SH 83: Bayou Gulch to El Paso County
Line MP 30.20 – MP 53.88
Project Code 23008

Appendix I - Wildlife Movement Technical Memorandum

Prepared for:

COLORADO
Department of Transportation

DOUGLAS COUNTY
COLORADO

Prepared by:

Pinyon
Environmental, Inc.

August 5, 2022

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION AND PROJECT BACKGROUND

The Colorado Department of Transportation (CDOT) is conducting a Safety and Operations Analysis on State Highway (SH) 83 in Douglas County from Bayou Gulch Road to El Paso County Line/Palmer Divide Avenue (Project). As a companion assessment, this Wildlife Movement Technical Memorandum (Memo) investigates opportunities to potentially enhance wildlife movement/passage across SH 83 approximately between mile posts (MPs) 30-54 (study area). The study area consists of the roadway itself and adjacent habitats. The Project is dedicated to following federal, state, and local regulations as they pertain to protecting wildlife and their habitats. Regulations are outlined in this Memo.

Information herein is based on desktop assessments. Once Project designs have been completed, it is recommended that site surveys occur to verify the information herein. Once field verification has been completed, Project personnel (non-agency [e.g., biologists, engineers] and agency [e.g., Colorado Parks and Wildlife (CPW), US Fish and Wildlife Service (USFWS), CDOT, and Douglas County]) should collaborate closely to identify the best and most feasible mitigation strategies for the Project as they relate to wildlife movement/passage.

FEDERAL, STATE, AND LOCAL REGULATIONS

Several regulations are in place to protect wildlife and their habitats that may occur within the Project area. Wildlife discussed in this Memo may be protected by the following regulations and policies:

- Colorado Executive Order D2019011 – Requires that "*CDOT shall enable safe wildlife passage and reduce wildlife-vehicle collisions and incorporate consideration of big gamemigration into all levels of its planning process, to the greatest extent possible* (Polis, 2019)". As part of the Executive Order, CDOT and CPW entered into a Memorandum of Agreement to outline expectations for collaboration on certain transportation projects that may affect wildlife (e.g., identify priority areas for wildlifecrossings along Colorado roadways).
- *The Endangered Species Act of 1973 (ESA)* – The ESA protects federally listed plant and animal species with the goal of ensuring their long-term survival and recovery (16 United States Code [USC] §1531-1543). Section 7 of the ESA charges federal agenciesto aid in the conservation of listed species and requires the agencies to ensure that theiractivities are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitats [Section 7 (a) (1 and 2)]. The ESA is administered by the USFWS.
- *The Colorado Nongame, Endangered, and Threatened Species Conservation Act* –The Conservation Act provides some protection within the state for listed species and establishes the State of Colorado's intent to protect endangered, threatened, and rare species (Colorado Revised Statutes Annotated § 33-2-101-108) (CPW, 2015b). Under the Conservation Act, Colorado law provides for the acquisition of habitat for species listed, as well as other protective measures. CPW is responsible for listing state species.
- *State Wildlife Action Plan (SWAP)*– Under this plan, **"**The Commerce, Justice and State Appropriations Act of Fiscal Year 2001, Title IX, Public Law 106-553 created the Wildlife Conservation and Restoration Program (WCRP), designed to provide funding for the conservation needs of wildlife, as well as for education and wildlife-related recreation. The WCRP was only funded for one year. A second act, the Department of the Interior and Related Agencies Appropriations Act of 2002, Public Law 107-63, Title 1, created a State Wildlife Grants program (SWG), which provides annual funding for conservation ofwildlife and wildlife habitats. The SWG requires that each state prepare and adopt a SWAP to remain eligible for SWG funding. This SWAP meets Colorado's obligation under this law" (CPW, 2015a).
- ***Douglas County's 2040 Comprehensive Master Plan*** – Section 9 - Wildlife, proposesnumerous policies and objectives to allow for development while minimizing impacts to wildlife, wildlife habitat, and wildlife movement (Douglas County, 2019).
- ***Douglas County's 2030 Parks, Trails, and Open Space (OS) Master Plan*** – In Section 5, Goals, Objectives, and Policies, Goal OS 3 proposes objectives (such as objectives OS 3D-F) to improve, protect,

and manage wildlife and wildlife habitat locatedin county open space through conservation and management practices (Douglas County, 2012).

- *Habitat Conservation Plan (HCP) and Environmental Assessment for Douglas County and the Towns of Castle Rock and Parker* – This is a specific HCP that pertains to Preble's meadow jumping mouse (*Zapus hudsonius preblei;* PMJM), a species listed as threatened at the state and federal level (Douglas County, 2006).

DATA GATHERING

To analyze the landscape for potential wildlife use within the study area, Pinyon Environmental Inc. (Pinyon), assessed potential habitat and wildlife movement patterns using publicly available data, including:

- *CDOT Wildlife-Vehicle Collision (WVC) Data* – CDOT has provided carcass data, and traffic and safety data to help identify WVCs occurring along SH 83 approximately between MPs 30-54 (CDOT, 2020a; CDOT, 2021). Carcass data are collected by CDOT maintenance crews as they remove carcasses from roadways. Traffic and safety data are received from the Colorado Department of Revenue where accident reports from state law enforcement agencies are compiled. Pinyon analyzed the data provided to generate Project-specific information(e.g., created a map to show WVCs within the study area; determined costs of WVCs withinthe study area). Pinyon prepared two figures displaying WVCs within the study area (one displays traffic and safety data, the other displays maintenance crews' data). Not all WVCs get reported; therefore, WVCs noted herein are an unknown percentage of the actual WVCs that have occurred within the study area.
- *CDOT Online Transportation Information System (OTIS) Data* – Pinyon reviewed CDOT OTIS data to determine identification numbers and additional information, such as photographs, built years, and structure classifications, for existing underpasses and overpasses within the study area.
- *CPWs Species Activity Mapping (SAM) Data* – SAM data is readily available data that displays approximate species occurrences within Colorado's landscape. Pinyon analyzed data for specific species that are either assumed or known to occur within the study area (CPW, 2019). SAM data were pulled for species that have been involved in WVCs within the study area (CDOT, 2020a; CDOT 2021). Pinyon prepared figures displaying species-specific concentrations/movements within the study area.
- *Douglas County Wildlife Maps* – Pinyon analyzed the following maps to assess wildlife habitat and potential movement corridors:
    - Map 9.1 Wildlife Resources map (Douglas County, 2019). This map includes relevant wildlife information including overland connection areas, wildlife movement corridors, habitat values by area, wildlife crossing areas, etc.
    - Douglas County's Riparian Conservation Zone (RCZ) map (i.e., PMJM habitat limits) (Douglas County, 2021).
- *Aerial imagery* – Pinyon analyzed aerial imagery such as Google Earth for Project-specific information (e.g., topography, vegetation) (Google, 2022).

CURRENT WILDLIFE CONDITIONS

Wildlife is essential to Colorado's economy. To help protect wildlife populations and provide safer travel corridors for drivers, mitigation is often required to reduce WVCs. This section describes current conditions within the study area regarding wildlife habitat, wildlife movement, and WVCs.

LANDSCAPE AND VEGETATION

The study area is in a rural area, mainly consisting of scattered residential properties and private lands. Castlewood Canyon State Park, as well as multiple Douglas County Open Space properties (e.g., Bayou Gulch Bridges [two], Hidden Mesa, Lincoln Mountain, and Prairie Canyon Ranch) also occur along and/or adjacent to, the study area. The Town of Franktown is located within the northern half of the study area.

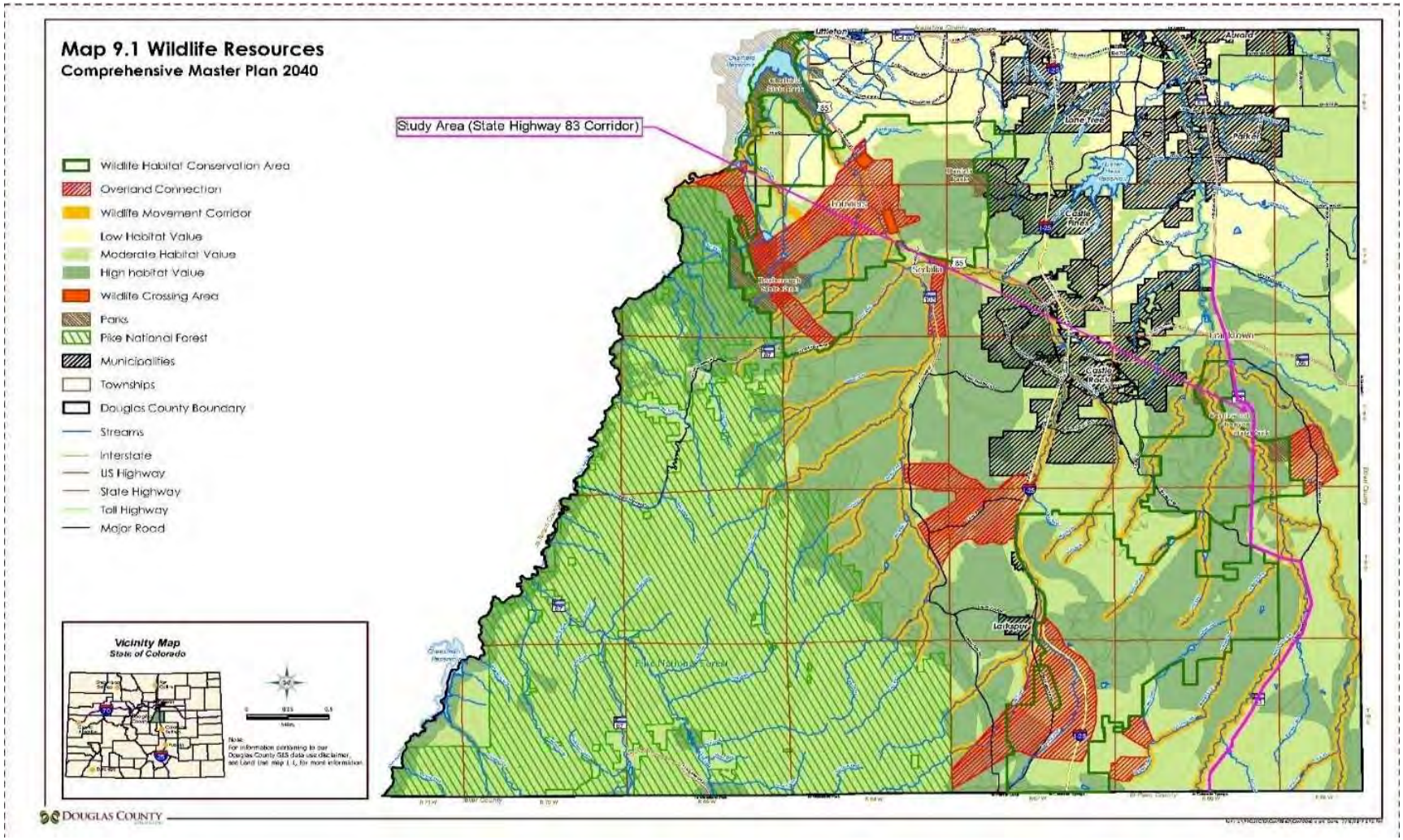
Based on aerial imagery (e.g., Google Earth), several streams (e.g., Cherry Creek and several of its tributaries) are located within and/or adjacent to the study area. Although a site visit was not conducted for the Project, imagery suggests that the area consists of upland, riparian, and wetland habitats. Some vegetation visible on Google Earth includes short-to-tall grasses (e.g., smooth brome [*Bromus inermis*]), and some hydrophytic vegetation near/along streams (e.g., reed canary grass [*Phalaris arundinacea*], cattail [*Typha* spp.]), shrubs (e.g., Gambel oak [*Quercus gambelii*], coyote willow [*Salix exigua*]), and trees such as Ponderosa pine (*Pinus ponderosa*). In conjunction with the vegetation observed, habitats within and adjacent to the study area include, but are not limited to, shortgrass prairie; riparian and wetland corridors; upland shrublands; forests; and rocky out-crops. These habitat types provide habitat for many species of wildlife as they provide food, water, and/or sanctuary.

Habitat within the landscape was once contiguous; however, due to the construction of SH 83 and other development, current conditions restrict the safe passage for most wildlife across SH 83. Because of this, WVCs occur frequently within the study area, presenting a challenge for both drivers and wildlife within the corridor.

Several bridges and culverts are located within the study area. Given the flatter terrain/topography along much of the corridor, most culverts are likely small to medium sized, providing limited opportunity for most large mammals (e.g., mule deer [*Odocoileus hemionus*] and elk [*Cervus canadensis*]) to cross under the highway. Wildlife exclusion fencing (wildlife fencing) does not occur within the study area.

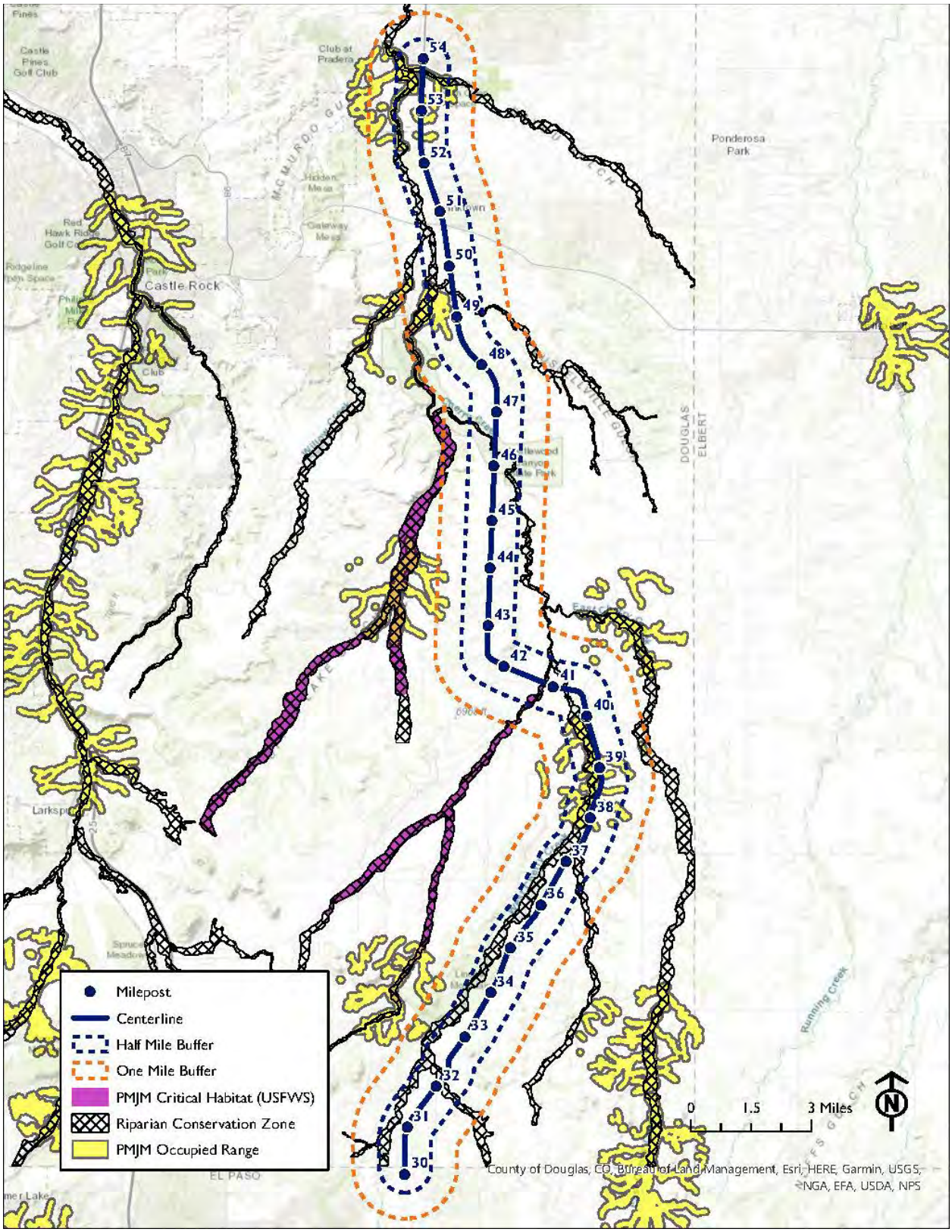
Per the Douglas County 2040 Comprehensive Master Plan (CMP), protection of wildlife habitat and movement corridors is critical to the support of healthy wildlife populations (Douglas County, 2019). As shown on *Map 9.1 Wildlife Resources* in the CMP (displayed in Figure 1 below), the study area intersects defined wildlife movement corridors, is noted to have "high" and "moderate" wildlife habitat value and crosses a Wildlife Habitat Conservation Area (Castlewood Canyon State Park). In general, the mapped wildlife movement corridors within/near the SH 83 corridor occur along the following streams (in approximate order from north to south): Willow Creek, Cherry Creek, Russellville Gulch, Lake Gulch, Upper Lake Gulch, West Cherry Creek, East Cherry Creek, Antelope Creek, and Iron Gulch. With the exception of Iron Gulch, these movement corridors are also mapped within the County-designated RCZ, which are designated areas where potential PMJM habitat occurs. The USFWS "considers areas within the RCZ to be an approximation of potential habitat for the mouse on non-Federal lands within Douglas County…critical habitat and the RCZ overlap but they are distinct" (Douglas County, 2021). Figure 2 shows mapped critical and occupied habitat for PMJM, as well as the RCZ boundary within/near the study area.

Figure 1 – Map 9.1, Wildlife Resources



Source: Douglas County, 2019

Figure 2 – Preble's Meadow Jumping Mouse Habitat



Source: Pinyon Environmental, Inc (CPW, 2019; Douglas County, 2021; USFWS, 2022)

WILDLIFE AND THEIR MOVEMENTS

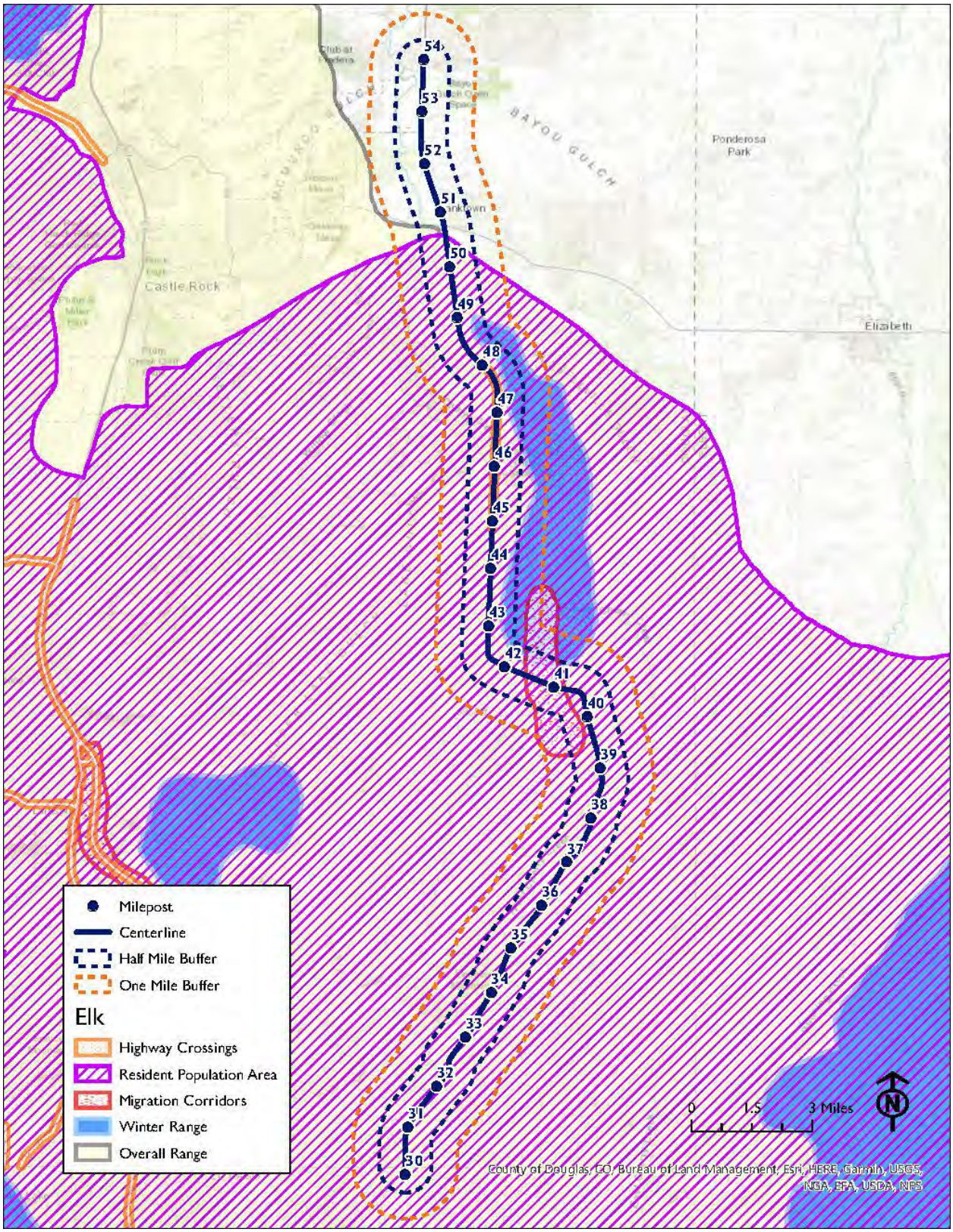
Ungulates and other large mammals known to occur within the study area include, but are not limited to, elk, mule deer, white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), mountain lion (*Puma concolor*), and pronghorn (*Antilocapra americana*). Other smaller mammals anticipated and/or known to occur within the study area include, but are not limited to, coyotes (*Canis latrans*), red foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), North American beavers (*Castor canadensis*), and PMJM.

Most of the large mammal species known to occur within the corridor are believed to be local populations, occupying habitats within and near the project corridor year-round. Figures 3-7 display SAM data for the larger wildlife species, including elk, mule deer, white-tailed deer, black bear, and pronghorn, that have been involved in WVCs within the study area. While many of these animals cross SH 83 throughout the year, CDOT traffic and safety data indicate some seasonality to WVCs, with collisions peaking in spring/summer (May through July) and fall (October and November) (CDOT, 2020a). Factors that drive wildlife to cross SH 83 are likely diversity in habitats (i.e., other sources of food, water, and sanctuary) and for mating and/or rearing purposes.

Most species that reside within the study area likely concentrate their movements along stream/drainage systems (e.g., Cherry Creek) and/or forested habitats; however, species like pronghorn tend to spend most of their time in more open country. Streams and forested habitats typically provide wildlife with food and/or water as well as better cover and sanctuary from weather and/or predators. Also, many of these species are more active during twilight (i.e., dawn and dusk) and nighttime hours, making it difficult for drivers traveling at high speeds to see wildlife on or near the roadway.

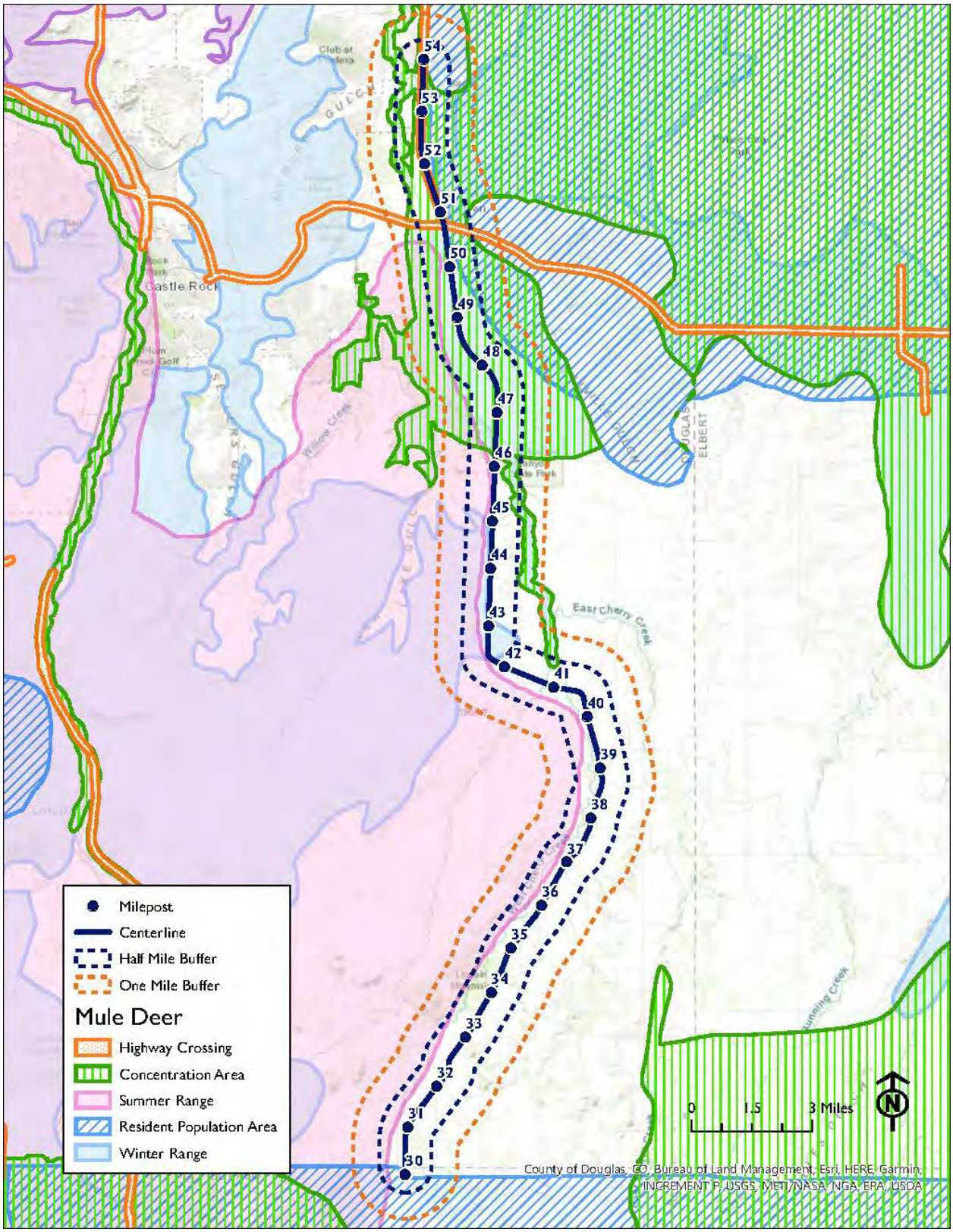
There are multiple structures within the study area that may provide safe passage for ungulates (e.g., bridges over Cherry Creek and Antelope Creek). In addition, there are several small-to-medium sized culverts that may provide safe passage for other species of wildlife (e.g., bears, coyotes, raccoons, mice). However, without an effective system that combines the use of functional crossing structures with wildlife fencing, these bridges and culverts will not be as effective as they could be. Areas where wildlife mitigation could be effective within the study area are discussed in the Mitigation Recommendations section below.

Figure 3 – Elk Range



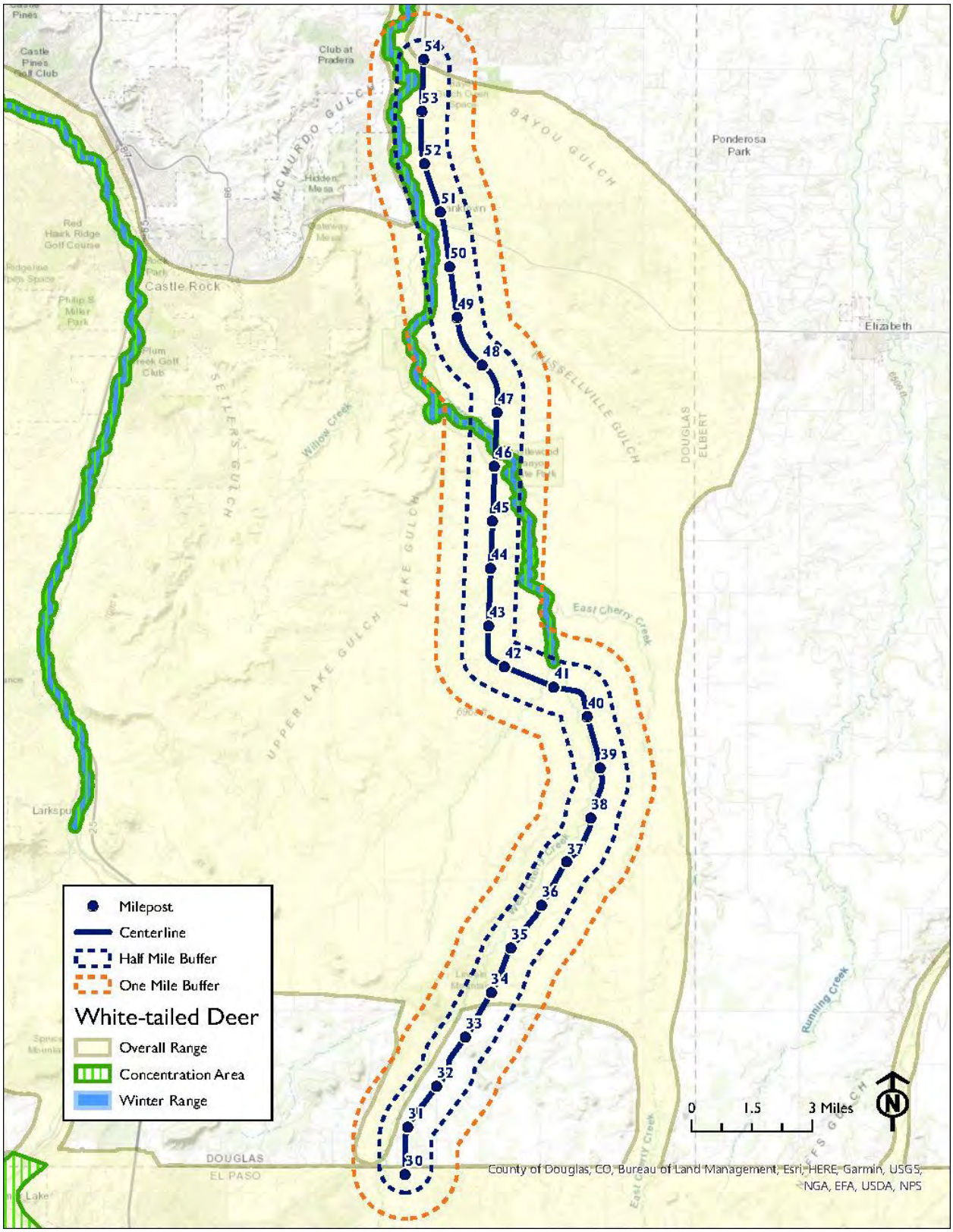
Source: Pinyon Environmental, Inc. (CPW, 2019)

Figure 4 – Mule Deer Range



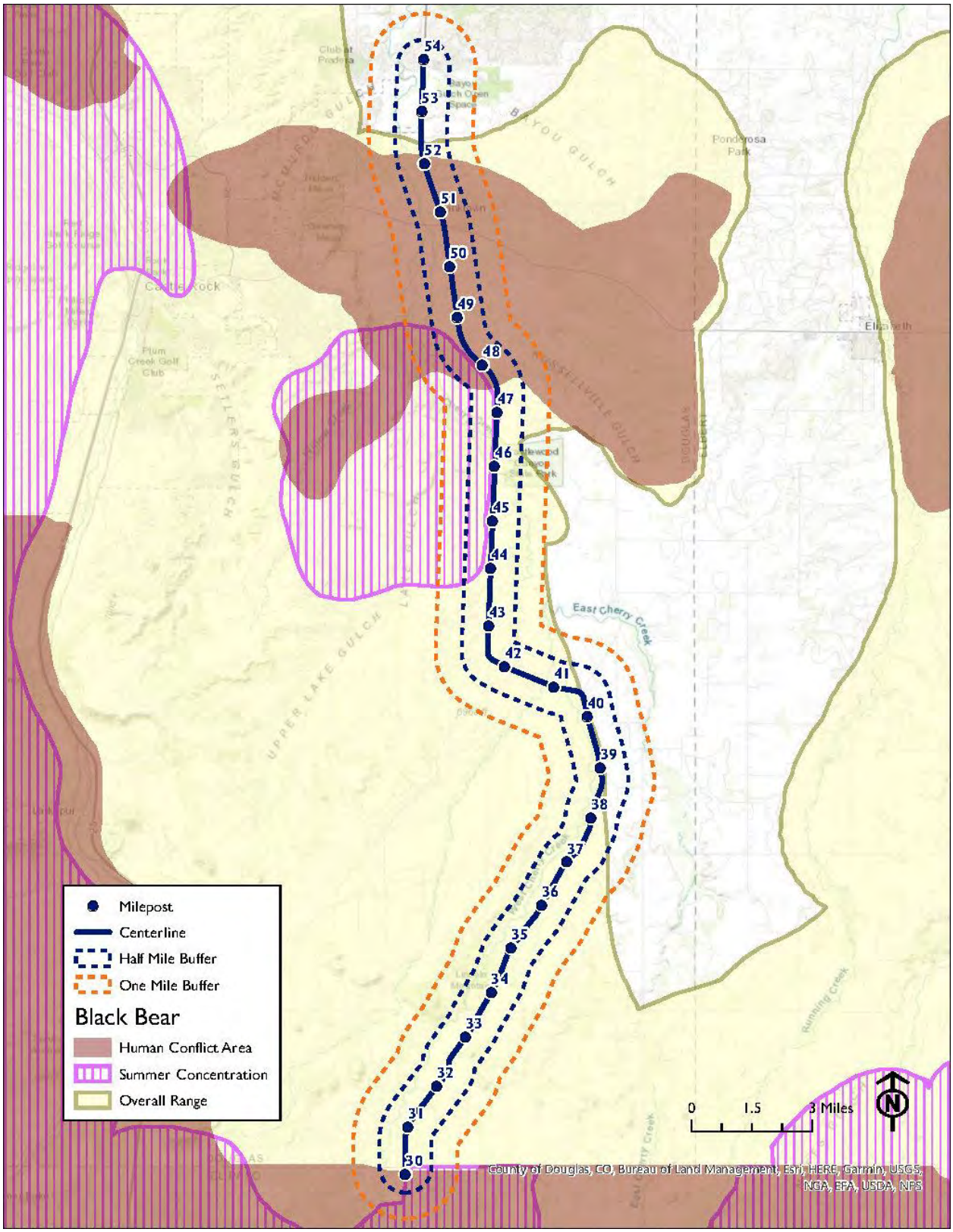
Source: Pinyon Environmental, Inc. (CPW, 2019)

Figure 5 – White-tailed Deer Range



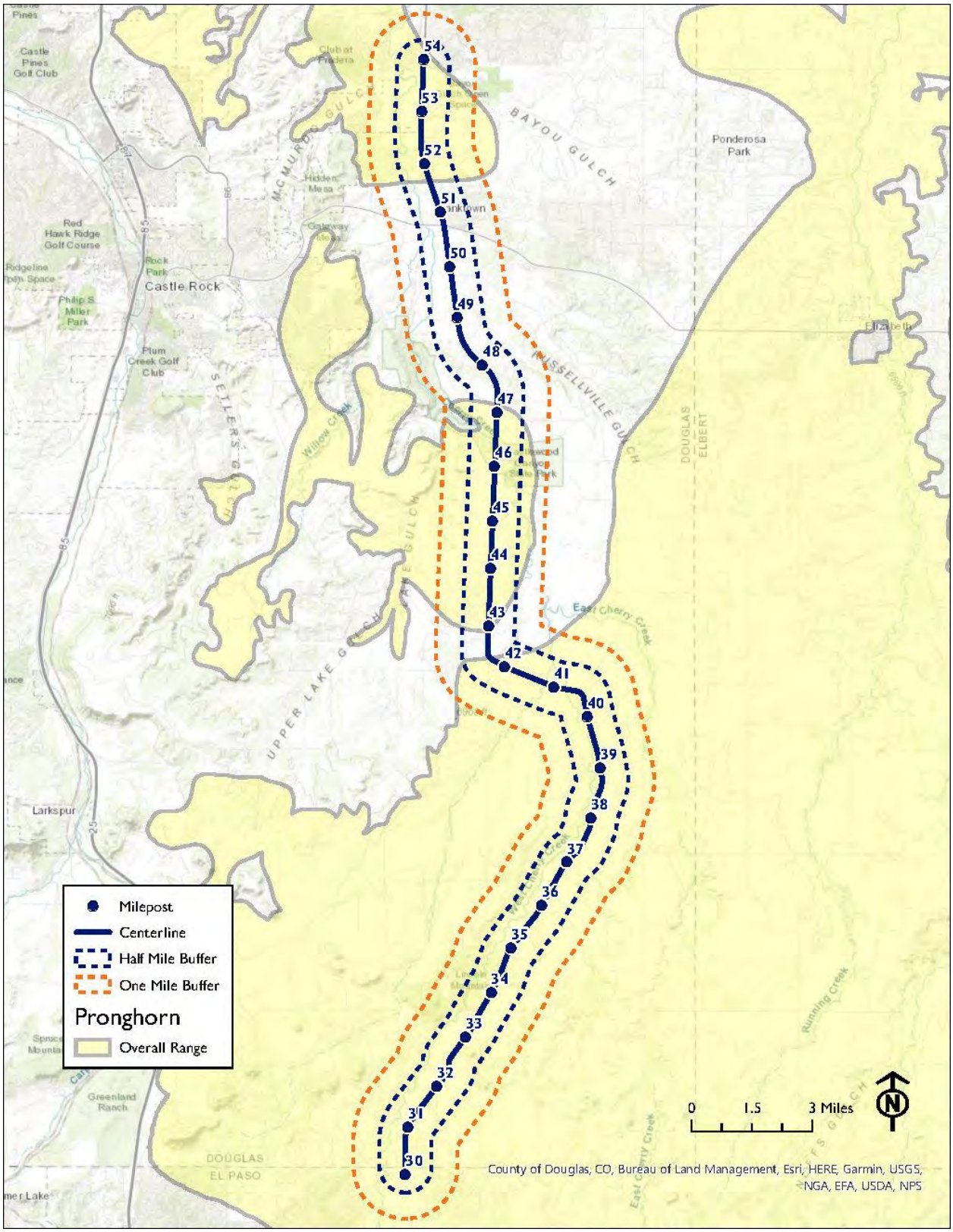
Source: Pinyon Environmental, Inc. (CPW, 2019)

Figure 6 – Black Bear Range



Source: Pinyon Environmental, Inc. (CPW, 2019)

Figure 7 – Pronghorn Range

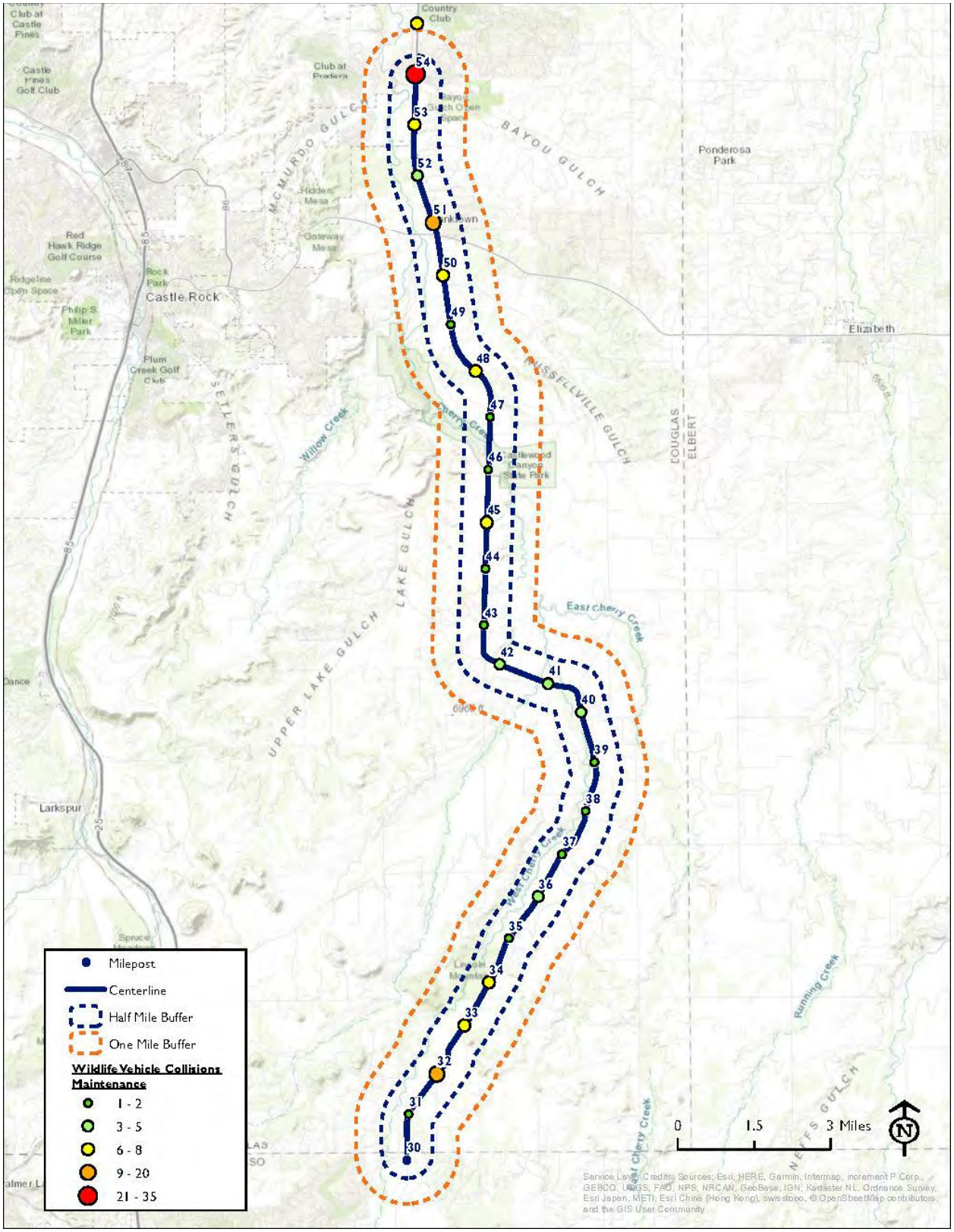


Source: Pinyon Environmental, Inc. (CPW, 2019)

WILDLIFE-VEHICLE COLLISIONS ON SH 83

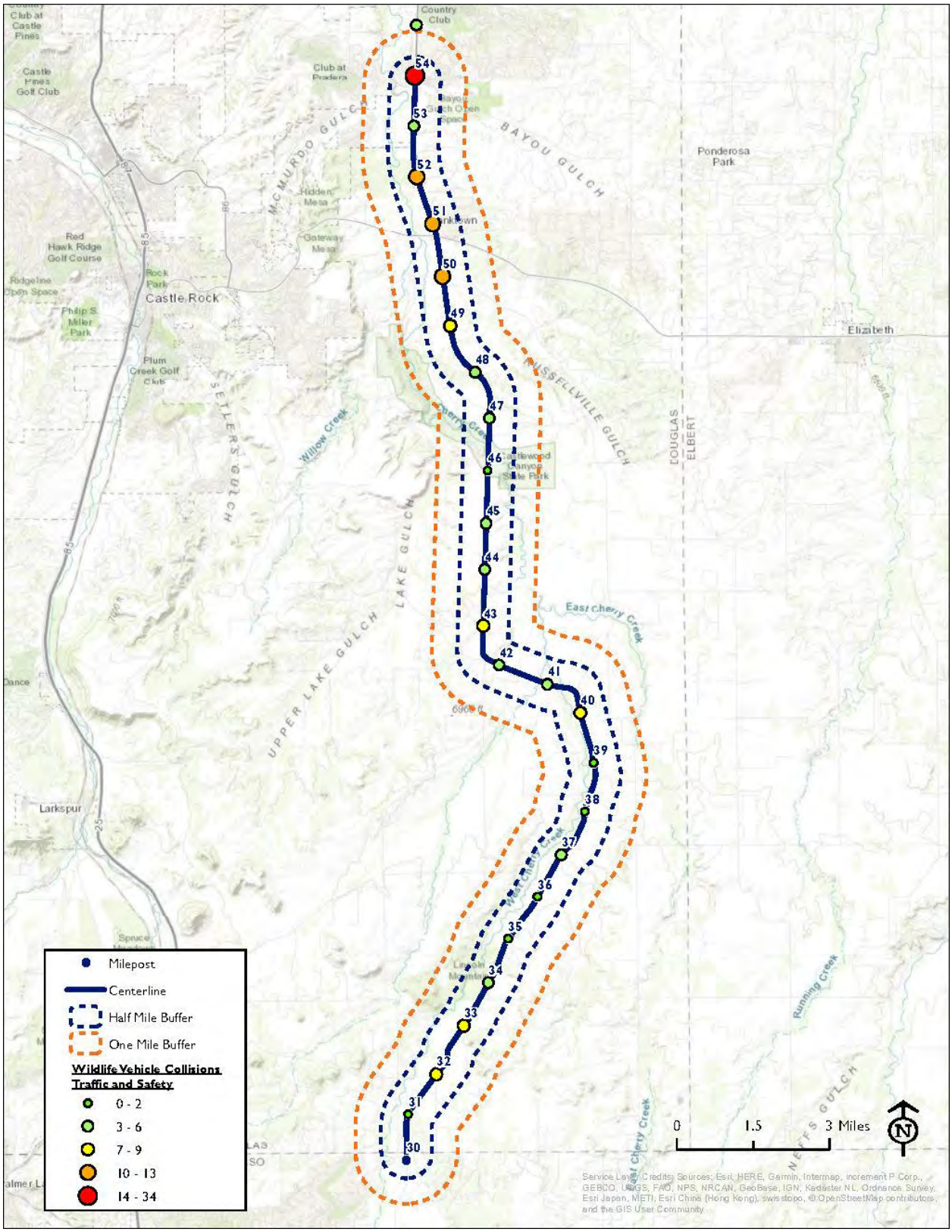
Because the study area does not currently have an effective system for wildlife movement (i.e., wildlife crossings, fencing, escape ramps, and guards [wildlife system]), the majority of wildlife must cross SH 83 at-grade. As part of the Project, certain areas of the SH 83 corridor may be expanded (e.g., adding turning lanes, widening shoulders); thus, permeability for wildlife movement will decrease further. Because of this, WVCs are likely to continue to occur and/or increase throughout the corridor, which endangers wildlife and drivers (and passengers) using the corridor. Figures 8 and 9 show WVCs that have occurred along the SH 83 corridor between MP 30-54.

Figure 8 – Wildlife Vehicle Collisions, Maintenance Crews' Carcass Data (2016 – 2021)



Source: Pinyon Environmental, Inc. (CDOT, 2021)

Figure 9 – Wildlife Vehicle Collisions, CDOT Traffic and Safety Data (2010 – 2020)



Source; Pinyon Environmental, Inc. (CDOT, 2020a)

Per CDOT data, between MPs 30-54, 320 WVCs were recorded between 2010 and 2021 (this number includes CDOT maintenance data [2016-2021] and traffic and safety data [2010-2020]) (CDOT, 2020a; CDOT, 2021). Of these WVCs, 169 were reported to law enforcement (traffic and safety data). These 169 WVCs resulted in 33 human injuries and 146 property damage incidents (CDOT, 2020a). No human fatalities resulted in the reported incidents. Reported data within the study area are presented in Table 1.

Table 1 – Number of Reported WVCs between MP 30-54, 2010-2020

Species Involved	Number of Animals Involved	Number of Vehicles Involved	*Crash Severity - Human			
			Fatality	Injury	Property Damage Only	Totals
Bear	1	1	0	0	1	1
Deer	137	138	0	21	169	123
Coyote	1	1	0	0	1	1
Elk	20	23	0	7	24	16
Pronghorn	6	6	0	5	5	5
Totals	165	169	0	33	146	179

Notes: "Deer" represents a combined number for mule deer and white-tailed deer. Data is from CDOT Traffic and Safety Data (CDOT, 2020a).

Per reported WVC data, deer were involved in most of the incidents within the study area (138 WVCs), followed by elk (23 WVCs) (CDOT, 2020a; Table 1). Per CDOT maintenance data, 108 deer and 15 elk carcasses were removed from the roadway (among other species) (CDOT, 2021). It is likely that deer and elk WVCs are reported more frequently than smaller species (e.g., coyotes) within the corridor because (1.) the corridor lacks wildlife crossings large enough for deer and elk to safely cross the roadway and (2.) drivers aren't reporting incidents with smaller wildlife due to less property/vehicle damage and/or injury. Although deer collisions are significantly higher than collisions with other species, the percentage of human injuries associated with elk and pronghorn are comparatively much higher. For example, per reported WVC data for MP 30-54 from 2010-2020, deer collisions resulted in a 15 percent injury rate, whereas elk collisions resulted in a 35 percent injury rate and pronghorn collisions resulted in an 83 percent injury rate (CDOT, 2020a).

Reported WVCs generally increased from 2010 through 2020, which may be attributed to a variety of factors, including but not limited to increased traffic in the area (CDOT, 2020a). Certain areas within the study area have more WVCs than others (Figure 8; Figure 9). In general, higher numbers of WVCs have been documented in areas where natural funnels (e.g., drainages, breaks in topography) occur. These areas often have denser habitat, which likely provides higher quality food, water, and shelter. For example, the high number of WVCs that occur near MP 54 may be attributed to the proximity of Cherry Creek and Bayou Gulch to the highway and surrounding habitat (e.g., Bayou Gulch Open Space and golf courses). As shown on aerial imagery of the corridor (e.g., Google Earth), SH 83 divides habitats on the west and east sides of the roadway (Google, 2022). Because the existing SH 83 alignment does not currently have an effective system for wildlife movement (i.e., a wildlife system), there is no choice for wildlife but to cross SH 83 at-grade.

WILDLIFE VEHICLE COLLISION COSTS

WVCs have direct and indirect costs in terms of driver safety, collision costs, and the ecological consequences to wildlife populations. As noted above, 169 WVCs were reported between MPs 30-54 between 2010 and 2020. Table 2 provides direct costs of WVCs for the corridor between those dates. Information provided in Table 2 is based on CDOT's assessment of the average economic costs of vehicular collisions (CDOT, 2020b). These cost estimates include wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers' uninsured costs.

Table 2 – Direct Costs Associated with Reported WVCs between MPs 30-54

Crash Severity	Number of Crashes	Cost per Crash	Total Cost
Human Fatality	0	$1,820,600	$0
Human Injury (includingdisabling and non-disabling)	33	$101,800	$3,359,400
Property Damage Only	146	$11,100	$1,620,600
Totals	179	-	$4,980,000

Sources: CDOT, 2020a; CDOT, 2020b, CDOT et al., 2021

Table 3 provides direct costs associated with wildlife values for deer, elk, and pronghorn for reported WVCs between MPs 30-54 between 2010-2020 (CDOT, 2020a; CDOT et al, 2021). These cost/value estimates relate to hunting expenses only, and are an average estimate based on annual resident and non-resident hunter expenditures (e.g., costs for consumer surplus/equipment, hunting licenses, and travel expenses). Values for other wildlife species have not yet been determined by the state. Costs noted in Table 3 are likely underestimated, as they may not include all costs/values of wildlife loss to Colorado's economy. Further, not all WVCs get reported. Therefore, estimated costs noted are likely a percentage of the actual cost associated with WVCs in area.

Table 3 – Direct Costs Associated with Wildlife Value for Reported WVCs between MPs 30-54

Species Involved	Number of Animals	Cost per Animal (Species)	Total Cost
Deer	137	$2,178	$298,386
Elk	20	$2,537	$50,740
Pronghorn	6	$2,106	$12,636
Totals	233	-	$361,762

Sources: CDOT, 2020a; CDOT et al., 2021

MITIGATION RECOMMENDATIONS

To help reduce WVCs along the Project corridor, the Project should consider implementing a wildlife system (i.e., a system that utilizes wildlife crossing[s], wildlife fence, wildlife escape ramps, wildlife guards, and wildlife signage). The system would assist in reestablishing habitat connectivity for wildlife by providing access to habitats on both sides of the roadway. For this system to be successful, designated wildlife crossing structures must facilitate the safe passage of large ungulates that are known to use the area. Because deer and elk utilize habitat along most of the corridor, recommended design options for wildlife crossings (i.e., overpasses or underpasses) should be geared towards span bridges and/or prefabricated arch structures, where feasible, as they can be made larger than most other structure types (e.g., concrete box culverts [CBCs]). Elk are often reluctant to utilize smaller crossing structures; therefore, the larger the opening/crossing, the more likely elk would be to utilize it. For elk to use underpasses, it is recommended that the structures be at least 12-feet-high and 30-feet-wide (Wildlife Consulting Resources and Felsburg, Holt, and Ullevig, 2014). Other larger species of wildlife (e.g., deer, pronghorn, bear), as well as small-to-medium sized wildlife (e.g., coyote, raccoon, mice), would also be expected to use larger structures, if constructed.

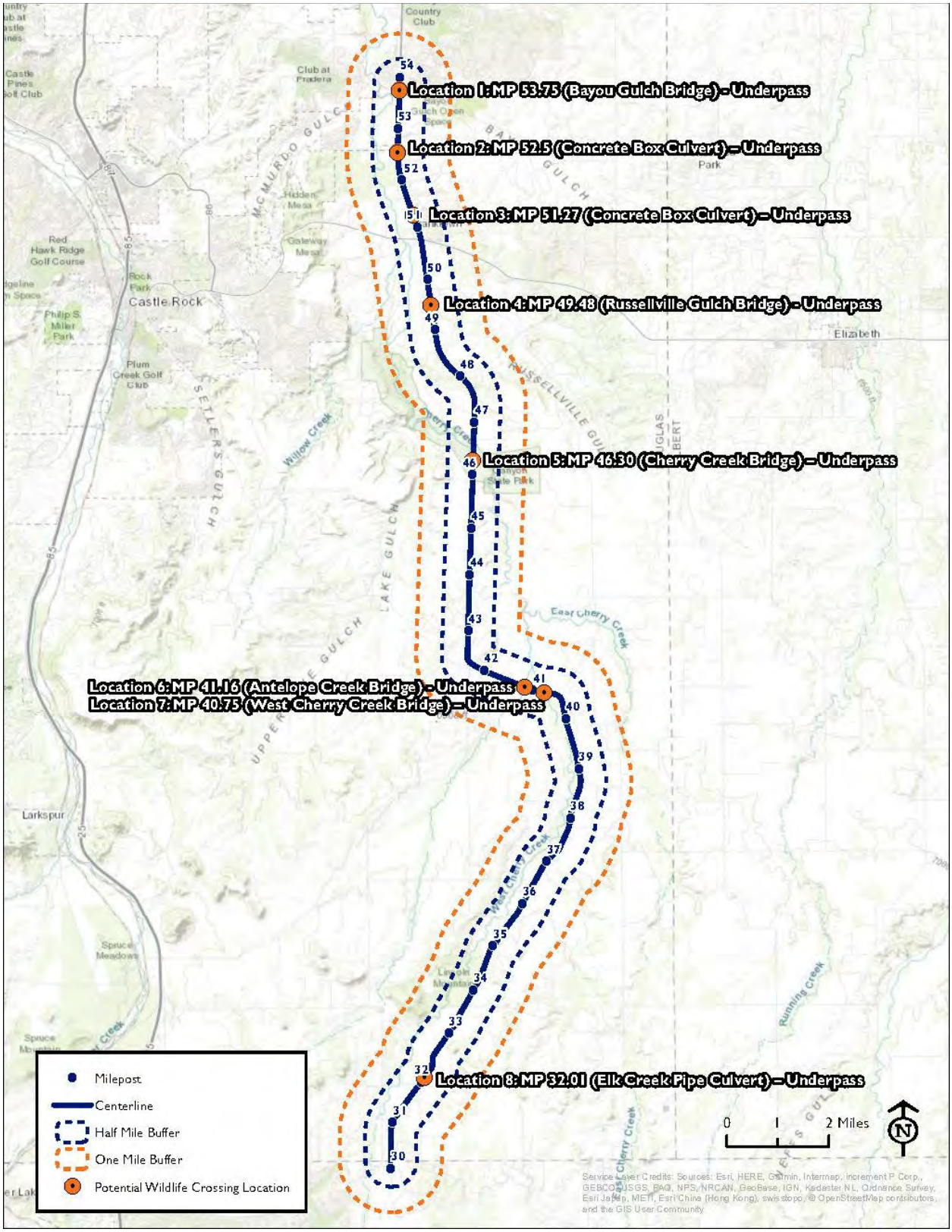
Crossing structures are an unnatural environment for wildlife; therefore, it is important to build crossing structures with a natural landscape at the approaches, as well as within the structure, to the extent possible. In doing so, wildlife will likely habituate to the structures more quickly and be more likely to continue using the structures for passage if the structure mimics natural conditions. Crossing structures should also provide direct line-of-sight through the structures and provide a natural substrate (e.g., soil). If rip-rap is necessary for erosion/sedimentation control under the structures (or at structure approaches), it is recommended that buried rip-rap be utilized, as many wildlife species will not cross over rip-rap materials. Further, ledges and artificial light within and/or around the structures are not recommended. Ledges

provide perching points for predators (e.g., mountain lion), which will likely raise concern for non-predatory species (e.g., deer, elk, pronghorn), while artificial light may deter wildlife from approaching and/or entering the structure.

There are no industry standards for wildlife crossings, and crossings should be designed on a location-by-location basis and based on targeted species, as certain species may require larger structures than others. Designs for crossings should be assessed/discussed between Project engineers and biologists.

Per WVC data, there are several areas along SH 83 where incidents occur at higher rates than others (Figure 8; Figure 9). Existing bridges and/or culverts near these locations may provide feasible options for wildlife movement/passage mitigation. Figure 10 displays existing structures that are potentially the most conducive for larger wildlife movements near the higher WVC areas. These locations are discussed in the following sub-sections, which are presented in directional order from north to south along the corridor.

Figure 10 – Wildlife Crossing Locations



Source: Pinyon Environmental, Inc.

LOCATION 1: MP 53.75 (BAYOU GULCH BRIDGE) – UNDERPASS

Location 1 is situated approximately 0.1 mile south of the interchange at Bayou Gulch Road and SH 83, where SH 83 crosses Bayou Gulch. The existing bridge structure at this location is G-17-BR (CDOT, 2022). Residential properties are located along Bayou Gulch Road to the north, and rural/open lands with little development (e.g., a church and a garden center) occur to the south. Bayou Gulch Open Space is located to the east and Cherry Creek is located approximately 0.4 mile to the west. A pedestrian trail connects Bayou Gulch Open Space to Cherry Creek. The trail passes under the south abutment of G-17-BR (south side of Bayou Gulch). There is a high level of human and dog traffic in this area, which may serve as a deterrent for wildlife crossing.

G-17-BR is a span bridge that is 11 feet tall and approximately 255 feet wide (abutment to abutment) and 120 feet long (guard rail to guard rail). Given its size, G-17-BR may already provide passage for some larger wildlife (e.g., deer). Small-to-medium sized wildlife are expected to utilize this structure for passage, as is. Bayou Gulch flows to the west into Cherry Creek and is mapped as a riverine intermittent streambed that is temporarily flooded (R4SBA) (USFWS, 2021). Based on review of aerial imagery, Bayou Gulch and its floodplain are generally dry and contains sparse upland vegetation. The gulch's channel has a sandy substrate.

Although this area is dry, Bayou Gulch is mapped within PMJM occupied range and within the RCZ. Bridge modifications for PMJM passage (e.g., ledges) are likely not necessary at this location. However, if vegetation is unable to grow underneath the bridge (connecting habitat on both sides of the bridge), installation of vegetation/shrubbery bundles may be an inexpensive and effective option to provide connectivity/cover for small mammal movements.

Per WVC data, deer are involved in most incidents in this area; no elk WVCs have occurred in this segment (CDOT, 2020a; CDOT, 2021). If G-17-BR currently provides suitable passage for deer, bridge modifications may not be necessary. Regardless, for this structure to better function as a wildlife crossing, wildlife fencing is recommended to direct animals toward the crossing. Wildlife fencing is discussed further in this Memo.

LOCATION 2: MP 52.5 (CORRUGATED METAL PIPE CULVERT) – UNDERPASS

Location 2 is situated approximately 0.12 mile south of the interchange at Castle Oaks Drive and SH 83, where SH 83 crosses an unnamed drainage. The existing structure at this location (Structure #083A052500BR) is a 7-foot diameter corrugated metal pipe built in 1968 (CDOT, 2022). Rural/open lands with some scattered development (e.g., houses) occur in the area.

Aerial imagery suggests that Structure #083A052500BR is approximately 130 feet long (west end to east end) and that there is approximately 6 to 14 feet of fill from the top of the culvert openings to the roadway, which may allow for replacement of the existing structure with a wider/taller structure that would be conducive for wildlife passage, particularly for larger animals (e.g., deer and elk) for which the current underpass is not suitable. Per WVC data, only deer have been involved in incidents in this area (CDOT, 2020a; CDOT, 2021). Upsizing the structure to an arch or span bridge design with a natural substrate would provide passage opportunities for wildlife.

The unnamed drainage at this location is mapped as a riverine intermittent streambed that is seasonally flooded (R4SBC) (USFWS, 2021). The drainage flows to the west but doesn't appear to connect with Cherry Creek (i.e., it terminates in an upland field). Small-to-medium sized wildlife may utilize this structure for passage as is. The drainage is mapped within PMJM occupied range; however, based on review of aerial imagery, the drainage likely lacks suitable habitat for PMJM. This drainage is expected to have somewhat low flows; therefore, mitigation for small mammal crossings (e.g., ledges) are likely not necessary for this location. Regardless, for this structure to better function as a wildlife crossing, wildlife fencing is recommended to help direct wildlife to the culvert.

LOCATION 3: MP 51.27 (CONCRETE BOX CULVERT) – UNDERPASS

Location 3 is situated approximately 0.11 mile south of the interchange at Rafter Road and SH 83, where SH 83 crosses an unnamed drainage. The existing structure at this location (Structure #083A051230BR) is a 10-foot wide by 8-foot tall

poured-in-place CBC built in 1942 (CDOT, 2022). Rural/open lands with some scattered development (e.g., houses) occur in the area.

Aerial imagery suggests there is approximately 8 to 10 feet of fill from the top of the culvert openings to the roadway, which may allow for the installation of a larger crossing structure to benefit larger wildlife passage (e.g., deer). Per WVC data, deer have been involved in most WVC incidents in this area; no elk WVCs have occurred in this segment (CDOT, 2020a; CDOT, 2021). If tall enough (approximately 10 feet tall or taller) this CBC may provide passage for some larger wildlife; however, upsizing the structure to an arch or span bridge design with a natural substrate would provide even better passage opportunities for wildlife.

The unnamed drainage at this location is mapped as an R4SBC stream (USFWS, 2021). The creek flows to the west and connects with Cherry Creek approximately 0.3 mile west of SH 83. Small-to-medium sized wildlife may utilize this structure for passage. This drainage is expected to have somewhat low flows; therefore, mitigation for small mammal crossings (e.g., ledges) are likely not necessary for this location. Regardless, for this structure to better function as a wildlife crossing, wildlife fencing is recommended to help direct wildlife to the culvert.

LOCATION 4: MP 49.54 (RUSSELLVILLE GULCH CONCRETE BOX CULVERT) – UNDERPASS

Location 4 is situated approximately 0.33 mile south of the interchange at Russellville Road and SH 83, where SH 83 crosses Russellville Gulch. The existing structure at this location is G-17-BN (CDOT, 2022). Rural/open lands with few homes occur in the area.

G-17-BN is a multicell CBC that is approximately 60 feet wide (abutment to abutment) and 45 feet long (guard rail to guard rail). Construction plans and inspection report sketches indicate the inside of G-17-BN as 8 feet tall, Cell #1 as 16 feet wide, Cell #2 as 24 feet wide, and Cell #3 as 16 feet wide. Because of the multiple cells, it is unlikely that deer or elk would pass through the structure. This structure is located within elk range; however, WVC data shows no elk involved in incidents within 2 miles of this location (closest incident being at MP 47.5) (CDOT, 2020a; CDOT, 2021). Small-to-medium sized wildlife are expected to utilize this structure for passage as currently configured. Regardless, for this structure to better function as a wildlife crossing, wildlife fencing is recommended.

Russellville Gulch is a tributary to Cherry Creek, generally flowing to the northwest to join Cherry Creek west of the study area. Russellville Gulch is mapped as a R4SBC stream (USFWS, 2021). Aerial imagery shows the gulch to be densely vegetated by willows east of the highway, and willows, other shrubs, and trees on the west side. Imagery also suggests that the stream channel is a few feet wide. Douglas County has mapped Russellville Gulch as a Wildlife Movement Corridor and has included it in the RCZ. Modifications for PMJM passage (e.g., ledges) are likely not necessary at this location. As vegetation would not be able to grow within the CBC (connecting habitat on both sides of the bridge), installation of vegetation/shrubbery bundles may be an inexpensive and effective option to provide connectivity/cover for small mammal movements.

LOCATION 5: MP 46.26 (CHERRY CREEK BRIDGE) – UNDERPASS

Location 5 is situated approximately 0.35 mile north of the Castlewood Canyon State Park entrance, where SH 83 crosses Cherry Creek. The existing bridge structure at this location is G-18-BL (CDOT, 2022). Rural/open lands with little development (e.g., Castlewood Canyon State Park buildings to the west) occur in the area.

G-18-BL is a span bridge that is approximately 450 feet wide (abutment to abutment) and 45 feet long (guard rail to guard rail). Rock walls/out-crops occur between the bridge abutments and the edge of the Cherry Creek floodplain. If the bridge is tall enough, wildlife would likely use these areas for passage. The area over the creek (the floodplain between the rock walls) is approximately 150 to 170 feet wide. The exact height of G-18-BL in this area is unknown; however, review of aerial imagery suggests it may be over 50 feet tall. At this size, G-18-BL would provide adequate passage for both large and small species of wildlife (specifically within the floodplain). Cherry Creek has been mapped by Douglas County as a Wildlife Movement Corridor. Per WVC data, deer and elk incidents have occurred in this segment (CDOT, 2020a; CDOT, 2021). For this structure to better function as a wildlife crossing, wildlife fencing is recommended.

At this location, Cherry Creek flows to the northwest. Cherry Creek is a perennial stream and is mapped as riverine, lower perennial with an unconsolidated bottom that is permanently flooded (R2UBH) (USFWS, 2021). Aerial imagery shows Cherry Creek flowing in an open channel with shrubby and herbaceous vegetation on both banks. Cherry Creek

occurs within the RCZ. Modifications for PMJM passage (e.g., ledges and vegetation/shrubbery bundles) are likely not necessary at this location as its assumed that the bridge is tall enough for vegetation growth under the structure.

LOCATION 6: MP 41.16 (ANTELOPE CREEK BRIDGE) – UNDERPASS

Location 6 is situated approximately 0.7 mile west of the interchange at South Russellville Road and SH 83, where SH 83 crosses Antelope Creek. The existing bridge structure at this location is G-18-H (CDOT, 2022). Rural/open lands with little development (e.g., houses) occur in the area.

G-18-H is a span bridge that is approximately 12 feet high based on drainage plans (at the midpoint of the bottom of the arched girder) although CDOT field biologists measured it in spring 2022 and indicated it is closer to 14 feet high (Schmude, 2022). The structure is about 90 feet wide (abutment to abutment) and 30 feet long (guard rail to guard rail). Antelope Creek has been mapped by Douglas County as a Wildlife Movement Corridor. Per WVC data, deer and elk have been involved in incidents in this area (CDOT, 2020a; CDOT, 2021). This structure may provide passage for deer as currently configured; however, elk (adult, antlered bulls in particular) would not be expected to use the structure due to its current height (i.e., the opening may be too short). Since elk are a species of concern as related to WVCs at this location, upsizing the structure (i.e., height) is recommended. Small-to-medium sized wildlife are expected to utilize this structure for passage as currently configured. Regardless, for this structure to better function as a wildlife crossing, wildlife fencing is recommended. Wildlife fencing can be tied together with Location 7 (West Cherry Creek Bridge), due to the close proximity of the two features, to increase its effectiveness. Fish have been noted in Antelope Creek.

Antelope Creek flows north into West Cherry Creek and is mapped as a palustrine emergent persistent wetland that is seasonally flooded (PEM1C) (USFWS, 2021). Antelope Creek is located within PMJM critical habitat and is within the RCZ. Bridge modifications for PMJM passage (e.g., ledges) are likely not necessary at this location. However, if vegetation is unable to grow underneath the bridge (connecting habitat on both sides of the bridge), installation of vegetation/shrubbery bundles may be an inexpensive and effective option to provide connectivity/cover for small mammal movements.

LOCATION 7: MP 40.75 (WEST CHERRY CREEK BRIDGE) – UNDERPASS

Location 7 is situated approximately 0.3 mile west of the interchange at South Russellville Road and SH 83, where SH 83 crosses West Cherry Creek. The existing bridge structure at this location is G-18-BC (CDOT, 2022). Rural/open lands with little development (e.g., houses) occur in the area.

G-18-BC is a span bridge that is approximately 10-11 feet high (at the midpoint of the bottom of the arched girder), 115 feet wide (abutment to abutment) and 30 feet long (guard rail to guard rail). West Cherry Creek has been mapped by Douglas County as a Wildlife Movement Corridor. Per WVC data, deer, elk, and pronghorn have been involved in incidents in this area (CDOT, 2020a; CDOT, 2021). This structure may provide passage for deer as currently configured; however, elk (adult, antlered bulls in particular) would not be expected to use the structure due to its current height (i.e., the opening is likely too short). Since elk are a species of concern as related to WVCs at this location, upsizing the structure (i.e., height) is recommended. Small-to-medium sized wildlife are expected to utilize this structure for passage as currently configured. There is barbed wire fencing under the bridge that poses a hazard to wildlife moving under the bridge; it is recommended that the barb wire be removed and/or replaced with wildlife friendly fence. There is riprap near the abutments that has chain link over the top of it. This is also a potential hazard, and it is recommended that this be corrected if there are to be improvements to wildlife passage.

Although deer and small-to-medium sized wildlife utilize this passage, they may sometimes be deterred due to ponding adjacent to and under the bridge. Therefore, construction of a bench or path is recommended to promote wildlife crossing. Wildlife fencing is also recommended and can be tied together with wildlife fencing at Location 6 (Antelope Creek Bridge). Fish have been noted in West Cherry Creek.

West Cherry Creek flows to the north and is mapped as a R4SBC stream (USFWS, 2021). This portion of West Cherry Creek is within PMJM occupied habitat and is within the RCZ. Bridge modifications for PMJM passage (e.g., ledges) are likely not necessary at this location. However, if vegetation is unable to grow underneath the bridge (connecting habitat on both sides of the bridge), installation of vegetation/shrubbery bundles may be an inexpensive and effective option to provide connectivity/cover for small mammal movements.

LOCATION 8: MP 32.11 (ELK CREEK PIPE CULVERT) – UNDERPASS

Location 8 is situated approximately 0.19 mile northeast of the interchange at County Road 82 and SH 83, where SH 83 crosses Elk Creek. The existing structure at this location (Structure #083A032060BR) is a pipe culvert with a max span and structure length of 4.8 feet, and an out-to-out width of 164 feet (CDOT, 2022). Rural/open lands with little development (e.g., houses) occur in the area.

Aerial imagery suggests there is approximately 10 to 15 feet of fill from the top of the culvert openings to the roadway, which may allow for the installation of a larger structure that can act as a wildlife crossing. Per Douglas County, Elk Creek is not mapped as a Wildlife Movement Corridor; however, it is located between mapped corridors (Iron Gulch and East Plum Creek to the east, and West Plum Creek to the west). Per WVC data, deer and elk have been involved in incidents in this area (CDOT, 2020a; CDOT, 2021). This structure does not currently provide passage for large wildlife. Since deer and elk are species of concern as related to WVCs at this location, upsizing the structure is recommended.

Elk Creek is mapped as a R4SBC stream (USFWS, 2021). The creek flows to the northwest where it joins West Cherry Creek. Near SH 83, the creeks floodplain is wide and heavily vegetated with no distinct channel. Small-to-medium sized wildlife may utilize this structure for passage as currently configured. Elk Creek is located within the RCZ; therefore, suitable PMJM habitat is expected to occur. For this structure to better function as a wildlife crossing, wildlife fencing is recommended to help direct wildlife to the culvert.

OTHER POTENTIAL CROSSINGS AND CONSIDERATIONS

In addition to the locations described above, the study area contains numerous box and pipe culverts, which may provide passage opportunities for small-to-medium sized fauna (e.g., coyote, rabbit, mice). It is anticipated that many of these culverts would need to be cleaned out, as sedimentation over time may have filled them in (partially or completely), rendering them less effective or ineffective for wildlife passage. Topographic conditions coupled with culvert upsizing can foster more opportunities to improve wildlife mobility beneath SH 83. Further, topography in areas may allow for the installation of a wildlife overpass. Overpasses can often be more effective than underpasses as they have a more natural, open feel. Regardless of the type of crossing, appropriate habitat and cover within and/or near crossing entrances and approaches should be prioritized to improve wildlife passage.

Of the eight locations noted above, most provide suitable habitat for some aquatic species; however, Location 5 (Cherry Creek) is the only location anticipated to provide suitable habitat for fish. It is important that Project work does not diminish habitat for aquatic species. While appropriate permitting will be necessary to conduct work within streams for this Project, it is important that stream quality and functionality be considered as work/design progresses.

Most drainages/streams that intersect SH 83 within the study area are anticipated to have somewhat low flows, except for Cherry Creek. Drainage design for potential wildlife crossings in these areas have not been completed; however, low-flow designs will help prevent erosion issues as well as reduce the risk of structure damage during heavy precipitation events. It is recommended that low-flow channels provide a natural setting, where applicable, including natural soil substrates. Below are a few options to be considered for drainage design (Option 1 is most desired while Option 3 is least desired for the Project). These options have been considered/implemented for other projects in Douglas County (e.g., I-25 South Gap Project). Regardless, whether the design option is advanced from the list below or a new option is used, Project engineers and biologists should discuss design(s) on a location-by-location basis as site conditions are variable:

- Option 1 – a natural drainage is provided. A natural drainage may include a meandering stream with natural materials. Sloped interior walls with buried armor materials (i.e., rip-rap) may be necessary to provide armor within the crossing.
- Option 2 – the drainage provides a natural slope to the center of the structure. Buried rip-rap may be used to provide armor for the stream.
- Option 3 – the drainage includes a concrete channel. Concrete channels are to be installed on one side of the structure to leave natural habitat in the other side for wildlife to use.

WILDLIFE CROSSING CONNECTIVITY AND FENCING

In addition to wildlife crossing structures, a minimum of 8-foot-high wildlife fence is recommended on both sides of SH 83, connecting wildlife crossing structures as well as other structures located within the corridor (e.g., culverts), to the extent practical. Fencing would funnel wildlife to the crossing locations, allowing wildlife to cross under (or over if an overpass is built) SH 83 safely in either direction. Further, wildlife-friendly fence is recommended to be installed in areas where livestock may access wildlife crossing structures. Wildlife friendly fence is designed to inhibit livestock (e.g., cattle) from entering certain areas (e.g., wildlife crossing structures), while allowing other wildlife to access those areas.

When installed correctly, wildlife fencing keeps wildlife off roadways; however, if faults occur in the fencing (e.g., gaps or holes in the fence), wildlife may access the roadway. Because of this possibility, mitigation measures should be put in place to allow wildlife to escape the roadway. Such mitigation measures include the installation of wildlife escape ramps. Where wildlife fencing is used, wildlife escape ramps are typically installed approximately every 0.5 mile, and staggered, on both sides of the roadway. Wildlife guards should also be installed where gaps in fencing are unavoidable (e.g., emergency access points, secondary and tertiary roads). There are several design options for wildlife guards, some of which tend to work better than others. At this time, it is recommended that either a round pipe or a matrix-like design be used for the Project, as these designs tend to be more difficult for wildlife to breach/walk over.

CPW provides strategies in a brochure on how to fence areas with wildlife in mind (CPW, 2015c). This brochure provides details on how to build and install wildlife-friendly fencing. As designs advance for the Project, it is recommended that a biologist assist with identifying locations and/or design for wildlife fencing, escape ramps, and wildlife guards, as these designs and locations should be evaluated on a location-by-location basis.

It is assumed that once the Project is complete, CDOT personnel will conduct maintenance of wildlife crossings, wildlife fencing, escape ramps, and wildlife guards annually at minimum. If faults are noted during an inspection, repairs and/or improvements should be addressed immediately to keep wildlife from breaching the system and accessing the roadway.

REFERENCES

CDOT, 2019. Colorado Department of Transportation. Deer Fence, Gates, and Ramp Details, M-607-4. Issued on July 13, 2020. Available at: 2019 M Standard Plans and Project Special drawings — Colorado Department of Transportation (codot.gov).

CDOT, 2020a. "Wildlife Vehicle Collision data for 2010-2020 for SH 83-mile posts 30-54," Traffic and Safety Data. Colorado Department of Transportation.

CDOT, 2020b. "Information derived from National Safety Council Data," Data Obtained from the Colorado Department of Transportation in October 2021.

CDOT, 2021. "Wildlife Conflict/Roadkill Data (2016-2021) for SH 83-mile posts 30-54," Provided by Colorado Department of Transportation Maintenance Crew.

CDOT, et al., 2021. "Wildlife Valuation using Contingent Valuation Methods for the Eastern Slope and Plains Wildlife Prioritization Study," Provided by Colorado Department of Transportation.

CDOT, 2022. CDOT Online Transportation Information System (OTIS). Available at: MapView (coloradodot.info). Accessed December 2021.

CPW, 2015a. "State Wildlife Action Plan. A Strategy for Conserving Wildlife in Colorado. Prepared for the citizens of Colorado and its Visitors by Colorado Parks and Wildlife." Colorado Parks and Wildlife. Available at: https://cpw.state.co.us/Documents/WildlifeSpecies/SWAP/CO_SWAP_FULLVERSION.pdf.

CPW, 2015b. "Colorado Nongame, Endangered, and Threatened Species Conservation Act." 1985. Colorado Revised Statutes Annotated (CRSA) § 33-2-101-108.

CPW, 2015c. Colorado Parks and Wildlife. Fencing with Wildlife in Mind. Available at: Fencing with Wildlife in Mind brochure (wildlifefriendly.org).

CPW, 2019. CPW, Species Activity Data Shapefile Download, Colorado Parks and Wildlife, last modified February 20, 2019. Available at: http://cpw.state.co.us/learn/Pages/KMZ-Maps.aspx

Douglas County, 2006. "Habitat Conservation Plan and Environmental Assessment for Douglas County and the Towns of Castle Rock and Parker." Douglas County and the Towns of Castle Rock and Parker.

Douglas County, 2012. "2030 Parks, Trails, and Open Space Master Plan – A Sub-element of the Comprehensive Master Plan," Douglas County. Available at: https://www.douglas.co.us/documents/2030-ptos.pdf/.

Douglas County, 2019. "2040 Comprehensive Master Plan," Douglas County. Available at: https://apps.douglas.co.us/planning/projects/download.aspx.

Douglas County, 2021. "Preble's Meadow Jumping Mouse," Douglas County Open Space and Natural Resources. Available at: https://www.douglas.co.us/government/departments/open-space/prebles-meadow- jumping-mouse/

Google Earth, 2022. "Google Earth Pro." Available for download at: https://www.google.com/earth/download/gep/agree.html.

Polis, 2019. "Executive Order D2019011, Conserving Colorado's Big Game Winter Range and Migration Corridors." Available at: http://www.codot.gov/programs/environmental/wildlife/governor-signs-wildlife-exec-order.

Schmude, Erik, 2022. Personal Communication.

USFWS, 2021. "National Wetlands Inventory," Wetlands Mapper. Updated May 3, 2021. Available at: https://www.fws.gov/wetlands/data/mapper.html.

USFWS, 2022. "USFWS Threatened & Endangered Species Active Critical Habitat Report." Updated February 10, 2022. Available at: https://ecos.fws.gov/ecp/report/table/critical-habitat.html.

Wildlife Consulting Resources and Felsburg, Holt, and Ullevig, 2014. "Wildlife Habitat Connectivity and Associated Wildlife Crossings for US Highway 160 Phases II and III." Prepared for CDOT, Region 5. Available at: wildlife-habitat-connectivity-and-associated-wildlife-crossings-for-us-highway-160-phases-ii-and-iii (codot.gov).