveals negative impacts to breeding harems due to sex ratio manipulation, then mitigation measures could include removing males, not introducing additional males, or releasing a larger proportion of females during the next gather.

Appendix E. Fertility Control Vaccine Treatment Standard Operating Procedures (SOPs)

The following management and monitoring requirements are part of the Proposed Action and Alternative 2:

Standard Operating Procedures for PZP Vaccine Treatments; One-Year Liquid Vaccine

The following implementation and monitoring requirements are part of the Proposed Action:

1. Fertility vaccine would be administered through darting by trained BLM personnel or collaborating partners only. For any darting operation, the designated personnel must have successfully completed a nationally recognized wildlife darting course and who have documented and successful experience darting wildlife under field conditions.
2. All jennies targeted for treatment will be clearly identifiable through photographs to enable darters and HMA managers to positively identify the animals during the project and at the time of removal during subsequent gathers. This will be accomplished by marking each individual with a freeze mark on the hip. Additionally, ear tags may be placed in an ear to assist in positively identifying individuals when they are long haired.
3. Only designated darters would prepare the emulsion. Vaccine-adjuvant emulsion would be loaded into darts at the darting site and delivered by means of a projector gun. Designated darters will follow safety guidance on EPA labeling for all adjuvants.
4. Delivery of the vaccine would be by intramuscular injection into the left or right hip/gluteal muscles while the jenny is standing still.
5. Safety for both humans and the burro is the foremost consideration in deciding to dart a jenny. The Dan Inject® gun would not be used at ranges in excess of 30 m while the Pneu-Dart® gun would not be used over 50 m, and no attempt would be taken when other persons are within a 30-m radius of the target animal.
6. No attempts would be taken in high wind (greater than 15 mph) or when the animal is standing at an angle where the dart could miss the hip/gluteal region and hit the rib cage. The ideal is when the dart would strike the skin of the horse at a perfect 90° angle.
7. If a loaded dart is not used within two hours of the time of loading, the contents would be transferred to a new dart before attempting another horse. If the dart is not used before the end of the day, it would be stored under refrigeration and the contents transferred to another dart the next day. Refrigerated darts would not be used in the field.
8. No more than two people should be present at the time of a darting. The second person is responsible for locating fired darts. The second person should also be responsible for identifying the horse and keeping onlookers at a safe distance.
9. To the extent possible, all darting would be carried out in a discrete manner. However, if darting is to be done within view of non-participants or members of the public, an explanation of the nature of the project would be carried out either immediately before or after the darting.
10. Attempts will be made to recover all darts. To the extent possible, all darts which are discharged and drop from the burro at the darting site would be recovered before another darting occurs. In exceptional situations, the site of a lost dart may be noted and marked, and recovery efforts made at a later time. All discharged darts would be examined after recovery in order to determine if the charge fired and the plunger fully expelled the vaccine. Personnel

conducting darting operations should be equipped with a two-way radio or cell phone to provide a communications link with the Project Veterinarian for advice and/or assistance. In the event of a veterinary emergency, darting personnel would immediately contact the Project Veterinarian, providing all available information concerning the nature and location of the incident.

11. In the event that a dart strikes a bone or imbeds in soft tissue and does not dislodge, the darter would follow the affected horse until the dart falls out or the horse can no longer be found. The darter would be responsible for daily observation of the horse until the situation is resolved.

Monitoring and Tracking of Treatments

1. At a minimum, estimation of population growth rates using helicopter or fixed-wing surveys will be conducted before any subsequent gather. During these surveys it is not necessary to identify which foals were born to which jennies; only an estimate of population growth is needed (i.e. # of foals to # of adults).
2. Population growth rates of herds selected for intensive monitoring will be estimated every year post-treatment using helicopter or fixed-wing surveys. During these surveys it is not necessary to identify which foals were born to which jennies, only an estimate of population growth is needed (i.e. # of foals to # of adults). If, during routine HMA field monitoring (on-the-ground), data describing jenny to foal ratios can be collected, these data should also be shared with the NPO for possible analysis by the USGS.
3. An Application Data sheet will be used by field applicators to record all pertinent data relating to identification of the jenny (including photographs if jennies are not freeze-marked) and date of treatment. Each applicator will submit an Application Report and accompanying narrative and data sheets will be forwarded to the NPO (Reno, Nevada). A copy of the form and data sheets and any photos taken will be maintained at the field office.

Standard Operating Procedures for GonaCon Vaccine Treatments

Administering the GonaCon Vaccine by Hand-Injection

1. For initial and booster treatments, mares would ideally receive 2.0 ml of GonaCon-Equine. However, experience has demonstrated that only 1.8 ml of vaccine can typically be loaded into 2 cc darts, and this dose has proven successful. Calculations below reflect a 1.8 ml dose.
2. With each injection, the vaccine should be injected into the left or right hind quarters of the mare, above the imaginary line that connects the point of the hip (hook bone) and the point of the buttocks (pin bone).
3. Darts should be weighed to the nearest hundredth gram by electronic scale when empty, when loaded with vaccine, and after discharge, to ensure that 90% (1.62 ml) of the vaccine has been injected. Animals receiving <50% should be darted with another full dose; those receiving >50% but <90% should receive a half dose (1 ml). All darts should be weighed to verify a combination of ≥1.62 ml has been administered. Therefore, every effort should be made to recover darts after they have fallen from animals.

4. A booster vaccine may be administered 90 or more days after the first injection to improve efficacy of the product over subsequent years.
5. Free ranging animals may be photographed using a telephoto lens and high quality digital receiver as a record of treated individuals, and the injection site can be recorded on data sheets to facilitate identification by animal markings and potential injection scars.
6. A tracking system would be maintained by NPO detailing the lot number(s) of the vaccine, quantity of vaccine issued, the quantity used, the date of vaccination, disposition of any unused vaccine, the date disposed, the number of treated mares by HMA, field office, and State along with the freeze-mark(s) applied by HMA and date.

Preparation of Darts for GonaCon Vaccine Remote Delivery:

1. The vaccine is distributed as preloaded doses (2 mL) in labeled syringes. Upon receipt, the vaccine should be kept refrigerated (4° C) until use. Do not freeze. The vaccine has a 6-month shelf-life from the time of production and the expiration date will be noted on each syringe that is provided. Important: label instructions must be followed for this product.
2. Although infrequent, dart injections can result in partial injections of the vaccine, and shots are missed. As a precaution, it is recommended that extra doses of the vaccine be ordered to accommodate failed delivery (~15 %). To determine the amount of vaccine delivered, the dart must be weighed before loading, and before and after delivery in the field.
3. For best results, darts with a gel barb should be used. (i.e. 2 cc Pneu-Dart brand darts configured with Slow-inject technology, 3.81 cm long 14 ga.tri-port needles, and gel collars positioned 1.27 cm ahead of the ferrule)
4. Wearing latex gloves, darts are numbered and filled with vaccine by attaching a loading needle (7.62 cm; provided by dart manufacturer) to the syringe containing vaccine and placing the needle into the cannula of the dart to the fullest depth possible. Slowly depress the syringe plunger and begin filling the dart. Periodically, tap the dart on a hard surface to dislodge air bubbles trapped within the vaccine. Due to the viscous nature of the fluid, air entrapment typically results in a maximum of approximately 1.8 ml of vaccine being loaded in the dart. The dart is filled to max once a small amount of the vaccine can be seen at the tri-ports.
5. Important! Do not load and refrigerate darts the night before application. When exposed to moisture and condensation, the edges of gel barbs soften, begin to dissolve, and will not hold the dart in the muscle tissue long enough for full injection of the vaccine. The dart needs to remain in the muscle tissue for a minimum of 1 minute to achieve dependable full injection. Sharp gel barbs are critical.
6. Darts (configured specifically as described above) can be loaded in the field and stored in a cooler prior to application. Darts loaded, but not used can be maintained in a cooler at about 4° C and used the next day, but do not store in a refrigerator or any other container likely to cause condensation.

Appendix F. Standard Operating Procedures for Field Castration (Gelding) of Wild Horse Stallions

Gelding will be performed with general anesthesia and by a veterinarian. The combination of pharmaceutical compounds used for anesthesia, method of physical restraint, and the specific surgical technique used will be at the discretion of the attending veterinarian with the approval of the authorized officer (I.M. 2009-063).

Pre-surgery Animal Selection, Handling and Care

1. Stallions selected for gelding will be greater than 6 months of age and less than 20 years of age.
2. All stallions selected for gelding will have a Henneke body condition score of 3 or greater. No animals which appear distressed, injured or in failing health or condition will be selected for gelding.
3. Stallions will not be gelded within 36 hours of capture and no animals that were roped during capture will be gelded at the temporary holding corrals for rerelease.
4. Whenever possible, a separate holding corral system will be constructed on site to accommodate the stallions that will be gelded. These gelding pens will include a minimum of 3 pens to serve as a working pen, recovery pen(s), and holding pen(s). An alley and squeeze chute built to the same specifications as the alley and squeeze chutes used in temporary holding corrals (solid sides in alley, minimum 30 feet in length, squeeze chute with non-slip floor) will be connected to the gelding pens.
5. When possible, stallions selected for gelding will be separated from the general population in the temporary holding corral into the gelding pens, prior to castration.
6. When it is not possible or practical to build a separate set of pens for gelding, the gelding operation will only proceed when adequate space is available to allow segregation of gelded animals from the general population of stallions following surgery. At no time will recently anesthetized animals be returned to the general population in a holding corral before they are fully recovered from anesthesia.
7. All animals in holding pens will have free access to water at all times. Water troughs will be removed from working and recovery pens prior to use.
8. Prior to surgery, animals in holding pens may be held off feed for a period of time (typically 12-24 hours) at the recommendation and direction of the attending veterinarian.
9. The final determination of which specific animals will be gelded will be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer.
10. Whether the procedure will proceed on a given day will be based on the discretion of the attending veterinarian in consultation with the Authorized Officer taking into consideration the prevailing weather, temperature, ground conditions and pen set up. If these field situations can’t be remedied, the procedure will be delayed until they can be, the stallions will be transferred to a prep facility, gelded, and later returned, or they will be released to back to the range as intact stallions.

Gelding Procedure

1. All gelding operations will be performed under a general anesthetic administered by a qualified and experienced veterinarian. Stallions will be restrained in a portable squeeze chute to allow the veterinarian to administer the anesthesia.
2. The anesthetics used will be based on a Xylazine/ketamine combination protocol. Drug dosages and combinations of additional drugs will be at the discretion of the attending veterinarian.
3. Animals may be held in the squeeze chute until the anesthetic takes effect or may be released into the working pen to allow the anesthesia to take effect. If recumbency and adequate anesthesia is not achieved following the initial dose of anesthetics, the animal will either be redosed or the surgery will not be performed on that animal at the discretion of the attending veterinarian.
4. Once recumbent, rope restraints or hobbles will be applied for the safety of the animal, the handlers and the veterinarian.
5. The specific surgical technique used will be at the discretion of the attending veterinarian.
6. Flunixin meglamine or an alternative analgesic medication will be administered prior to recovery from anesthesia at the professional discretion of the attending veterinarian.
7. Tetanus prophylaxis will be administered at the time of surgery.

The animal would be sedated then placed under general anesthesia. Ropes are placed on one or more limbs to help hold the animal in position and the anesthetized animals are placed in either lateral or dorsal recumbency. The surgical site is scrubbed and prepped aseptically. The scrotum is incised over each testicle, and the testicles are removed using a surgical tool to control bleeding. The incision is left open to drain. Each animal would be given a Tetanus shot, antibiotics, and an analgesic.

Any males that have inguinal or scrotal hernias would be removed from the population, sent to a regular BLM facility and be treated surgically as indicated, if possible, or euthanized if they have a poor prognosis for recovery (IM 2009-041, IM 2009-063). Horses with only one descended testicle may be removed from the population and managed at a regular BLM facility according to BLM policy or anesthetized with the intent to locate the undescended testicle for castration. If an undescended testicle cannot be located, the animal may be recovered and removed from the population if no surgical exploration has started. Once surgical exploration has started, those that cannot be completely castrated would be euthanized prior to recovering them from anesthesia according to BLM policy (IM 2009-041, IM 2009-063). All animals would be rechecked by a veterinarian the day following surgery. Those that have excessive swelling, are reluctant to move or show signs of any other complications would be held in captivity and treated accordingly. Once released no further veterinary interventions would be possible.

Selected stallions would be shipped to the facility, gelded, and returned to the range within 30 days. Gelded animals could be monitored periodically for complications for approximately 7-10 days following release. In the proposed alternatives, gelding is not part of a research study, but additional monitoring on the range could be completed either through aerial reconnaisance, if available, or field observations from major roads and trails. It is not anticipated that all the geldings would be observed but if the goal is to detect complications on the range, then this level of casual observation may help BLM determine if those are occurring. Periodic observations of the long term outcomes of gelding could be recorded during routine resource monitoring work. Such observations could include but not be limited to band size, social interactions with other geldings and harem bands, distribution within their habitat, forage utilization and activities around key water sources. Periodic population inventories and future gather statistics could provide additional anecdotal information about how logistically effective it is to manage a portion of the herd as non-breeding animals.

Appendix G. Literature Cited

Angle, M., J. W. Turner Jr., R. M. Kenney, and V. K. Ganjam. 1979. Androgens in feral stallions. Pages 31–38 in Proceedings of the Symposium on the Ecology and Behaviour of Wild and Feral Equids, University of Wyoming, Laramie.

Asa, C. S. 1999. Male reproductive success in free-ranging feral horses. Behavioural Ecology and Sociobiology 47:89–93.

Asa, C. S., D. A. Goldfoot, and O. J. Ginther. 1979. Sociosexual behavior and the ovulatory cycle of ponies (*Equus caballus*) observed in harem groups. Hormones and Behavior 13:49–65.

Asa, C. S., D. A. Goldfoot, M. C. Garcia, and O. J. Ginther. 1980*a*. Dexamethasone suppression of sexual behavior in the ovariectomized mare. Hormones and Behavior.

Asa, C., D. A. Goldfoot, M. C. Garcia, and O. J. Ginther. 1980*b*. Sexual behavior in ovariectomized and seasonally anovulatory pony mares (*Equus caballus*). Hormones and Behavior 14:46–54.

Asa, C., D. Goldfoot, M. Garcia, and O. Ginther. 1984. The effect of estradiol and progesterone on the sexual behavior of ovariectomized mares. Physiology and Behavior 33:681–686.

Ashley, M.C., and D.W. Holcombe. 2001. Effects of stress induced by gathers and removals on reproductive success of feral horses. Wildlife Society Bulletin 29:248-254.

Ashley, M.C., and D.W. Holcombe. 2001. Effects of stress induced by gathers and removals on reproductive success of feral horses. Wildlife Society Bulletin 29:248-254.

Bagavant, H., C. Sharp, B. Kurth, and K.S.K. Tung. 2002. Induction and immunohistology of autoimmune ovarian disease in cynomolgus macaques (*Macaca fascicularis*). American Journal of Pathology 160:141-149.

Baker, D.L., J.G. Power, J.I. Ransom, B.E. McCann, M.W. Oehler, J.E. Bruemmer, N.L. Galloway, D.C. Eckery, and T.M. Nett. 2018. Reimmunization increases contraceptive effectiveness of gonadotropin-releasing hormone vaccine (GonaCon-Equine) in free-ranging horses (*Equus caballus*): Limitations and side effects. PLoS ONE 13(7): e0201570.

Baker, D.L., J.G. Powers, J. Ransom, B. McCann, M. Oehler, J. Bruemmer, N. Galloway, D. Eckery, and T. Nett. 2017. Gonadotropin-releasing hormone vaccine (GonaCon-Equine) suppresses fertility in free-ranging horses (*Equus caballus*): limitations and side effects. Proceedings of the 8th International Wildlife Fertility Control Conference, Washington, D.C.

Baker, D.L., J.G. Powers, M.O. Oehler, J.I. Ransom, J. Gionfriddo, and T.M. Nett. 2013. Field evaluation of the Immunocontraceptive GonaCon-B in Free-ranging Horses (*Equus caballus*) at Theodore Roosevelt National Park. Journal of Zoo and Wildlife Medicine 44:S141-S153.

Baldock, P. A. J., H. A. Morris, A. G. Need, R. J. Moore, and T. C. Durbridge. 1998. Variation in the short-term changes in bone cell activity in three regions of the distal femur immediately following ovariectomy. Journal of Bone and Mineral Research 13:1451–1457.

Baldrighi, J.M., C.C. Lyman, K. Hornberger, S.S. Germaine, A. Kane, and G.R. Holyoak. 2017. Evaluating the efficacy and safety of silicone O-ring intrauterine devices as a horse contracetive through a captive breeding trial. Clinical Theriogenology 9:471.

Balet, L., F. Janett, J. Hüsler, M. Piechotta, R. Howard, S. Amatayakul-Chantler, A. Steiner, and G. Hirsbrunner, 2014. Immunization against gonadotropin-releasing hormone in dairy cattle: Antibody titers, ovarian function, hormonal levels, and reversibility. Journal of Dairy Science 97:2193-2203.

Barber, M.R., and R.A. Fayer-Hosken. 2000. Evaluation of somatic and reproductive immunotoxic effects of the porcine zone pellucida vaccination. Journal of Experimental Zoology 286:641-646.

Bartholow, J. 2007. Economic benefit of fertility control in wild horse populations. The Journal of Wildlife Management 71:2811-2819.

Bartholow, J.M. 2004. An economic analysis of alternative fertility control and associated management techniques for three BLM wild horse herds. USGS Open-File Report 2004-1199.

Bartholow, J.M. 2007. Economic benefit of fertility control in wild horse populations. Journal of Wildlife Management 71:2811-2819.

Bechert, U., J. Bartell, M. Kutzler, A. Menino, R. Bildfell, M. Anderson, and M. Fraker. 2013. Effects of two porcine zona pellucida immunocontraceptive vaccines on ovarian activity in horses. The Journal of Wildlife Management 77:1386-1400.

Bechert, U.S., and M.A. Fraker. 2018. Twenty years of SpayVac research: potential implications for regulating feral horse and burro populations in the United States. Human-Wildlife Interactions 12:117-130.

Beckett, T., A. E. Tchernof, and M. J. Toth. 2002. Effect of ovariectomy and estradiol replacement on skeletal muscle enzyme activity in female rats. Metabolism 51:1397–1401.

Belsito, K. R., B. M. Vester, T. Keel, T. K. Graves, and K. S. Swanson. 2008. Impact of ovariohysterectomy and food intake on body composition, physical activity, and adipose gene expression in cats. Journal of Animal Science 87:594–602.

Berger, J. 1986. Wild horses of the Great Basin. University of Chicago Press, Chicago.

Bertin, F. R., K. S. Pader, T. B. Lescun, and J. E. Sojka-Kritchevsky. 2013. Short-term effect of ovariectomy on measures of insulin sensitivity and response to dexamethasone administration in horses. American Journal of Veterinary Research 74:1506–1513.

BLM. 2010. BLM-4700-1 Wild Horses and Burros Management Handbook. Washington, D.C.

Boedeker, N.C., L.A.C. Hayek, S. Murray, D.M. De Avila, and J.L. Brown. 2012. Effects of a gonadotropin-releasing hormone vaccine on ovarian cyclicity and uterine morphology of an Asian elephant (Elephas maximus). Journal of Zoo and Wildlife Medicine 43:603-614.

Bohrer, B.M., W.L. Flowers, J.M. Kyle, S.S. Johnson, V.L. King, J.L. Spruill, D.P. Thompson, A.L. Schroeder, and D.D. Boler. 2014. Effect of gonadotropin releasing factor suppression with an immunological on growth performance, estrus activity, carcass characteristics, and meat quality of market gilts. Journal of Animal Science 92:4719-4724.

Borsberry, S. 1980. Libidinous behaviour in a gelding. Veterinary Record 106:89–90.

Botha, A.E., M.L. Schulman, H.J. Bertschinger, A.J. Guthrie, C.H. Annandale, and S.B. Hughes. 2008. The use of a GnRH vaccine to suppress mare ovarian activity in a large group of mares under field conditions. Wildlife Research 35:548-554.

Bowen, Z. 2015. Assessment of spay techniques for mare in field conditions. Letter from US Geological Survey Fort Collins Science Center to D. Bolstad, BLM. November 24, 2015. Appendix D *in* Bureau of Land Management, 2016, Mare Sterilization Research Environmental Assessment, DOI-BLM-O-B000-2015-055-EA, Hines, Oregon.

Brown, B.W., P.E. Mattner, P.A.Carroll, E.J. Holland, D.R. Paull, R.M. Hoskinson, and R.D.G. Rigby. 1994. Immunization of sheep against GnRH early in life: effects on reproductive function and hormones in rams. Journal of Reproduction and Fertility 101:15-21.

Bureau of Land Management (BLM). 2010. Wild Horse and Burro Management Handbook 4700-1.

Camara, C., L.-Y. Zhou, Y. Ma, L. Zhu, D. Yu, Y.-W. Zhao, and N.-H. Yang. 2014. Effect of ovariectomy on serum adiponectin levels and visceral fat in rats. Journal of Huazhong University of Science and Technology [Medical Sciences] 34:825–829.

Chaudhuri, M., and J. R. Ginsberg. 1990. Urinary androgen concentrations and social status in two species of free ranging zebra (Equus burchelli and E. grevyi). Reproduction 88:127–133.

Coit V. A., F. J. Dowell, and N. P. Evans. 2009. Neutering affects mRNA expression levels for the LH- and GnRH-receptors in the canine urinary bladder. Theriogenology 71:239-247.

Coit, V.A., F.J. Dowell, and N.P.Evans. 2009. Neutering affects mRNA expression levels for the LH-and GnRH-receptors in the canine urinary bladder. Theriogenology 71:239-247.

Colborn, D. R., D. L. Thompson, T. L. Roth, J. S. Capehart, and K. L. White. 1991. Responses of cortisol and prolactin to sexual excitement and stress in stallions and geldings. Journal of Animal Science 69:2556–2562.

Collins, G. H., and J. W. Kasbohm. 2016. Population dynamics and fertility control of feral horses.

Journal of Wildlife Management 81: 289-296.

Cooper, D.W. and C.A. Herbert. 2001. Genetics, biotechnology and population management of over-abundant mammalian wildlife in Australasia. Reproduction, Fertility and Development 13:451-458.

Cooper, D.W. and E. Larsen. 2006. Immunocontraception of mammalian wildlife: ecological and immunogenetic issues. Reproduction 132, 821–828.

Costantini, R. M., J. H. Park, A. K. Beery, M. J. Paul, J. J. Ko, and I. Zucker. 2007. Post-castration retention of reproductive behavior and olfactory preferences in male Siberian hamsters: Role of prior experience. Hormones and Behavior 51:149–155.

Crabtree, J. R. 2016. Can ovariectomy be justified on grounds of behaviour? Equine Veterinary Education 28: 58–59.

Creel, S., B. Dantzer, W. Goymann, and D.R. Rubenstein. 2013. The ecology of stress: effects of the social environment. Functional Ecology 27:66-80.

Crowell-Davis, S. L. 2007. Sexual behavior of mares.

Curtis, P.D., R.L. Pooler, M.E. Richmond, L.A. Miller, G.F. Mattfeld, and F.W Quimby. 2001. Comparative effects of GnRH and porcine zona pellucida (PZP) immunocontraceptive vaccines for controlling reproduction in white-tailed deer (*Odocoileus virginianus*). Reproduction (Cambridge, England) Supplement 60:131-141.

Curtis, P.D., R.L. Pooler, M.E. Richmond, L.A. Miller, G.F. Mattfeld, and F.W. Quimby. 2008. Physiological Effects of gonadotropin-releasing hormone immunocontraception in white-tailed deer. Human-Wildlife Conflicts 2:68-79.

Curtis, P.D., R.L. Pooler, M.E. Richmond, L.A. Miller, G.F. Mattfeld, and F.W Quimby. 2001. Comparative effects of GnRH and porcine zona pellucida (PZP) immunocontraceptive vaccines for controlling reproduction in white-tailed deer (*Odocoileus virginianus*). Reproduction (Cambridge, England) Supplement 60:131-141.

Daels, P.F, and J.P. Hughes. 1995. Fertility control using intrauterine devices: an alternative for population control in wild horses. Theriogenology 44:629-639.

Dalin, A.M., Ø. Andresen, and L. Malmgren. 2002. Immunization against GnRH in mature mares: antibody titres, ovarian function, hormonal levels and oestrous behaviour. Journal of Veterinary Medicine Series A 49:125-131.

Dalmau, A., A. Velarde, P. Rodríguez, C. Pedernera, P. Llonch, E. Fàbrega, N. Casal, E. Mainau, M. Gispert, V. King, and N. Slootmans. 2015. Use of an anti-GnRF vaccine to suppress estrus in crossbred Iberian female pigs. Theriogenology 84:342-347.

de Seve, C.W. and S.L. Boyles Griffin. 2013. An economic model demonstrating the long-term cost benefits of incorporating fertility control into wild horse (*Equus caballus*) management in the United States. Journal of Zoo and Wildlife Medicine 44:S34-S37.

de Seve, C.W. and S.L. Boyles-Griffin. 2013. An economic model demonstrating the long-term cost benefits of incorporating fertility control into wild horse (*Equus caballus*) management in the United States. Journal of Zoo and Wildlife Medicine 44(4s:S34-S37).

Deniston, R. H. 1979. The varying role of the male in feral horses. Pages 93–38 in Proceedings of the Symposium on the Ecology and Behaviour of Wild and Feral Equids, University of Wyoming, Laramie.

Dixson, A. F. 1993. Sexual and aggressive behaviour of adult male marmosets (Callithrix jacchus) castrated neonatally, prepubertally, or in adulthood. Physiology and Behavior 54:301–307.

Dong, F., D.C. Skinner, T. John Wu, and J. Ren. 2011. The Heart: A Novel Gonadotrophin-Releasing Hormone Target. Journal of Neuroendocrinology 23:456-463.

Donovan, C.E., T. Hazzard, A. Schmidt, J. LeMieux, F. Hathaway, and M.A. Kutzler. 2013. Effects of a commercial canine gonadotropin releasing hormone vaccine on estrus suppression and estrous behavior in mares. Animal Reproduction Science, 142:42-47.

Dunbar, I. F. 1975. Behaviour of castrated animals. The Veterinary Record 92–93.

Duncan, C.L., J.L. King, and P. Stapp. 2017. Effects of prolonged immunocontraception on the breeding behavior of American bison. Journal of Mammalogy 98:1272-1287.

Eagle, T. C., C. S. Asa, R. A. Garrott, E. D. Plotka, D. B. Siniff, and J. R. Tester. 1993. Efficacy of dominant male sterilization to reduce reproduction in feral horses. Wildlife Society Bulletin 21:116–121.

Ekernas, L.S. 2017. Statistical analysis for 2017 survey of horse abundance in Nevada Wild Horse Range HMA (NV). Memo from USGS to BLM.

Elhay, M., A. Newbold, A. Britton, P. Turley, K. Dowsett, and J. Walker. 2007. Suppression of behavioural and physiological oestrus in the mare by vaccination against GnRH. Australian Veterinary Journal 85:39-45.

Environmental Protection Agency (EPA). 2012. Porcine Zona Pellucida. Pesticide fact Sheet. Office of Chemical Safety and Pollution Prevention 7505P. 9 pages.

EPA (United States Environmental Protection Agency). 2009a. Pesticide Fact Sheet: Mammalian Gonadotropin Releasing Hormone (GnRH), New Chemical, Nonfood Use, USEPA-OPP, Pesticides and Toxic Substances. US Environmental Protection Agency, Washington, DC

EPA. 2009b. Memorandum on GonaCon ™ Immunocontraceptive Vaccine for Use in White-Tailed Deer. Section 3 Registration. US Environmental Protection Agency, Washington, DC.

EPA 2013. Notice of pesticide registration for GonaCon-Equine. US Environmental Protection Agency, Washington, DC.

EPA. 2015. Label and CSF Amendment. November 19, 2015 memo and attachment from Marianne Lewis to David Reinhold. US Environmental Protection Agency, Washington, DC.

Evans, J. W., A. Borton, H. F. Hintz, and L. D. Van Vleck. 1977. The Horse. San Francisco, California: W.H. Freeman and Company. Pages 373–377.

Feh, C. 1999. Alliances and reproductive success in Camargue stallions. Animal Behaviour 57:705–713.

Feh, C. 2012. Delayed reversibility of PZP (porcine zona pellucida) in free-ranging Przewalski's horse mares. In International Wild Equid Conference. Vienna, Austria: University of Veterinary Medicine.

Feh, C., and B. Munkhtuya. 2008. Male infanticide and paternity analyses in a socially natural herd of Przewalski's horses: Sexual selection? Behavioral Processes 78:335-339.

Feist, J. D., and D.R. McCullough. 1976. Behavior patterns and communication in feral horses. *Zietschrift für Tierpsychologie* 41:337–371.

Fettman, M. J., C. A. Stanton, L. L. Banks, D. W. Hamar, D. E. Johnson, R. L. Hegstad, and S. Johnston. 1997. Effects of neutering on bodyweight, metabolic rate and glucose tolerance of domestic cats. Research in Veterinary Science 62:131–136.

Fonner, R. and A.K. Bohara. 2017. Optimal control of wild horse populations with nonlethal methods. Land Economics 93:390-412.

Freeman, C.E., and S.K. Lyle. 2015. Chronic intermittent colic in a mare attributed to uterine marbles. Equine Veterinary Education 27:469-473.

French, H., E. Peterson, R. Ambrosia, H. Bertschinger, M. Schulman, M. Crampton, R. Roth, P. Van Zyl, N. Cameron-Blake, M. Vandenplas, and D. Knobel. 2017. Porcine and recombinant zona pellucida vaccines as immunocontraceptives for donkeys in the Caribbean. Proceedings of the 8th International Wildlife Fertility Control Conference, Washington, D.C.

Garcia, M. C., and O. J. Ginther. 1976. Effects of Ovariectomy and Season on Plasma Luteinizing Hormone in Mares. Endocrinology 98:958–962.

Garrott , R.A., and D.B. Siniff. 1992. Limitations of male-oriented contraception for controlling feral horse populations. Journal of Wildlife Management 56:456-464.

Garrott, R.A., and M.K. Oli. 2013. A Critical Crossroad for BLM's Wild Horse Program. Science 341:847-848.

Garrot. R. A., and I. Taylor. 1990. Dynamics of a feral horse population in Montana. Journal of Wildlife Management 54:603-612.

Garza, F., D.L. Thompson, D.D. French, J.J. Wiest, R.L. St George, K.B. Ashley, L.S. Jones, P.S. Mitchell, and D.R. McNeill. 1986. Active immunization of intact mares against gonadotropin-releasing hormone: differential effects on secretion of luteinizing hormone and follicle-stimulating hormone. Biology of Reproduction 35:347-352.

Getman, L.M. 2009. Review of castration complications: strategies for treatment in the field. AAEP Proceedings 55:374-378.

Gionfriddo, J.P., A.J. Denicola, L.A. Miller, and K.A. Fagerstone. 2011a. Efficacy of GnRH immunocontraception of wild white-tailed deer in New Jersey. Wildlife Society Bulletin 35:142-148.

Gionfriddo, J.P., A.J. Denicola, L.A. Miller, and K.A. Fagerstone. 2011b. Health effects of GnRH immunocontraception of wild white-tailed deer in New Jersey. Wildlife Society Bulletin 35:149-160.

Government Accountability Office (GAO). 2008. Bureau of Land Management; Effective Long-Term Options Needed to Manage Unadoptable Wild Horses. Report to the Chairman, Committee on Natural Resources, House of Representatives, GAO-09-77.

Goodloe, R.B., 1991. Immunocontraception, genetic management, and demography of feral horses on four eastern US barrier islands. UMI Dissertation Services.

Gradil, C. 2019. The Upod IUD: a potential simple, safe solution for long-term, reversible fertility control in feral equids. Oral presentation at the Free Roaming Equids and Ecosystem Sustainability Summit, Reno, Nevada.

Gray, M.E. and E.Z. Cameron. 2010. Does contraceptive treatment in wildlife result in side effects? A review of quantitative and anecdotal evidence. Reproduction 139:45-55.

Gray, M.E., D.S. Thain, E.Z. Cameron, and L.A. Miller. 2010. Multi-year fertility reduction in free-roaming feral horses with single-injection immunocontraceptive formulations. Wildlife Research 37:475-481.

Gray, ME., 2009. The influence of reproduction and fertility manipulation on the social behavior of feral horses (*Equus caballus*). Dissertation. University of Nevada, Reno.

Green, N.F. and H.D. Green. 1977. The wild horse population of Stone Cabin Valley Nevada: a preliminary report. In Proceedings, National Wild Horse Forum. University of Nevada Reno Cooperative Extension Service.

Griffin, P.C., L.S. Ekernas, K.A. Schoenecker, and B.C. Lubow. 2020. Standard operating procedures for wild horse and burro double-observer aerial surveys: U.S. Geological Survey Techniques and Methods, book 2, chap. A16, 76 p. https://doi.org/10.3133/tm2A16.

Gross, J.E. 2000. A dynamic simulation model for evaluating effects of removal and contraception on genetic variation and demography of Pryor Mountain wild horses. Biological Conservation 96:319-330.

Gupta, S., and V. Minhas. 2017. Wildlife population management: are contraceptive vaccines a feasible proposition? Frontiers in Bioscience, Scholar 9:357-374.

Guttilla, D. A., and P. Stapp. 2010. Effects of sterilization on movements of feral cats at a wildland–urban interface. Journal of Mammalogy 91:482–489.

Hailer, F., B. Helander, A.O. Folkestad, S.A. Ganusevich, S. Garstad, P. Hauff, C. Koren, T. Nygård, V. Volke, C. Vilà, and H. Ellegren. 2006. Bottlenecked but long-lived: high genetic diversity retained in white-tailed eagles upon recovery from population decline. Biology Letters 2:316-319.

Hailer, F., B. Helander, A.O. Folkestad, S.A. Ganusevich, S. Garstad, P. Hauff, C. Koren, T. Nygård, V. Volke, C. Vilà, and H. Ellegren. 2006. Bottlenecked but long-lived: high genetic diversity retained in white-tailed eagles upon recovery from population decline. Biology Letters 2:316-319.

Hall, S. E., B. Nixon, and R.J. Aiken. 2016. Non-surgical sterilization methods may offer a sustainable solution to feral horse (*Equus caballus*) overpopulation. Reproduction, Fertility and Development, published online: https://doi.org/10.1071/RD16200

Hampson, B. A., M. A. De Laat, P. C. Mills, and C. C. Pollitt. 2010a. Distances travelled by feral horses in 'outback' Australia. Equine Veterinary Journal, Suppl. 38:582–586.

Hampson, B. A., J. M. Morton, P. C. Mills, M. G. Trotter, D. W. Lamb, and C. C. Pollitt. 2010b. Monitoring distances travelled by horses using GPS tracking collars. Australian Veterinary Journal 88:176–181.

Hampton, J.O., T.H. Hyndman, A. Barnes, and T. Collins. 2015. Is wildlife fertility control always humane? Animals 5:1047-1071.

Hart, B. L. 1968. Role of prior experience in the effects of castration on sexual behavior of male dogs. Journal of Comparative and Physiological Psychology 66:719–725.

Hart, B. L., and R. A. Eckstein. 1997. The role of gonadal hormones in the occurrence of objectionable behaviours in dogs and cats. Applied Animal Behaviour Science 52:331–344.

Hart, B. L., and T. O. A. C. Jones. 1975. Effects of castration on sexual behavior of tropical male goats. Hormones and Behavior 6:247–258.

Heilmann, T.J., R.A. Garrott, L.L. Cadwell, and B.L. Tiller, 1998. Behavioral response of free-ranging elk treated with an immunocontraceptive vaccine. Journal of Wildlife Management 62: 243-250.

Henneke, D.R., G.D. Potter, J.L. Kreider, and B.F. Yeates. 1983. Relationship between body condition score, physical measurements and body fat percentage in mares. Equine veterinary Journal 15:371-372.

Herbert, C.A. and T.E. Trigg. 2005. Applications of GnRH in the control and management of fertility in female animals. Animal Reproduction Science 88:141-153.

Hobbs, N.T., D.C. Bowden and D.L. Baker. 2000. Effects of Fertility Control on Populations of Ungulates: General, Stage-Structured Models. Journal of Wildlife Management 64:473-491.

Hobbs, N.T., D.C. Bowden and D.L. Baker. 2000. Effects of Fertility Control on Populations of Ungulates: General, Stage-Structured Models. Journal of Wildlife Management 64:473-491.

Holtan, D. W., E. L. Squires, D. R. Lapin, and O. J. Ginther. 1979. Effect of ovariectomy on pregnancy in mares. Journal of Reproduction and Fertility, Supplement 27:457–463.

Hooper, R. N., T. S. Taylor, D. D. Varner, and B. T. L. 1993. Effects of bilateral ovariectomy via coloptomy in mares: 23 cases (1984-1990). Journal of the American Veterinary Medical Association 203:1043–1046.

Hsueh, A.J.W. and G.F. Erickson. 1979. Extrapituitary action of gonadotropin-releasing hormone: direct inhibition ovarian steroidogenesis. Science 204:854-855.

Huang, R. Y., L. M. Miller, C. S. Carlson, and M. R. Chance. 2002. Characterization of bone mineral composition in the proximal tibia of Cynomolgus monkeys: effect of ovariectomy and nandrolone decanoate treatment. Bone 30:492–497.

Imboden, I., F. Janett, D. Burger, M.A. Crowe, M. Hässig, and R. Thun. 2006. Influence of immunization against GnRH on reproductive cyclicity and estrous behavior in the mare. Theriogenology 66:1866-1875.

Jacob, J., G. R. Singleton, and L. A. Hinds. 2008. Fertility control of rodent pests. Wildlife Research 35:487.

Janett, F., R. Stump, D. Burger, and R. Thun. 2009b. Suppression of testicular function and sexual behavior by vaccination against GnRH (Equity™) in the adult stallion. Animal Reproduction Science 115:88-102.

Janett, F., U. Lanker, H. Jörg, E. Meijerink, and R. Thun. 2009a. Suppression of reproductive cyclicity by active immunization against GnRH in the adult ewe. Schweizer Archiv fur Tierheilkunde 151:53-59.

Jenkins, S.H. 1996. Wild Horse Population Model. Version 3.2.

Jerome, C. P., C. H. Turner, and C. J. Lees. 1997. Decreased bone mass and strength in ovariectomized cynomolgus monkeys (*Macaca fascicularis*). Calcified Tissue International 60:265–270.

Jeusette, I., J. Detilleux, C. Cuvelier, L. Istasse, and M. Diez. 2004. Ad libitum feeding following ovariectomy in female Beagle dogs: effect on maintenance energy requirement and on blood metabolites. Journal of Animal Physiology and Animal Nutrition 88:117–121.

Jeusette, I., S. Daminet, P. Nguyen, H. Shibata, M. Saito, T. Honjoh, L. Istasse, and M. Diez. 2006. Effect of ovariectomy and ad libitum feeding on body composition, thyroid status, ghrelin and leptin plasma concentrations in female dogs. Journal of Animal Physiology and Animal Nutrition 90:12–18.

Jewell, P. A. 1997. Survival and behaviour of castrated Soay sheep (Ovis aries) in a feral island population on Hirta, St. Kilda, Scotland. Journal of Zoology 243:623–636.

Joonè, C.J., H.J. Bertschinger, S.K. Gupta, G.T. Fosgate, A.P. Arukha, V. Minhas, E. Dieterman, and M.L. Schulman. 2017a. Ovarian function and pregnancy outcome in pony mares following immunocontraception with native and recombinant porcine zona pellucida vaccines. Equine Veterinary Journal 49:189-195.

Joonè, C.J., H. French, D. Knobel, H.J. Bertschinger, and M.L. Schulman. 2017b. Ovarian suppression following PZP vaccination in pony mares and donkey jennies. Proceedings of the 8th International Wildlife Fertility Control Conference, Washington, D.C.

Joonè, C.J., M.L. Schulman, G.T. Fosgate, A.N. Claes, S.K. Gupta, A.E. Botha, A-M Human, and H.J. Bertschinger. 2017c. Serum anti-Müllerian hormone dynamics in mares following immunocontraception with anti-zona pellucida or -GnRH vaccines, Theriogenology (2017), doi: 10.1016/

Joonè, C.J., M.L. Schulman, and H.J. Bertschinger. 2017d. Ovarian dysfunction associated with zona pellucida-based immunocontraceptive vaccines. Theriogenology 89:329-337.

Kamm, J. L., and D. A. Hendrickson. 2007. Clients' perspectives on the effects of laparoscopic ovariectomy on equine behavior and medical problems. Journal of Equine Veterinary Science 27:435–438.

Kane, A.J. 2018. A review of contemporary contraceptives and sterilization techniques for feral horses. Human-Wildlife Interactions 12:111-116.

Kaseda, Y., H. Ogawa, and A. M. Khalil. 1997. Causes of natal dispersal and emigration and their effects on harem formation in Misaki feral horses. Equine Veterinary Journal 29:262–266.

Kaur, K. and V. Prabha. 2014. Immunocontraceptives: new approaches to fertility control. BioMed Research International v. 2014, ArticleID 868196, 15 pp. http:/dx.doi.org/10.1155/2014/868196

Kean, R.P., A. Cahaner, A.E. Freeman, and S.J. Lamont. 1994. Direct and correlated responses to multitrait, divergent selection for immunocompetence. Poultry Science 73:18-32.

Khalil, A. M., and N. Murakami. 1999. Effect of natal dispersal on the reproductive strategies of the young Misaki feral stallions. Applied Animal Behaviour Science 62:281–291.

Khalil, A.M., N. Murakami, and Y. Kaseda. 1998. Relationship between plasma testosterone concentrations and age, breeding season, and harem size in Misaki feral horses. Journal of Veterinary Medical Science 60:643-645.

Khodr, G.S., and T.M. Siler-Khodr. 1980. Placental luteinizing hormone-releasing factor and its synthesis. Science 207:315-317.

Killian, G., D. Thain, N.K. Diehl, J. Rhyan, and L. Miller. 2008. Four-year contraception rates of mares treated with single-injection porcine zona pellucida and GnRH vaccines and intrauterine devices. Wildlife Research 35:531–539.

Killian, G., N.K. Diehl, L. Miller, J. Rhyan, and D. Thain. 2006. Long-term efficacy of three contraceptive approaches for population control of wild horses. In Proceedings-Vertebrate Pest Conference.

Killian, G., T.J. Kreeger, J. Rhyan, K. Fagerstone, and L. Miller. 2009. Observations on the use of GonaCon™ in captive female elk (*Cervus elaphus*). Journal of Wildlife Diseases 45:184-188.

King, S.R.B., and J. Gurnell. 2005. Habitat use and spatial dynamics of takhi introduced to Hustai

National Park, Mongolia. Biological Conservation 124:277-290.

King, S.R.B., and J. Gurnell. 2006. Scent-marking behaviour by stallions: an assessment of function in a reintroduced population of Przewalski horses (Equus ferus przewalskii). Journal of Zoology 272:30–36.

Kirkpatrick, J. 2012. Sworn statement of Dr. Jay Kirkpatrick. Unpublished record of opinion.

Kirkpatrick, J. F., and A. Turner. 2008. Achieving population goals in a long-lived wildlife species (*Equus caballus*) with contraception. Wildlife Research 35:513.

Kirkpatrick, J.F. and A. Turner. 2002. Reversibility of action and safety during pregnancy of immunization against porcine zona pellucida in wild mares (*Equus caballus*). Reproduction Supplement 60:197-202.

Kirkpatrick, J.F. and A. Turner. 2003. Absence of effects from immunocontraception on seasonal birth patterns and foal survival among barrier island wild horses. Journal of Applied Animal Welfare Science 6:301-308.

Kirkpatrick, J.F. and J.W. Turner. 1991. Compensatory reproduction in feral horses. The Journal of Wildlife Management 55:649-652.

Kirkpatrick, J.F. and J.W. Turner. 1991. Compensatory reproduction in feral horses. Journal of Wildlife Management 55:649-652.

Kirkpatrick, J.F., A.T. Rutberg, and L. Coates-Markle. 2010. Immunocontraceptive reproductive control utilizing porcine zona pellucida (PZP) in federal wild horse populations, 3rd edition. P.M. Fazio, editor. Downloaded from http://www.einsten.net/pdf/110242569.pdf

Kirkpatrick, J.F., A.T. Rutberg, L. Coates-Markle, and P.M. Fazio. 2012. Immunocontraceptive Reproductive Control Utilizing Porcine Zona Pellucida (PZP) in Federal Wild Horse Populations. Science and Conservation Center, Billings, Montana.

Kirkpatrick, J.F., I.M.K. Liu, J.W. Turner, R. Naugle, and R. Keiper. 1992. Long-term effects of porcine zonae pellucidae immunocontraception on ovarian function in feral horses (*Equus caballus*). Journal of Reproduction and Fertility 94:437-444.

Kirkpatrick, J.F., R.O. Lyda, and K. M. Frank. 2011. Contraceptive vaccines for wildlife: a review. American Journal of Reproductive Immunology 66:40-50.

Kitchell, K., S. Cohn, R. Falise, H. Hadley, M. Herder, K. Libby, K. Muller, T. Murphy, M. Preston, M. J. Rugwell, and S. Schlanger. 2015. Advancing Science in the BLM: An Implementation Strategy. Bureau of Land Management. March 2015.

Klabnik-Bradford, J., M.S. Ferrer, C. Blevins, and L. Beard. 2013. Marble-induced pyometra in an Appaloosa mare. Clinical Theriogenology 5: 410.

Knight, C.M. 2014. The effects of porcine zona pellucida immunocontraception on health and behavior of feral horses (*Equus caballus*). Graduate thesis, Princeton University.

Lee, M., and D. A. Hendrickson. 2008. A review of equine standing laparoscopic ovariectomy. Journal of Equine Veterinary Science 28:105–111.

Levy, J.K., J.A. Friary, L.A. Miller, S.J. Tucker, and K.A. Fagerstone. 2011. Long-term fertility control in female cats with GonaCon™, a GnRH immunocontraceptive. Theriogenology 76:1517-1525.

Line, S. W., B. L. Hart, and L. Sanders. 1985. Effect of prepubertal versus postpubertal castration on sexual and aggressive behavior in male horses. Journal of the American Veterinary Medical Association 186:249–251.

Linklater, W. L., and E. Z. Cameron. 2000. Distinguishing cooperation from cohabitation: the feral horse case study. Animal Behaviour 59:F17–F21.

Liu, I.K.M., M. Bernoco, and M. Feldman. 1989. Contraception in mares heteroimmunized with pig zonae pellucidae. Journal of Reproduction and Fertility, 85:19-29.

Loesch, D. A., and D. H. Rodgerson. 2003. Surgical approaches to ovariectomy in mares. Continuing Education for Veterinarians 25:862–871.

Lundon, K., M. Dumitriu, and M. Grynpas. 1994. The long-term effect of ovariectomy on the quality and

quantity of cancellous bone in young macaques. Bone and Mineral 24:135–149.
Madosky, J.A., D.I. Rubenstein, J.J. Howard, and S. Stuska. 2010. The effect of immunocontraception on harem fidelity in a feral horse (Equus caballus) population. Applied Animal Behaviour Science: 128:50-56.
Magiafoglou, A., M. Schiffer, A.A. Hoffman, and S.W. McKechnie. 2003. Immunocontraception for population control: will resistance evolve? Immunology and Cell Biology 81:152-159.
Mask, T.A., K.A. Schoenecker, A.J. Kane, J.I.Ransom, and J.E. Bruemmer. 2015. Serum antibody immunoreactivity to equine zona protein after SpayVac vaccination. Theriogenology, 84:261-267.
Mavropoulos, A., S. Kiliaridis, R. Rizzoli, and P. Ammann. 2014. Normal masticatory function partially protects the rat mandibular bone from estrogen-deficiency induced osteoporosis. Journal of Biomechanics 47:2666–2671.
McDonnell, S.M. 2012. Mare and foal behavior. American Association of Equine Practitioners Proceedings 58:407-410.
McKinnon, A.O., and J.R. Vasey. 2007. Selected reproductive surgery of the broodmare. Pages 146-160 in Current therapy in equine reproduction, J.C. Samper, J.F. Pycock, and A.O. McKinnon, eds. Saunders Elsevier, St. Louis, Missouri.
Miller, L.A., J.P. Gionfriddo, K.A. Fagerstone, J.C. Rhyan, and G.J. Killian. 2008. The Single-Shot GnRH Immunocontraceptive Vaccine (GonaCon™) in White-Tailed Deer: Comparison of Several GnRH Preparations. American Journal of Reproductive Immunology 60:214-223.
Miller, L.A., K.A. Fagerstone, and D.C. Eckery. 2013. Twenty years of immunocontraceptive research: lessons learned. Journal of Zoo and Wildlife Medicine 44:S84-S96.
Miller, R. 1983. Seasonal Movements and Home Ranges of Feral Horse Bands in Wyoming’s Red Desert. Journal of Range Management 36:199–201.
Mills, L.S. and F.W. Allendorf. 1996. The one-migrant-per-generation rule in conservation and management. Conservation Biology 10:1509-1518.
National Research Council (NRC). 2013. Using science to improve the BLM wild horse and burro program: a way forward. National Academies Press. Washington, DC.
National Research Council of the National Academies (NRC). 2015. Review of proposals to the Bureau of Land Management on Wild Horse and Burro sterilization or contraception, a letter report. Committee for the review of proposals to the Bureau of Land Management on Wild Horse and Burro Sterilization or Contraception. Appendix B in: BLM, 2016, Mare sterilization research Environmental Assessment DOI-BLM-OR-B000-2015-0055-EA, BLM Burns District Office, Hines, Oregon.
Nelson, K. J. 1980. Sterilization of dominant males will not limit feral horse populations. USDA Forest Service Research Paper RM-226.
Nettles, V. F. 1997. Potential consequences and problems with wildlife contraceptives. Reproduction, Fertility and Development 9, 137–143.
Nickolmann, S., S. Hoy, and M. Gauly. 2008. Effects of castration on the behaviour of male llamas (Lama glama). Tierärztliche Praxis Großtiere 36:319–323.
Nie, G.J., K.E., Johnson, T.D. Braden, and J. G.W. Wenzel. 2003. Use of an intra-uterine glass ball protocol to extend luteal function in mares. Journal of Equine Veterinary Science 23:266-273.

Nock, B. 2013. Liberated horsemanship: menopause…and wild horse management. Warrenton, Missouri: Liberated Horsemanship Press.
Nock, B. 2017. Gelding is likely to cause wild horses undo suffering. Unpublished record of opinion.
NRC (National Research Council). 2013. Using science to improve the BLM wild horse and burro program: a way forward. National Academies Press. Washington, DC.

Nuñez, C.M., J.S. Adelman, and D.I. Rubenstein. 2010. Immunocontraception in wild horses (*Equus caballus*) extends reproductive cycling beyond the normal breeding season. PLoS one, 5(10), p.e13635.

Nuñez, C.M., J.S. Adelman, H.A. Carr, C.M. Alvarez, and D.I. Rubenstein. 2017. Lingering effects of contraception management on feral mare (*Equus caballus*) fertility and social behavior. Conservation Physiology 5(1): cox018; doi:10.1093/conphys/cox018.

Nuñez, C.M.V, J.S. Adelman, J. Smith, L.R. Gesquiere, and D.I. Rubenstein. 2014. Linking social environment and stress physiology in feral mares (*Equus caballus*): group transfers elevate fecal cortisol levels. General and Comparative Endocrinology. 196:26-33.

Nuñez, C.M.V. 2018. Consequences of porcine zona pellucidz immunocontraception to feral horses. Human-Wildlife Interactions 12:131-142.

Nuñez, C.M.V., J.S. Adelman, C. Mason, and D.I. Rubenstein. 2009. Immunocontraception decreases group fidelity in a feral horse population during the non-breeding season. Applied Animal Behaviour Science 117:74-83.

O'Farrell, V., and E. Peachey. 1990. Behavioural effects of ovariohysterectomy on bitches. Journal of Small Animal Practice 31:595–598.

Pader, K., L. J. Freeman, P. D. Constable, C. C. Wu, P. W. Snyder, and T. B. Lescun. 2011. Comparison of Transvaginal Natural Orifice Transluminal Endoscopic Surgery (NOTES®) and Laparoscopy for Elective Bilateral Ovariectomy in Standing Mares. Veterinary Surgery 40:998–1008.

Payne, R. M. 2013. The effect of spaying on the racing performance of female greyhounds. The Veterinary Journal 198:372–375.

Pearce, O. 1980. Libidinous behaviour in a gelding. Veterinary Record 106:207–207.

Powell, D.M. 1999. Preliminary evaluation of porcine zona pellucida (PZP) immunocontraception for behavioral effects in feral horses (*Equus caballus*). Journal of Applied Animal Welfare Science 2:321-335.

Powell, D.M. and S.L. Monfort. 2001. Assessment: effects of porcine zona pellucida immunocontraception on estrous cyclicity in feral horses. Journal of Applied Animal Welfare Science 4:271-284.

Powers, J.G., D.L. Baker, M.G. Ackerman, J.E. Bruemmer, T.R. Spraker, M.M. Conner, and T.M. Nett. 2012. Passive transfer of maternal GnRH antibodies does not affect reproductive development in elk (*Cervus elaphus nelson*) calves. Theriogenology 78:830-841.

Powers, J.G., D.L. Baker, R.J. Monello, T.J. Spraker, T.M. Nett, J.P. Gionfriddo, and M.A. Wild. 2013. Effects of gonadotropin-releasing hormone immunization on reproductive function and behavior in captive female Rocky Mountain elk (*Cervus elaphus nelsoni*). Journal of Zoo and Wildlife Medicine meeting abstracts S147.

Prado, T., and J. Schumacher. 2017. How to perform ovariectomy through a colpotomy. Equine Veterinary Education 13:doi: 10.1111/eve.12801

Ramsey, D. 2005. Population dynamics of brushtail possums subject to fertility control. Journal of Applied Ecology 42:348–360.

Ramsey, D. 2007. Effects of fertility control on behavior and disease transmission in brushtail possums. Journal of Wildlife Management 71:109–116.

Ransom, J. I., and B. S. Cade. 2009. Quantifying Equid Behavior--A Research Ethogram for Free-Roaming Feral Horses. Publications of the US Geological Survey. U.S. Geological Survey Techniques and Methods 2-A9.

Ransom, J.I. and B.S. Cade. 2009. Quantifying equid behavior: A research ethogram for free-roaming feral horses. U.S. Geological Survey Techniques and Methods Report 2-A9.

Ransom, J.I., B.S. Cade, and N.T. Hobbs. 2010. Influences of immunocontraception on time budgets, social behavior, and body condition in feral horses. Applied Animal Behaviour Science 124:51-60.

Ransom, J.I., J.E. Roelle, B.S. Cade, L. Coates-Markle, and A.J. Kane. 2011. Foaling rates in feral horses treated with the immunocontraceptive porcine zona pellucida. Wildlife Society Bulletin 35:343-352.

Ransom, J.I., J.G. Powers, N.T. Hobbs, and D.L. Baker. 2014a. Ecological feedbacks can reduce population-level efficacy of wildlife fertility control. Journal of Applied Ecology 51:259-269.

Ransom, J.I., J.G. Powers, H.M. Garbe, M.W. Oehler, T.M. Nett, and D.L. Baker. 2014b. Behavior of feral horses in response to culling and GnRH immunocontraception. Applied Animal Behaviour Science 157: 81-92.

Ransom, J.I., N.T. Hobbs, and J. Bruemmer. 2013. Contraception can lead to trophic asynchrony between birth pulse and resources. PLoS One 8(1), p.e54972.

Reichler, I. M. 2009. Gonadectomy in Cats and Dogs: A Review of Risks and Benefits. Reproduction in Domestic Animals 44:29–35.

Rios, J. F. I., and K. Houpt. 1995. Sexual behavior in geldings. Applied Animal Behaviour Science 46:133–133.

Röcken, M., G. Mosel, K. Seyrek-Intas, D. Seyrek-Intas, F. Litzke, J. Verver, and A. B. M. Rijkenhuizen. 2011. Unilateral and Bilateral Laparoscopic Ovariectomy in 157 Mares: A Retrospective Multicenter Study. Veterinary Surgery 40:1009–1014.

Roelle, J. E., F. J. Singer, L. C. Zeigenfuss, J. I. Ransom, L. Coates-Markle, and K. A. Schoenecker. 2010. Demography of the Pryor Mountain Wild Horses, 1993–2007. pubs.usgs.gov. U.S. Geological Survey Scientific Investigations Report 2010-5125.

Roelle, J.E. and J. I. Ransom. 2009. Injection-site reactions in wild horses (*Equus caballus*) receiving an immunocontraceptive vaccine. US Geological Survey Report 2009-5038.

Roelle, J.E. and S.J. Oyler-McCance, S.J., 2015. Potential demographic and genetic effects of a sterilant applied to wild horse mares. US Geological Survey Report 2015-1045.

Roelle, J.E., and J.I. Ransom. 2009. Injection-site reactions in wild horses (*Equus caballus*) receiving an immunocontraceptive vaccine: U.S. Geological Survey Scientific Investigations Report 2009–5038.

Roelle, J.E., F.J. Singer, L.C. Zeigenfuss, J.I. Ransom, F.L. Coates-Markle, and K.A. Schoenecker. 2010. Demography of the Pryor Mountain Wild Horses, 1993-2007. U.S. Geological Survey Scientific Investigations Report 2010–5125.

Roelle, J.E., S.S. Germaine, A.J. Kane, and B.S. Cade. 2017. Efficacy of SpayVac ® as a contraceptive in feral horses. Wildlife Society Bulletin 41:107-115.

Roessner, H. A., K.A. Kurtz, and J.P. Caron. 2015. Laparoscopic ovariectomy diminishes estrus-associated behavioral problems in mares. Journal of Equine Veteriniary Science 35: 250–253 (2015).

Rowland, A.L., K.G. Glass, S.T. Grady, K.J. Cummings, K. Hinrichs, and A.E. Watts. 2018. Influence of caudal epidural analgesia on cortisol concentrations and pain-related behavioral responses in mares during and after ovariectomy via colpotomy. Veterinary Surgery 2018:1-7. DOI: 10.1111/vsu.12908

Rubenstein, D.I. 1981. Behavioural ecology of island feral horses. Equine Veterinary Journal 13:27-34.

Rubin, C., A. S. Turner, S. Bain, C. Mallinckrodt, and K. McLeod. 2001. Low mechanical signals strengthen long bones. Nature 412:603–604.

Rutberg, A. 2011. Re: Modified decision record, WY-040-EA11-124. Unpublished record of opinion.

Rutberg, A., K. Grams, J.W. Turner, and H. Hopkins. 2017. Contraceptive efficacy of priming and boosting does of controlled-release PZP in wild horses. Wildlife Research: http://dx.doi.org/10.1071/WR16123

Sacco, A.G., M.G. Subramanian, and E.C. Yurewicz. 1981. Passage of zona antibodies via placenta and milk following active immunization of female mice with porcine zonae pellucidae. Journal of Reproductive Immunology 3:313-322.

Salter, R. E. Biogeography and habitat-use behavior of feral horses in western and northern Canada. in

Symposium on the Ecology and Behaviour of Wild and Feral Equids 129–141 (1979).

Saltz, D., M. Rowen, and D. I. Rubenstein. 2000. The effect of space-use patterns of reintroduced Asiatic wild ass on effective population size. Conservation Biology 14:1852–1861.

Sarker, N., M. Tsudzuki, M. Nishibori, and Y. Yamamoto. 1999. Direct and correlated response to divergent selection for serum immunoglobulin M and G levels in chickens. Poultry Science 78:1-7.

Saunders, G., J. McIlroy, M. Berghout, B. Kay, E. Gifford, R. Perry, and R. van de Ven. 2002. The effects of induced sterility on the territorial behaviour and survival of foxes. Journal of Applied Ecology 39:56–66.

Scasta JD, Mortality and operational attributes relative to feral horse and burro capture techniques based on publicly available data from 2010-2019, *Journal of Equine Veterinary Science* (2020), doi: https://doi.org/10.1016/j.jevs.2019.102893.

Schaut, R.G., M.T. Brewer, J.M. Hostetter, K. Mendoza, J.E. Vela-Ramirez, S.M. Kelly, J.K. Jackman, G. Dell'Anna, J.M. Howard, B. Narasimhan, and W. Zhou. 2018. A single dose polyanhydride-based vaccine platform promotes and maintains anti-GnRH antibody titers. Vaccine 36:1016-1023.

Scholz-Ahrens, K. E., G. Delling, P. W. Jungblut, E. Kallweit, and C. A. Barth. 1996. Effect of ovariectomy on bone histology and plasma parameters of bone metabolism in nulliparous and multiparous sows. Zeitschrift für Ernährungswissenschaft 35:13–21.

Schulman, M.L., A.E. Botha, S.B. Muenscher, C.H. Annandale, A.J. Guthrie, and H.J. Bertschinger. 2013. Reversibility of the effects of GnRH-vaccination used to suppress reproductive function in mares. Equine Veterinary Journal 45:111-113.

Schumacher, J. 1996. Complications of castration. Equine Veterinary Education 8:254-259.

Schumacher, J. 2006. Why do some castrated horses still act like stallions, and what can be done about it? Compendium Equine Edition Fall:142–146.

Science and Conservation Center (SCC). 2015. Materials Safety Data Sheet, ZonaStat-H. Billings, Montana.

Scott, E. A., and D. J. Kunze. 1977. Ovariectomy in the mare: presurgical and postsurgical considerations. The Journal of Equine Medicine and Surgery 1:5–12.

Searle, D., A.J. Dart, C.M. Dart, and D.R. Hodgson. 1999. Equine castration: review of anatomy, approaches, techniques and complications in normal, cryptorchid and monorchid horses. Australian Veterinary Journal 77:428-434.

Seidler, R. G., and E. M. Gese. 2012. Territory fidelity, space use, and survival rates of wild coyotes following surgical sterilization. Journal of Ethology 30:345–354.

Shoemaker, R. W., E. K. Read, T. Duke, and D. G. Wilson. 2004. In situ coagulation and transection of the ovarian pedicle: an alternative to laparoscopic ovariectomy in juvenile horses. Canadian Journal of Veterinary Research 68:27-32.

Shoemaker, R., Bailey, J., Janzen, E. and Wilson, D.G., 2004. Routine castration in 568 draught colts: incidence of evisceration and omental herniation. Equine Veterinary Journal, 36:336-340.

Shumake, S.A. and G. Killian. 1997. White-tailed deer activity, contraception, and estrous cycling. Great Plains Wildlife Damage Control Workshop Proceedings, Paper 376.

Sigrist, I. M., C. Gerhardt, M. Alini, E. Schneider, and M. Egermann. 2007. The long-term effects of ovariectomy on bone metabolism in sheep. Journal of Bone and Mineral Metabolism 25:28–35.

Sigurjónsdóttir, H., M. C. Van Dierendonck, S. Snorrason, and A. G. Thorhallsdóttir. 2003. Social relationships in a group of horses without a mature stallion. Behaviour 140:783–804.

Skinner, S.M., Mills, T., Kirchick, H.J. and Dunbar, B.S., 1984. Immunization with Zona Pellucida Proteins Results in Abnormal Ovarian Follicular Differentiation and Inhibition of Gonadotropin-induced Steroid Secretion. Endocrinology, 115:2418-2432.

Smith, J. A. 1974. Proceedings: Masculine behaviour in geldings. The Veterinary Record 94:160–160.

Stout, T.A.E., J.A. Turkstra, R.H. Meloen, and B. Colenbrander. 2003. The efficacy of GnRH vaccines in controlling reproductive function in horses. Abstract of presentation from symposium, "Managing African elephants: act or let die? Utrecht University, Utrecht, Netherlands.

Thompson, D. L., Jr, B. W. Pickett, E. L. Squires, and T. M. Nett. 1980. Sexual behavior, seminal pH and accessory sex gland weights in geldings administered testosterone and(or) estradiol-17. Journal of Animal Science 51:1358–1366.

Turner, J.W, A.T. Rutberg, R.E. Naugle, M.A. Kaur, D.R.Flanagan, H.J. Bertschinger, and I.K.M. Liu. 2008. Controlled-release components of PZP contraceptive vaccine extend duration of infertility. Wildlife Research 35:555-562.

Turner, J.W., and J.F. Kirkpatrick. 2002. Effects of immunocontraception on population, longevity and body condition in wild mares (*Equus caballus*). Reproduction (Cambridge, England) Supplement, 60, pp.187-195.

Turner, J.W., I.K. Liu, A.T. Rutberg, and J.F. Kirkpatrick. 1997. Immunocontraception limits foal production in free-roaming feral horses in Nevada. Journal of Wildlife Management 61:873-880.

Turner, J.W., I.K. Liu, D.R. Flanagan, A.T. Rutberg, and J.F. Kirkpatrick. 2007. Immunocontraception in wild horses: one inoculation provides two years of infertility. Journal of Wildlife Management 71:662-667.

Turner, J.W., I.K. Liu, D.R. Flanagan, K.S. Bynum, and A.T. Rutberg. 2002. Porcine zona pellucida (PZP) immunocontraception of wild horses (*Equus caballus*) in Nevada: a 10 year study. Reproduction Supplement 60:177-186.

Turner, J.W., I.K.M. Liu, and J.F. Kirkpatrick. 1996. Remotely delivered immunocontraception in free-roaming feral burros (*Equus asinus*). Journal of Reproduction and Fertility 107:31-35.

Twigg, L. E., T. J. Lowe, G. R. Martin, A. G. Wheeler, G. S. Gray, S. L. Griffin, C. M. O'Reilly, D. J. Robinson, and P. H. Hubach. 2000. Effects of surgically imposed sterility on free-ranging rabbit populations. Journal of Applied Ecology 37:16–39.

Tyler, S. 1972. The behaviour and social organisation of the New Forest ponies. Animal Behaviour Monographs 5:85–196.

Van Dierendonck, M. C., H. De Vries, and M. B. H. Schilder. 1995. An analysis of dominance, its behavioural parameters and possible determinants in a herd of Icelandic horses in captivity. Journal of Zoology 45:362–385.

Van Dierendonck, M. C., H. De Vries, M. B. H. Schilder, B. Colenbrander, A. G. Þorhallsdóttir, and H. Sigurjónsdóttir. 2009. Interventions in social behaviour in a herd of mares and geldings. Applied Animal Behaviour Science 116:67–73.

Van Dierendonck, M. C., H. Sigurjónsdóttir, B. Colenbrander, and A. G. Thorhallsdóttir. 2004. Differences in social behaviour between late pregnant, post-partum and barren mares in a herd of Icelandic horses. Applied Animal Behaviour Science 89:283–297.

Vinke, C. M., R. van Deijk, B. B. Houx, and N. J. Schoemaker. 2008. The effects of surgical and chemical castration on intermale aggression, sexual behaviour and play behaviour in the male ferret (Mustela putorius furo). Applied Animal Behaviour Science 115:104–121.

Wang-Cahill, F., J. Warren, T. Hall, J. O'Hare, A. Lemay, E. Ruell, and R. Wimberly. In press. Use of GonaCon in wildlife management. Chapter 24 in USDA-APHIS, Human health and ecological risk assessment for the use of wildlife damage management methods by APHIS-Wildlife Services. USDA APHIS, Fort Collins, Colorado.

Webley, G. E., and E. Johnson. 1982. Effect of ovariectomy on the course of gestation in the grey squirrel (*Sciurus carolinensis*). Journal of Endocrinology 93:423–426.

Wright, S. 1931. Evolution in Mendelian populations. Genetics 16:97-159

Yao, Z., W. Si, W. Tian, J. Ye, R. Zhu, X. Li, S. Ki, Q. Zheng, Y. Liu, and F. Fang. 2018. Effect of active immunization using a novel GnRH vaccine on reproductive function in rats. Theriogenology 111:1-8. https://doi.org/10.1016/j.theriogenology.2018.01.013

Yoder, C.A. and L.A. Miller. 2010. Effect of GonaCon™ vaccine on black-tailed prairie dogs: immune response and health effects. Vaccine 29:233-239.

Zhang, Y., W.-P. Lai, P.-C. Leung, C.-F. Wu, and M.-S. Wong. 2007. Short- to Mid-Term Effects of Ovariectomy on Bone Turnover, Bone Mass and Bone Strength in Rats. Biological and Pharmaceutical Bulletin 30:898–903.

Zoo Montana. 2000. Wildlife Fertility Control: Fact and Fancy. Zoo Montana Science and Conservation Biology Program, Billings, Montana.

Appendix H. Standard Stipulations and Mitigation Measures

1. Fire and Fuels

1.1. Compliance with fire restrictions is mandatory while fire restrictions are in effect (43 CFR 9212). Fire restrictions are generally enacted May through October. Fire restriction orders are available for review at BLM district offices and on the BLM website. Contact the Southern Nevada District Office on current fire danger two weeks prior to ground activities.

1.2. The use of standard fire prevention measures should be practiced at all times (43 CFR 2805.12). Conditions that support wildfires can occur any time of the year in Southern Nevada.

1.3. All wildfires are to be immediately reported to the Las Vegas Interagency Communication Center at (702) 631-2350 and the appropriate the NTTR liaison. Accommodations to allow immediate safe entry of firefighting apparatus and personnel are required as allowed and authorized by the USAF. The BLM provides wildfire response to the NTTR.

1.4. An Origin and Cause Investigation will be carried out on any human caused fire by BLM law enforcement or their designated representative and the USAF. To minimize disturbance of potential evidence located at the fire scene, the applicant/proponent shall properly handle and preserve evidence in coordination with the BLM. The BLM shall pursue cost recovery for all costs and damages incurred from human-caused fires on when the responsible party(s) has been identified and evidence of legal liability or intent exists. Legal liability includes, but is not limited to, negligence and strict liability (including statutory and contractual liability), products liability, etc.

2. Invasive Species and Noxious Weeds

2.1. The Proponent will keep their project area free of state-listed noxious weeds to the extent practicable. The Proponent shall perform monitoring for invasive species/noxious weeds during field activities. Any detections of noxious weeds should be reported to the SNDO Weed Management Specialist immediately (702-515-5000) to determine the best course action.

2.2. In order to reduce the accidental spread of noxious weeds, the Proponent and/or any contractors shall avoid or minimize all types of travel through a state listed noxious weed-infested areas that can be carried to the project area. In order to minimize the threat of spreading noxious weeds project-related equipment (i.e. undercarriages and wheel wells) should be cleaned of all mud, dirt, and plant parts before moving into relatively weed-free areas or out of relatively weed-infested areas. Project workers shall inspect, remove, and dispose of weed seed and plant parts found on their clothing and personal equipment, bag the product, and dispose of it in a dumpster. If you have questions, consult with the BLM SNDO noxious weed coordinator.

2.3. During Project activities the Proponent shall:

2.3.1. Inspect the Project Area for noxious weeds prior to any ground disturbance.

2.3.2. Limit the size of any vegetation and/or ground disturbance to the absolute minimum necessary to perform the activity safely and as designed.

2.3.3. Begin activities in weed free areas whenever feasible before operating in weed-infested areas.

2.3.4. Locate equipment storage, machine and vehicle parking or any other area needed for the temporary placement of people, machinery and supplies in areas that are relatively weed-free.

2.3.5. Avoid or minimize all types of travel through weed-infested areas or restrict major activities to periods of time when the spread of seed or plant parts are least likely.

2.3.6. Use hay or feed that is certified weed free.

3. MIGRATORY BIRD MITIGATION MEASURES

3.1. Trap sites will not be set up near known populations of sensitive species, or in riparian areas, or within Wilderness Study Areas (WSA). In order to avoid potential impacts to breeding migratory birds from gather sites, a nest survey would be conducted by a biologist familiar with birds of the area, within potential breeding habitat prior to any surface disturbance proposed during the avian breeding season (March 1st through August 31st). Surveys must be conducted a maximum of three (3) days prior to disturbance and are valid for only 3 days. If 3 days from the time of the survey pass, the area must be surveyed again.

3.2. All active nests are to be protected until the nest is either abandoned (due to the birds own will) or the nestlings fledge (fledge in this instance means to be no longer dependent on the nest). This includes active nests found outside the breeding season, as well as nests found after construction activities have begun.

3.3. Protecting active nests involves establishing disturbance-free buffers within which activities are restricted. Buffer distances are determined by species biology, susceptibility to disturbance, and temperament. Example buffer distances for various species are listed in the BLM’s Southern Nevada Nesting Bird Management Plan (2019).