WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

TRUCKEE TAHOE AIRPORT

Mead & Hunt

WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

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Project Team

The Wildlife Hazard Site Visit (WHSV) for the Truckee Tahoe Airport (TRK or "the Airport") was conducted by Mead & Hunt, Inc. in October 2019. The site visit and report were conducted in cooperation with the Truckee Tahoe Airport District (TTAD) staff.

The Mead & Hunt team included the following:

- Rick Jones, a Qualified Airport Wildlife Biologist in accordance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5200-36B, "Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports" (FAA, 2019a.). Mr. Jones conducted all wildlife surveys and prepared the WHSV Report.

- Lisa Harmon is a Senior Aviation/Environmental planner who provided review of the WHSV Report. Lisa has extensive wildlife hazard management experience in California.

- Bradley Musinski, a Senior Aviation planner with extensive knowledge and experience working at TRK. Mr. Musinski provided review of the WHSV Report.

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Section 1
Introduction

Conflicts between aircraft and wildlife have occurred since the dawn of aviation. Orville Wright was the pilot associated with the first documented bird strike in 1905 during a flight over Dayton, Ohio. The first fatality associated with a wildlife strike occurred on April 3, 1912, when Calbraith Rodgers died after his aircraft struck a gull and crashed in Long Beach, California.

The Federal Aviation Administration (FAA) and the United States Department of Agriculture-Wildlife Services (USDA-WS) publish an annual report that summarizes wildlife strikes to civilian aircraft in the United States since the FAA began to record strike data in 1990. According to the most recent annual report, *Wildlife Strikes to Civil Aircraft in the United States 1990–2018*, the following statistics are representative of wildlife strikes with civilian aircraft in the United States:

- The number of wildlife strikes reported to the FAA has increased by a factor of 8.7 since 1990, from a total of 1,356 reported strikes in 1990 to a total of 15,799 reported strikes in 2018.

- During the period from 1990 to 2018, a total of 214,048 strikes were reported. In 2018, birds were involved in 94.7 percent of the reported strikes, terrestrial mammals in 1.8 percent, bats in 3.2 percent and reptiles in 0.3 percent. (FAA 2019b)

Awareness has increased among both the public and the aviation community regarding the hazards posed by birds and other wildlife to aviation safety. The number of reported wildlife strikes increased between 2009 and 2017. This increase in reported strikes may be attributed to numerous factors including the 2009 "Miracle on the Hudson", which heightened awareness about wildlife strikes and improved reporting methods. This combined with the growth of some wildlife populations and increased aircraft operations has resulted in more strikes being documented.

Although the number of reported strikes in United States has increased since 1990, the number of reported damaging strikes has declined since 2000: whereas the number of reported strikes increased 169 percent (from 5,871 strikes in 2000 to 15,799 in 2018), the number of damaging strikes declined by approximately 8 percent (from 741 strikes in 2000 to 684 in 2018). The decrease in damaging strikes has been most pronounced for commercial aircraft in the airport environment. The rate of damaging strikes has not decreased for general aviation (GA) aircraft operations.

1.1 Regulatory Background

The FAA is the agency responsible for establishing and enforcing Federal Aviation Regulations (FARs), which are codified in Title 14 of the Code of Federal Regulations (CFR). The FAA establishes regulations and policy to enhance public safety both at airports holding certificates under 14 CFR Part 139 (Part 139) and at non-certificated federally obligated airports.

The Truckee-Tahoe Airport (TRK) is owned and operated by the Truckee-Tahoe Airport District (TTAD). Although TTAD does not hold a certificate from FAA to operate the airport pursuant to FAR Part 139, TTAD receives funds from the FAA to undertake capital improvements. When an airport owner, such as TTAD, accepts funds from the FAA, it must agree to maintain and operate its airport facilities safely and efficiently in accordance with specified conditions known as grant assurances.

The FAA has established 37 specific grant assurances that airport operators must adhere to when they receive federal funds. Wildlife hazard management is associated with FAA Airport Improvement Program (AIP) Grant Assurance No. 19, “Operations and Maintenance.” The FAA may recommend that a federally obligated airport conduct a wildlife study, such as a WHSV or Wildlife Hazard Assessment (WHA) in accordance with Grant Assurance No. 19. At the discretion of TTAD, the WHSV Report may be shared with the FAA for review. Based on the results of the WHSV Report, the FAA may recommend that an airport conduct a 12-month WHA or develop a Wildlife Hazard Management Plan (WHMP) in accordance with guidance set forth at 14 CFR Part 139. In some cases, a project sponsor may provide written adoption of the WHSV recommendations, which may be sufficient to make the recommendations eligible for AIP funding following review and concurrence by the FAA’s Airport District Office. In such cases, the written adoption of the WHSV recommendations can serve as a WHMP (FAA 2019c)

1.2 Project Purpose and Objectives

TTAD undertook a WHSV to identify the presence of potentially hazardous wildlife on and near TRK that could pose risks to aircraft operations. The WHSV was conducted in October 2019 in accordance with FAA guidance and FAA AC 150/5200-38, “Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans” (FAA 2018). According to the AC, a WHSV must include three components:

- Gathering airport information;
- Conducting field observations; and
- Preparing a final report with recommendations.

Airport operators can use the results and conclusions from the WHSV to evaluate and mitigate potential hazards quickly and to determine whether a WHA or a WHMP is necessary. In accordance with AC 150/5200-38, the objectives of the WHSV Report are to:

- Identify the wildlife species observed, their numbers, locations, and local movements;
- Identify and locate features on and near the airport that are attractive to potentially hazardous wildlife;
- Provide a description of the wildlife hazards to aircraft operations; and
- Recommend actions for reducing identified wildlife hazards to aircraft operations.

Section 2
Airport Background

2.1 Site Background

TRK is located within the Sierra Nevada Level III and IV Ecoregions established by the United States Environmental Protection Agency (EPA, 2019). This ecoregion is characterized by deeply dissected block fault that rises sharply from the arid basin and range ecoregions on the east and slopes gently toward the Central California Valley to the west. The eastern portion has been strongly glaciated and generally contains higher mountains than are found in the Klamath Mountains to the northwest. Much of the central and southern parts of the region is underlain by granite. The higher elevations of this region are largely federally owned and include several national parks. The vegetation grades from mostly ponderosa pine at the lower elevations on the west side and lodgepole pine on the east side, to fir and spruce at the higher elevations. Alpine conditions exist at the highest elevations.

The climate is characterized by four distinct seasonal patterns. The summers are warm, arid, and mostly clear, and the winters are long, freezing, wet, and partly cloudy. Over the course of the year, the temperature typically varies from 16 degrees Fahrenheit to 82 degrees Fahrenheit. Truckee experiences significant seasonal variation in monthly rainfall and heavy snowfall in the winter months. The Airport is located in a rural environment dominated by pine forest and sagebrush habitat.

The FAA designates TRK as a regional GA airport. It is situated in the Martis Valley approximately 2 miles southeast of downtown Truckee, California, and 7 miles north of Lake Tahoe. Airport property falls in the Town of Truckee and unincorporated areas within both Nevada County and Placer County. The Airport was constructed in 1933 and used by the Boeing Company as an emergency landing runway for the Trans-Sierra airmail route between San Francisco and Salt Lake City. In the mid-1950s, the Chamber of Commerce representing Truckee's business owners was eager to have a modern airport that would bring tourists to the area. In 1958 the TTAD was formed by a vote of residents.

2.2 Airport Facility

The 936-acre airport is adjacent to pine woodlands at its northern and northeastern boundaries. Martis Creek occurs approximately 0.5 mile south and east of the airport, and Martis Creek Lake is located approximately 0.3 mile east of the airport. **Photos 1 through 4** show various locations on the Airport, terminal and AOA. **Figure 1** shows the Airport location and **Figure 2** details the vicinity around TRK.

TRK is adjacent to the Tahoe Truckee Sanitation District (TTSD) to the north. Commercial development occurs to the southwest, and west. Open area and some industrial development are located to the south. The area west of the airport includes the Ponderosa Golf Course and residential development. The area south and southwest of the airport is characterized by commercial and industrial development. The Martis Creek Wildlife Area, and pine woodlands, and residential development occur farther south. Open sage brush fields and Martis Creek Lake are located to the east.

There are two intersecting runways at TRK, which are equipped with parallel taxiways:

- Runway 11/29 is a northwest-southeast oriented runway that is 7,001 feet long and 100 feet wide.
- Runway 2/20 is a northeast-southwest oriented runway that is 4,654 feet long and 75 feet wide.

According to Airport records, there were 34,847 operations in calendar year 2018, which includes glider operations. There are 229 hangar structures at TRK.

Several wildlife attractants were observed within the airport vicinity. These attractants include woodlands, sage brush, creeks, lake, golf courses, etc. **Figure 3** presents an aerial photograph that identifies wildlife attractants and other features on and near the airport that were considered during the planning and conduct of the WHSV.

Photo 1: Looking northeast across the ramp at the TRK Airport terminal

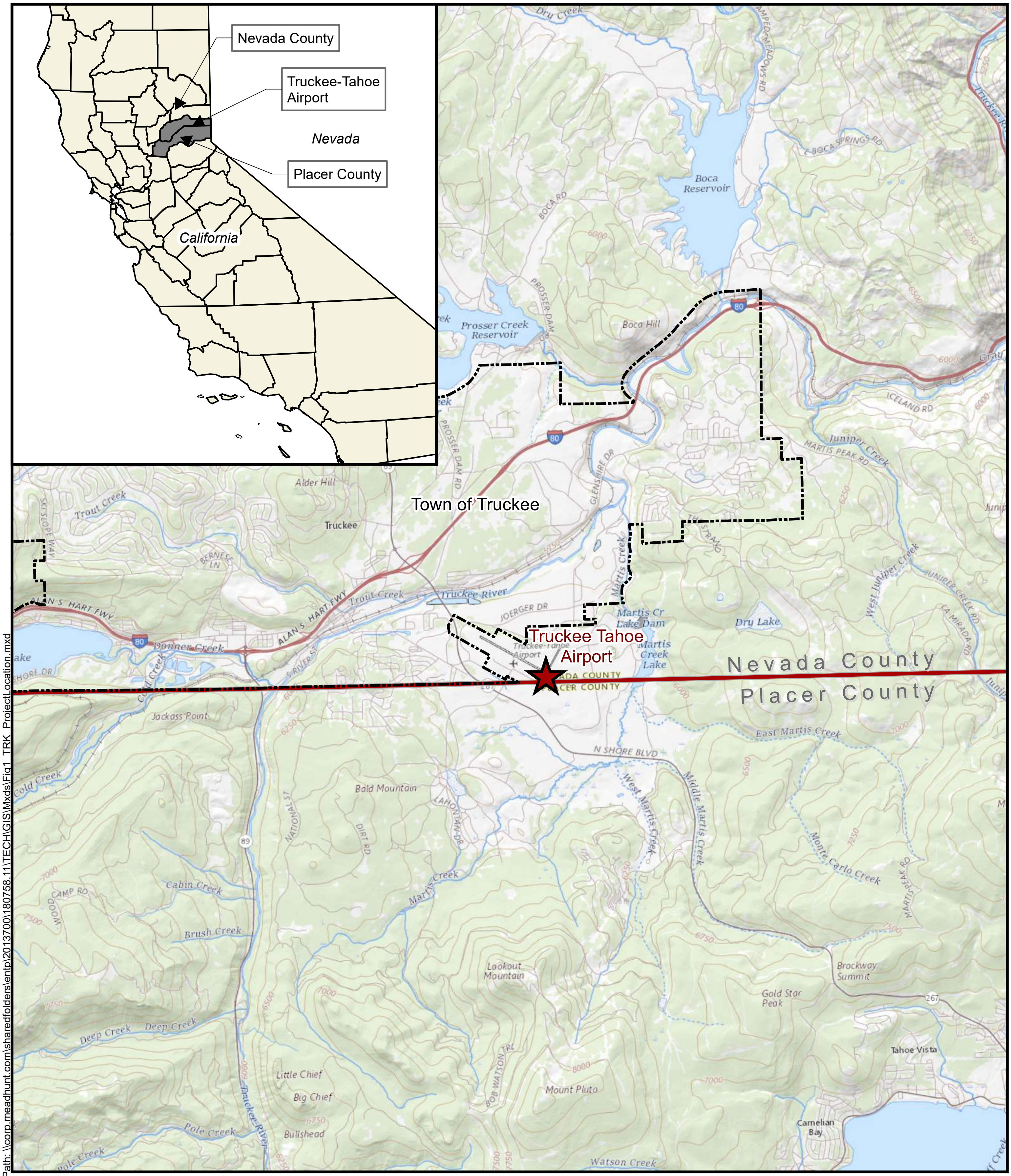

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Figure 1
Site Location
Truckee Tahoe Airport
Nevada and Placer Counties, California

Source: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed December, 2019.

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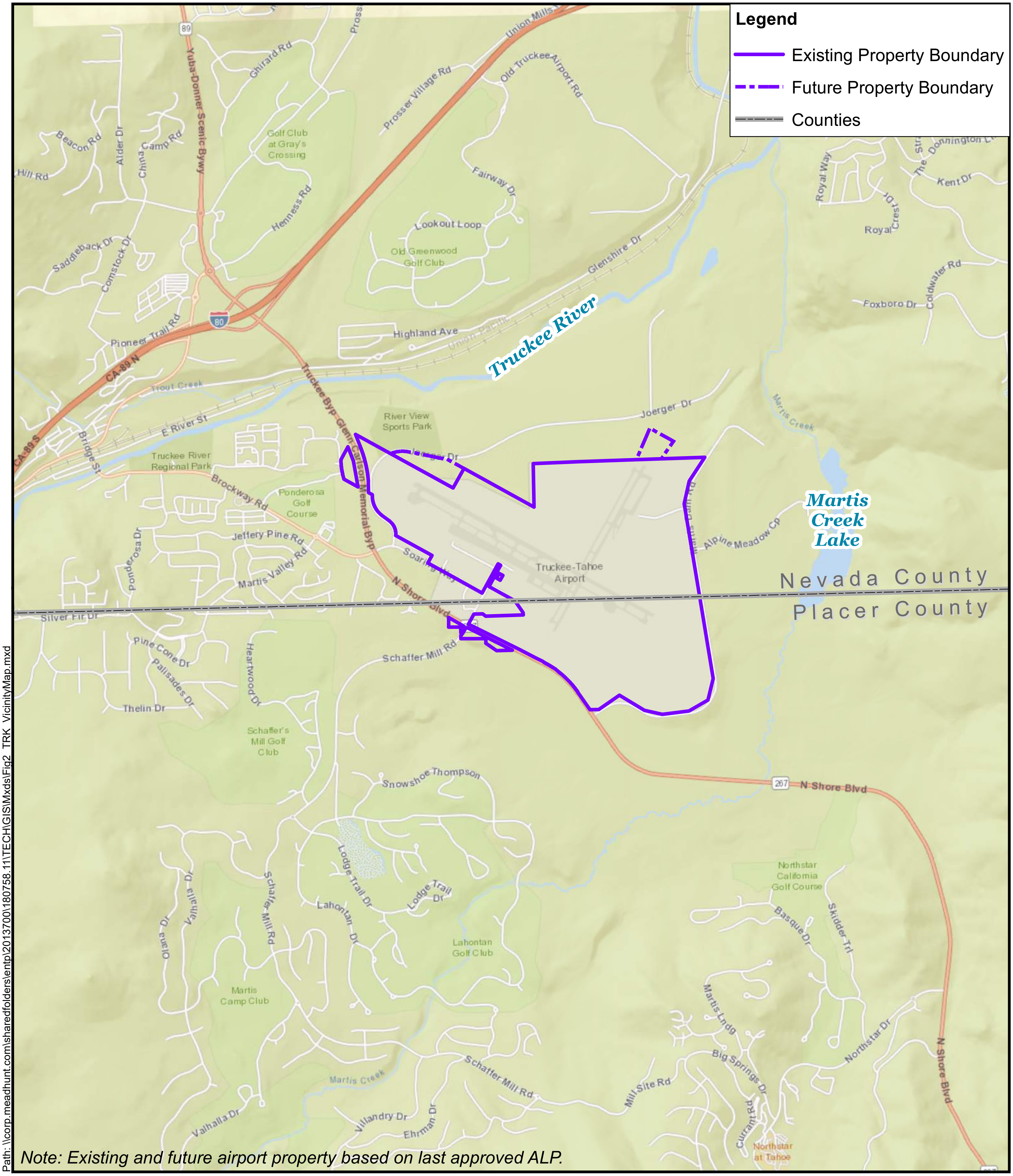

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Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Figure 2
Site Vicinity
Truckee Tahoe Airport
Nevada and Placer Counties, California

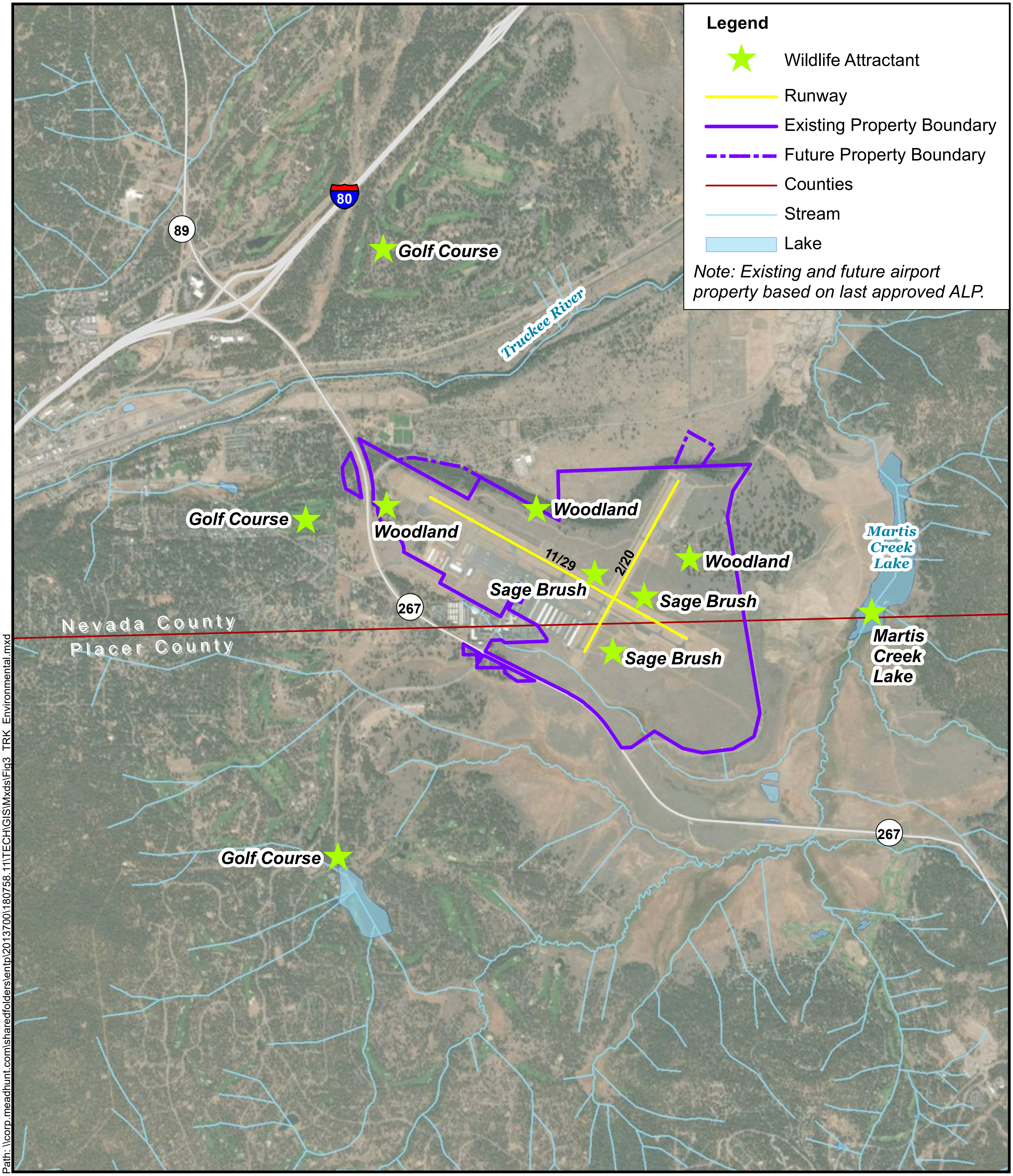

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Figure 3
Land Uses and Wildlife Attractants
Truckee Tahoe Airport
Nevada and Placer Counties, California

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Photo 2: Looking northeast at Runway 20.

Photo 3: Looking southeast across the infield and Runway 11/29 towards the terminal.

Photo 4: View of the ramp and various aircraft based at the airport (looking northeast).

2.3 Existing Wildlife Hazard Management at TRK

Ms. Stacey Justesen, Airport Safety and Security Manager stated that operations staff members patrol the Air Operations Area (AOA) regularly to disperse wildlife from the airfield (birds, deer, and coyotes). The Airport is not equipped with a perimeter security fence or wildlife fence to exclude mammals from entering the AOA. A cattle fence is present along the eastern portion of the airport boundary (**Photo 5**). The Airport does not hold a federal depredation permit to perform lethal control of migratory birds or a state permit for the lethal control of deer and coyotes.

TTAD maintains vegetation regularly throughout the airfield. The grass within runway safety areas (RSAs) was observed to be less than 6 inches high at the time of the site visit, and Ms. Justesen stated that the grass is typically maintained at a height of 6 inches or lower, depending on field conditions and weather. Ms. Justesen also stated that the airport mows sagebrush that is located within the AOA (**Photo 6**) to maintain fire breaks and removes trees that become obstructions.

Past and present land management practices at TRK.

- Mow the infield and firebreaks throughout the property.
- Currently, limbing trees and masticating campground area located northeast side of airfield.
- 2019 - Cut down about 30 mature conifers on the north slope of the approach end of Runway 20.
- 2019 - Cut down 3 mature conifers and about 10 younger trees near the approach end of Runway 11.

Photo 5: View of the airport perimeter fence along Martis Dam Road.

Photo 6: Airfield vegetation includes dense sagebrush that extends to the edge of the RSA.

2.4 Personnel Responsible for Airport Operations

Mr. Kevin Smith serves as the general manager for TRK. The day-to-day operations of the airport are managed by Dave Hoffman, Director of the Operations and Maintenance Department. The personnel responsible for airport wildlife hazard management is Ms. Stacey Justesen, Airport Safety and Security Manager.

2.5 Recent Airport Improvements

The most recent improvement projects at TRK include the following:

- Repaving Taxiway R (2019);
- Construction of Executive Hangar Rows N and P on the southwestern side of the airport (2018); and
- Maintenance Shop Building addition on the southwest side of the airport (2017).

2.6 FAA Wildlife Strike Database Records

The FAA maintains a National Wildlife Strike Database that includes strike records from 1990 to the present. According to the FAA National Wildlife Strike Database, eleven wildlife strikes have been reported at TRK.

- Five deer strikes were reported. The first occurred in 1992, and the most recent occurred in 2016.
- Six bird strikes were recorded. Two strikes were associated with unidentified species (2003 and 2018). One strike was associated with each of the following: perching birds (2014), rock pigeon (2014), a red-a tailed hawk (2015), and a horned lark (2015).

FAA data must be used with caution. Strike reporting is voluntary, and the FAA estimates that only 20 percent of all strikes that occurred nationwide from 1990 to 2008 were recorded in the database, and only 40 percent of all strikes that occurred since 2009 were recorded (FAA 2018).

2.7 Current Wildlife Hazard Threats and Concerns

As previously stated, TRK is not equipped with a security fence or wildlife fence to exclude mammals from the AOA. Wildlife species that pose the greatest risk to aircraft operations are deer and coyotes, which are frequently observed in the AOA and aircraft movement areas. Other species that pose the greatest risk to aircraft operations include various bird species that forage and loaf within the AOA, such as raptors (e.g., red-tailed hawk and northern harrier), and bird species that fly to and from the Martis Creek Lake area and pass through airspace associated with TRK (Canada Geese, great blue herons, and waterfowl species). Other bird species that pose a potential risk to aircraft operations that were not observed during the WHSV include those are associated with spring and fall migrations, such as gulls, raptors, ducks, blackbirds, and various passerine species. The following features were observed on and near TRK that have the potential to attract potentially hazardous wildlife:

- **Sage brush.** The most significant wildlife attractants observed at TRK were the large expanses of sage brush (see **Photo 7**) located outside of the RSAs but within the AOA. Sage brush is attractive to various large and hazardous bird species, and it provides dense cover for coyotes and deer. The extensive sage brush within the AOA attracts various bird species that forage, loaf, and nest within the grass. The dense brush obscures potentially hazardous birds and mammals from the view of airport maintenance staff and pilots. Brush removal is a necessary measure for preventing or reducing potential conflicts between wildlife and aircraft operations at TRK.

- **Open Water.** Martis Creek Lake is located east of the AOA (see **Photo 8**). This open water source attracts Canada geese, various duck species, great blue herons, and other water and shorebirds which pose hazards as they pass through nearby airspace and fly across or loaf within the AOA.
- **Woodlands.** Woodlands are located at the perimeter of the airport and attract raptors, ravens, doves, and other birds that fly back and forth across the AOA and runways (see **Photo 9**). These woodlands also provide cover for coyotes and deer that can move across the AOA from woodland to woodland.
- **Golf Course.** Numerous golf courses occur north, west, and southwest of the airport. These golf courses include groves of trees in which birds can roost (e.g., raptors and blackbirds) and expansive turf areas that attract Canada geese and other species. Avian species that travel to and from these areas can pose hazards to aircraft as they pass through nearby airspace.

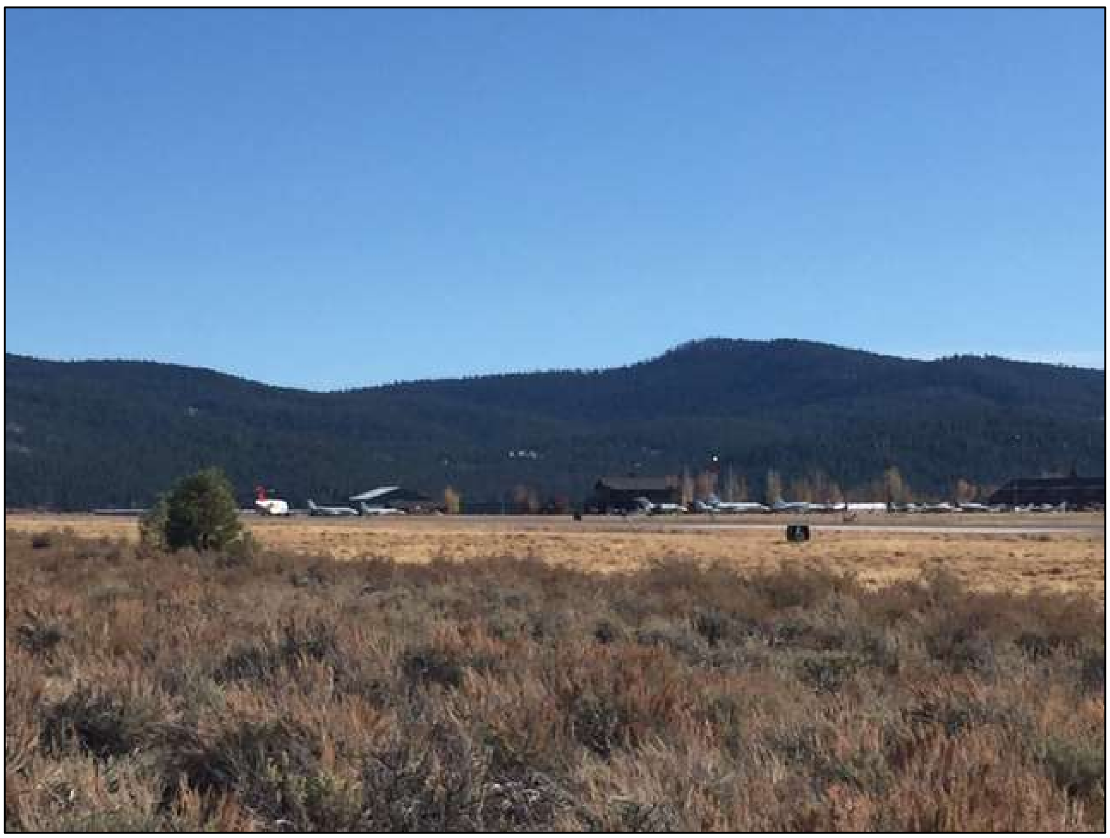

Photo 7: Sage brush in the AOA provides attractive habitat for various birds and mammals.

Photo 8: Martis Creek Lake is located immediately east of the airport. This open water source attracts Canada geese, various species of ducks, great blue herons, and other water and shorebirds which pose hazards to aircraft as they fly between this lake and enter TRK airspace or even fly across or loaf within the AOA.

Photo 9: Woodlands located on the airport provide nesting and perching opportunities for numerous bird species and cover for coyotes and deer.

Section 3
Methodology

Prior to conducting the WHSV, the Mead & Hunt team reviewed pertinent background information to gain familiarity with the surroundings and the types of wildlife expected to occur in the airport vicinity. Aerial photographs were reviewed to consider the airport property in relation to its surroundings and the nearby features or facilities that could attract potentially hazardous wildlife. This information was summarized and used as reference material during the interviews with airport personnel and field surveys.

3.1 Wildlife Surveys

Mead & Hunt conducted a three-day site visit from October 25 to 27, 2019. Rick Jones, an FAA Qualified Airport Wildlife Biologist (QAWB), surveyed TRK property to evaluate property boundaries, identify monitoring locations, and document existing conditions. Weather conditions during the three-day site visit were partly sunny skies with moderate to high winds. High temperatures ranged from in the high 50s Fahrenheit to low 60s Fahrenheit and morning lows occurred in the in the 20s^{o} Fahrenheit.

Twelve locations were established for wildlife surveys (see **Figure 4**). Seven on-Airport monitoring locations were established to provide visual coverage of the AOA including runways, taxiways, aprons, infield sage brush areas, buildings, and structures. Five off-airport monitoring locations were established in areas that were identified as potential wildlife attractants (lakes, golf course, open space, and woodlands) or located in aircraft approach and departure zones. These off-Airport locations included the areas within a 10,000-foot radius of the AOA.

Sections 3.1.1 through 3.1.4 describe the survey methods implemented during the three-day site visit.

3.1.1 Fixed-point Wildlife Surveys

The QAWB conducted fixed-point wildlife surveys to observe wildlife presence and behavior. Six surveys were conducted over the three-day period: two morning surveys, two mid-day surveys, and two evening surveys. The morning survey began at dawn and the evening survey began approximately two hours before sunset. The mid-day survey took place between 11:00 a.m. and 2:00 p.m. During each survey, the QAWB recorded all species observed from each monitoring location during a five-minute interval. All data were recorded on an airport WHSV data observation sheet.

3.1.2 Spotlight Surveys

Spotlight surveys were conducted to determine the presence of nocturnal wildlife presence during night hours. The spotlight surveys were conducted on-Airport approximately one hour after sunset on October 25 and 26. The QAWB drove along runways, taxiways, ramp areas, and the infield turf areas. Wildlife observations and locations were recorded.

3.1.3 Game Camera Surveys

A game camera was installed to monitor mammal activity during the two-night site visit. The camera location was moved each day to monitor wildlife presence and movement on-Airport during day and night.

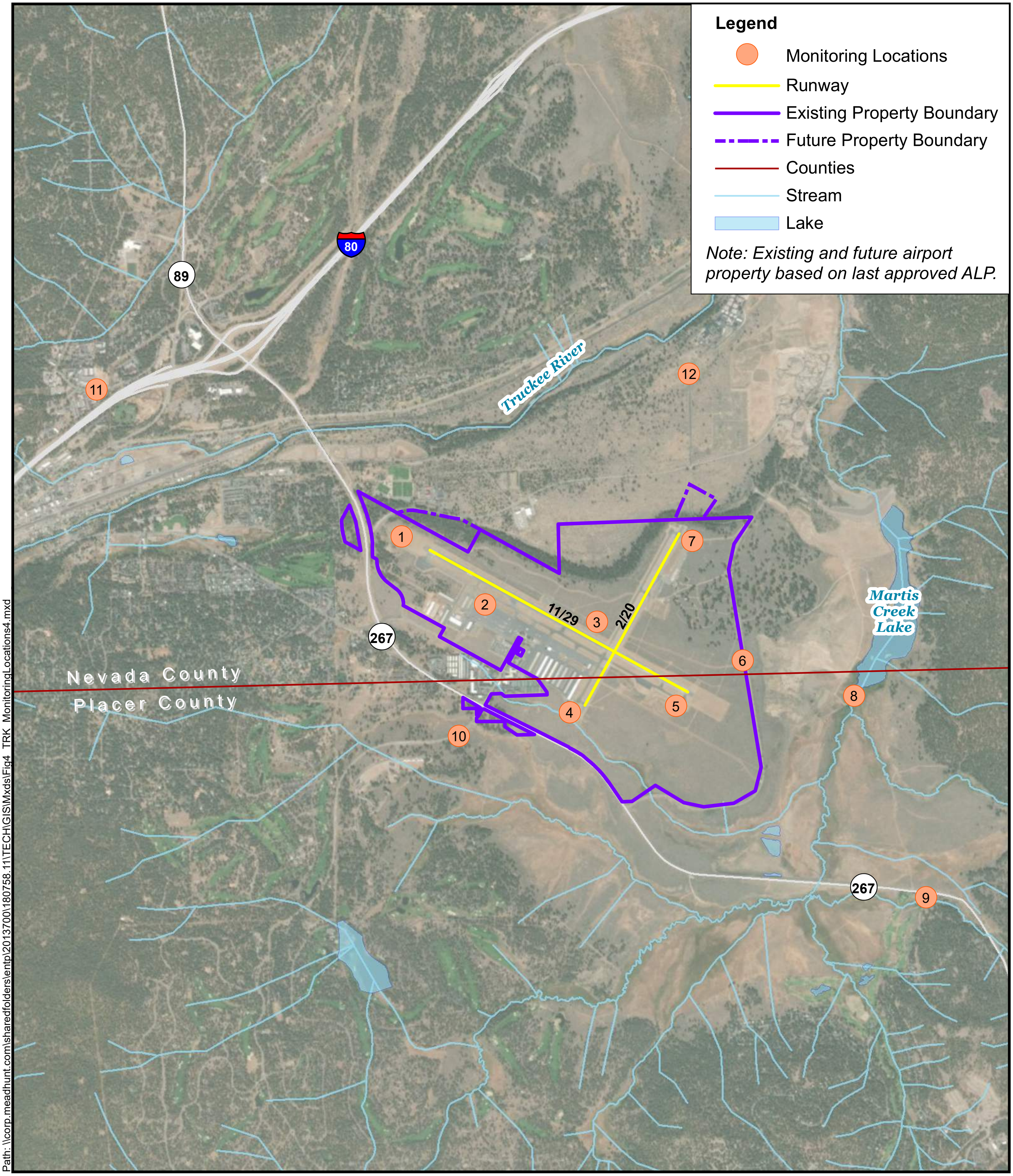

Figure 4
WHA Observation Points
Truckee Tahoe Airport
Nevada and Placer Counties, California

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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3.1.4 General Observations

In addition to data obtained during formal survey events, data was obtained from general observations pertaining to the presence or evidence of wildlife (e.g., scat, tracks) that were not associated with a fixed-point monitoring location. General observations included wildlife observed while traveling between monitoring locations, in hangars, adjacent to the airport, or while conducting other activities on TRK property.

3.2 Additional Data Collection

3.2.1 Habitat Observation

The QAWB also identified habitats and biological communities present on Airport property that could attract or support wildlife (vegetation, sage brush, woodlands, lakes, structures, buildings, and hangars).

3.2.2 Interviews with Airport Personnel

Mead & Hunt conducted interviews with Ms. Stacey Justesen, Safety and Security Manager, to discuss their observation of wildlife, known wildlife strike, and to gain an understanding of known wildlife hazard issues and wildlife management techniques used at TRK.

3.2.3 General Inspections of On-Airport and Off-Airport Areas

General inspections were conducted to identify features that were observed or had the potential to attract hazardous wildlife. Such features included sage brush, lakes, woodlands, golf courses, buildings, hangars, and airfield structures.

Wildlife use of the TRK property and facilities may change over time as a result of seasonal and daily variations in site conditions and weather patterns. The WHSV data provides only a snapshot of the wildlife presence and behavior on and near the Airport; therefore, the data should not be viewed as a definitive representation of wildlife populations and behavior at TRK, but as a baseline for identifying recommendations to support future studies. Any proposed modifications or improvements to TRK property or facilities should be evaluated by a QAWB to identify their potential effect on wildlife presence, location, behavior, and abundance in the AOA and surrounding areas. Such modifications include changes to structures, landscaping, and stormwater management and drainage facilities.

4.1 Wildlife Observations

4.1.1 Standardized Wildlife Surveys

Table 4-1 presents the number of birds and mammals observed both on and near the Airport property during standardized surveys.

Table 4-1. Birds and Mammals Observed during Standardized Surveys October 25-27, 2019

Guilds and Species Observed	*Scientific Name*	Abundance
Raptors		
Northern Harrier	*Circus hudsonius*	3
Red-tailed Hawk	*Buteo jamaicensis*	7
Sparrows/Larks		
Song Sparrow	*Melospiza melodia*	10
Horned Lark	*Eremophila alpestris*	6
Waterbirds		
Great Blue Heron	*Ardea herodias*	1
Common Merganser	*Mergus merganser*	6
Pied-billed Grebe	*Podilymbus podiceps*	7
Eared Grebe	*Podiceps nigricollis*	7
Doves/Pigeons		
Rock Pigeon	*Columba livia*	39
Waterfowl		
Canada Goose	*Branta canadensis*	96
Mallard	*Anas platyrhynchos*	30
American Coot	*Fulica americana*	325
American Wigeon	*Setophaga ruticilla*	223
Ring-necked Duck	*Aythya collaris*	13
Blackbirds		
European Starling	*Sturnus vulgaris*	40
Red-winged Blackbird	*Agelaius phoeniceus*	1
Corvids		
Common Raven	*Corvus corax*	28
Other		
Mountain Bluebird	*Sialia currucoides*	14
Northern Flicker	*Colaptes auratus*	7
Steller's Jay	*Cyanocitta stelleri*	6
Northern Mockingbird	*Mimus polyglottos*	3
American Robin	*Turdus migratorius*	2
Mammals		
Coyote	*Canis latrans*	6
Mule Deer	*Odocoileus hemionus*	36
Total individuals observed from 24 species		**916**

As shown on **Table 4-1**, a total of 916 birds and mammals from 24 wildlife species were observed. To analyze the wildlife data, the species observed were organized into groups or “guilds” based on similar behavior or habitat preferences. While some guild members may be taxonomically different and have different diets, they typically exhibit similar behavior are found in similar vegetative habitats or pose similar risks to aircraft operations. Birds that exhibit similar behavior tend to respond in a similar way to wildlife control methods, such as habitat modification, exclusion, or hazing using dispersal techniques.

The species richness observed at TRK was typical for the region and during the time of year the WHSV was conducted (late fall migration). Most of the species observed are common to the area or are fall migrants through the Truckee region. The most frequently observed bird species observed at TRK were waterfowl (e.g., ducks and Canada geese) that were observed at Martis Creek Lake. Coyotes and deer were frequently observed within the AOA.

4.1.2 Nighttime Spotlight Surveys

Two nighttime spotlight surveys were conducted during the WHSV. Coyotes and deer were observed within the AOA during the spotlight surveys. For both nights, three coyotes were observed, and 26 deer were observed within the AOA.

4.1.3 Game Camera Surveys

A game camera was installed on the airfield to monitor mammal activity during the two-night site visit. The camera location was moved each day to monitor wildlife presence and movement throughout the airport both day and night. The game camera documented the presence of deer in the AOA.

4.1.4 Threatened and/or Endangered Species

The United States Fish and Wildlife Service (USFWS) identifies rare, threatened, and endangered species throughout the nation. USFWS data were reviewed to identify the presence of federally listed species in the airport vicinity. Two federally endangered species were identified for Placer and Nevada counties: the Sierra Nevada yellow-legged frog (*Rana sierrae*) and the Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*). Neither of these species was observed during the WHSV. In addition to federally listed species, migratory bird species receive protection under the federal Migratory Bird Treaty Act (MBTA).

The California Department of Fish and Wildlife issues a list of threatened, endangered, and species of special concern within the State of California. No state-listed species were observed during the WHSV.

4.2 Wildlife Attractants

4.2.1 On-Airport Wildlife Attractants

The greatest wildlife attractants observed on TRK were the large expanses of sage brush outside the RSAs and within the AOA. This dense sage brush is attractive to various species of hazardous birds and provides cover for coyotes and deer. The extensive sage brush within the AOA attracts various bird species that forage, loaf, and nest within the grass. As previously stated, the dense brush obscures views of potentially hazardous birds and mammals from the airport staff and the removal or clearing of the brush will make hazardous wildlife more visible to maintenance staff and aircraft. Brush removal is a necessary measure for preventing or reducing potential conflicts between wildlife and aircraft operations at TRK.

Woodlands are located at the airport boundary that are attractive to raptors, ravens, doves, and other woodland birds that fly back and forth across the AOA and runways. These woodlands also provide cover for coyotes and deer that can move across the AOA from woodland to woodland.

Wildlife exclusion is an important component in managing on-site wildlife attractants. The absence of a security fence provides mammals, such as deer, dogs, and coyotes, with unrestricted access to aircraft movement areas. Mammals can create a significant hazard to aircraft as they move across the AOA.

Strikes with large mammals can be catastrophic. FAA identifies deer and other mammals as the species that pose the greatest threat to aircraft operations. Given the presence and abundance of deer within the local environment (**Photo 10**), it is strongly recommended that the TTAD consider the construction of a wildlife exclusion fence around the AOA. The wildlife exclusion fence should be of sufficient height to exclude deer, and the fence should be flush with ground level to prevent burrowing by coyotes and other *mammals. More detail on a wildlife exclusion fence can be found in the FAA Draft AC 150/5200-33B, Hazardous Wildlife Attractants on and Near Airports,* and FAA CertAlert No. 04-16, *Deer Hazard to Aircraft and Deer Fencing*.

Photo 10: Deer are frequently observed on the runway. This night photo was taken of a plane landing and deer loafing off the edge of the runway.

4.2.2 Off-Airport Wildlife Attractants

Martis Creek Lake is located northeast of the AOA. This open water source attracts Canada geese, various species of ducks, great blue herons, and other water and shorebirds which pose hazards to aircraft as they enter TRK airspace or even fly across or loaf within the AOA. Numerous golf courses are present north, west, and southwest of the airport. These golf courses include large groves of trees in which potentially hazardous bird species can roost (e.g., raptors and blackbirds) and large expanses of turf grass that are attractive to Canada geese and other waterfowl that pass above TRK and through its associated airspace as they travel to and from these locations.

FAA AC 150/5200-33B, *Hazardous Wildlife Attractants on and Near Airports*, identifies land use practices that attract or sustain hazardous wildlife and recommends minimum separation criteria between those land uses and airports. The FAA recommends a separation distance of at least 5,000 feet between hazardous wildlife attractants and airports that serve piston-powered aircraft, and at least 10,000 feet between attractants and airports, such as TRK, that serve turbine-powered aircraft. For all airports, the FAA recommends a separation of 5 statute miles between the farthest edge of the AOA and a hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace. AC 150/5200-33B identifies the following land uses as potential hazardous wildlife attractants: landfills, water management facilities, wetlands, spoil containment areas, agricultural activities, golf courses, and landscaping.

Section 5
Recommendations

Table 5-1 presents the passive management actions, active management actions, and administrative actions that are recommended at TRK. Each measure is prioritized to assist management with implementation.

Table 5-1. Recommended Wildlife Hazard Management Actions at TRK

Action Type	Action	Priority
Passive Management Actions	Construct a wildlife exclusion fence to prevent mammals, such as deer, from entering the AOA. The fence should be equipped with barbed-wire outriggers and a buried skirt to prevent burrowing by mammals. (Specifications regarding the construction of a wildlife exclusion fence are provided in FAA AC 150.5200-13.) FAA grant funds may be available to support fence construction.	Critical
Active Management Actions	• Continue to manage/mow sage brush in the AOA and increase the separation between sage brush and aircraft movement areas. • Consider use of pyrotechnical devices, such as screamers and bangers, to disperse wildlife from airport property. This report recognizes that TTAD may reject using pyrotechnic devices, and alternative dispersal techniques are recommended, such as biosonic calls, including alarm and distress calls, visual repellants, effigies, predator models/decoys, lasers, dogs and falconry, and lights and mirrors (examples of these dispersal techniques are further described in **Appendix C**, ACRP Report 23, Chapter 4), • Conduct regular wildlife patrols at the airport to identify hazardous wildlife in the AOA and to maintain the wildlife exclusion fence following construction. Specifically: monitor the on-site sagebrush and woodlands and disperse deer, coyotes, and birds from these locations. Continue to monitor wildlife presence and abundance at Martis Creek Lake to determine if birds are entering TRK airspace. • Obtain a federal depredation permit and Incorporate lethal controls, as necessary, to manage hazardous bird species (e.g., Canada geese, red-tailed hawks, etc.). In addition, obtain a state depredation permit to manage hazardous mammal species (e.g., coyote and deer). • Provide staff with wildlife hazard management training from a QAWB.	High
Administrative Actions	Record Wildlife Activity and Management Measures • Establish a Wildlife Observation and Management Log and document all wildlife management actions. • Report all wildlife strikes to the FAA Wildlife Strike Database: http://wildlife.faa.gov/database.aspx. • Formulate a protocol for airport users and/or pilots to report wildlife sightings or strikes directly to Airport management. Obtain necessary federal and state depredation permits to perform lethal control of hazardous bird species such as, Canada geese, red-tailed hawks, etc. • Advise pilots to issue pilot reports (PIREPs) relating to wildlife hazards on or near the airport. • Advise staff to issue a notice to airmen (NOTAM) if consistent and persistent wildlife hazards are identified on or near the airport at specific times. • Post signs and information on airport property (e.g., at airport user and fixed-base operator (FBO) offices) to increase awareness and promote the reporting of wildlife hazards.	High

5.1 Passive Management Actions

Construct the Perimeter Security/Wildlife Fence

It is recommended that the airport construct a wildlife exclusion fence, which may be eligible for FAA funding. As identified in FAA CertAlert No. 04-16, the fence should enclose the entire airport property, which will exclude wildlife from the AOA. Additionally, in accordance with FAA Order 5100-38D, Change 1, wildlife fencing is normally eligible and justified on the Sponsor's adoption of the WHSV Report.

Mammals, such as deer, pose risks to aircraft when they have access to the AOA. Mammal strikes can cause severe damage up to the complete destruction of aircraft because such strikes occur during sensitive takeoff and landing cycles. The QAWB who completed the site visit determined that the primary concern at TRK is the absence of a perimeter fence, which allows deer and other mammals to pass through the AOA. The construction of a wildlife exclusion fence may be eligible for FAA funding through an AIP grant. If FAA funding is not available, it is highly recommended that the TTAD undertake a phased approach to the installation of a complete perimeter fence.

5.2 Active Management Actions

Establish Regular Wildlife Patrols at the Airport and Within the AOA

It is recommended that TTAD establish daily wildlife patrols to identify hazardous wildlife on and near the AOA, and staff should record observations in a wildlife management logbook. The frequency of wildlife patrols should increase during the spring and fall to address the presence of migratory birds. The wildlife patrols can be incorporated into ongoing inspections of the AOA and movement areas.

Continue to Monitor Wildlife Presence, Behavior, and Abundance both On and Off Airport

The data obtained during the three-day WHSV presents a snapshot of wildlife presence at TRK. Site conditions and wildlife presence vary daily, seasonally, and annually; therefore, it is important that TTAD continue to monitor wildlife presence, behavior, and abundance on and adjacent to the airport.

In addition, off-site monitoring should be performed regularly at the following locations:

- *Monitor Martis Creek Lake for the Presence of Hazardous Bird Abundance.* Martis Creek Lake attracts large numbers of Canada geese, various species of waterfowl, great blue herons, and other water birds and shore birds. Airport staff should monitor the lake to determine whether birds that travel to and from this location also gain access to the AOA or fly through nearby airspace. If birds at this location are entering the AOA, it is recommended TTAD work with the United States Army Corp of Engineers to address possible bird control/management at the lake.

- *Monitor on-Airport and Adjacent Woodlands for Hazard Bird Abundance.* The on-site and adjacent woodlands provide perching and roosting opportunities for birds and provide cover for deer and coyotes. Birds that fly to or disperse from these locations and have the potential to fly across the runway or enter nearby airspace, and they have the potential to create adverse effects on departing or landing aircraft. Airport staff should monitor the on-Airport and adjacent woodlands to determine whether birds that are going to/from this location are crossing into the

AOA or flying through protected airspace. If birds are entering the AOA from off-Airport woodlands, it is recommended TTAD seek permission from the property owner to disperse the birds and work with or a QAWB to identify potential bird control measures that could be implemented in cooperation with the property owner.

Use Pyrotechnics or Alternative Devices to Disperse/Harass Wildlife

It is recommended that TTAD actively harass wildlife observed within the AOA by incorporating the use of pyrotechnic devices or alternative devices that help disperse wildlife. ACRP Report 32 (Chapter 4), *Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports* (**Appendix C**) provides detailed information on the use of pyrotechnics to disperse/harass hazardous wildlife.

After discussion with TTAD staff, the use of pyrotechnics, especially during the dry season (which corresponds to the migratory season) is discouraged at the Airport. As an alternative, the following alternative dispersal techniques are suggested for TTAD to use in lieu of pyrotechnic devices: biosonic calls, including alarm and distress calls, visual repellants, effigies, predator models/decoys, lasers, dogs and falconry, and lights and mirrors. Examples of these dispersal techniques are further described in ACRP Report 23, Chapter 4 (**Appendix C**).

Incorporate Lethal Control as Necessary

Most wildlife will habituate to non-lethal harassment measures over time. Lethal control can help to reinforce the use of non-lethal methods. ACRP Synthesis Report 39, *Airport Wildlife Population Management,* provides detailed information on incorporating lethal control of hazardous wildlife. Although lethal control may not be desirable to the public, the benefits outweigh the negative impacts. Lethal control should always be used only as a last resort when other methods fail or require reinforcement. USDA-WS and private wildlife control contractors may also implement lethal control through a contract with TADD, if needed.

Continue to Manage and Mow On-Airport Sage Brush

The most significant wildlife attractants observed at TRK were large expanses of sage brush outside the RSAs and within the AOA. The dense brush obscures potentially hazardous birds and mammals from the view of airport staff, and its removal will make hazardous wildlife more visible to maintenance staff and aircraft. Brush removal is a necessary measure for preventing or reducing potential conflicts between wildlife and aircraft operations at TRK. It is imperative that TTAD continue to monitor wildlife use in these areas and incorporate necessary wildlife management measures. such as increasing the separation between sage brush and aircraft movement areas.

5.3 Administrative Actions

Document Wildlife Management Actions

It is recommended that TTAD staff document all wildlife management actions performed at the airport using a wildlife management log. The log can be used to demonstrate TTAD's diligence in addressing wildlife hazards. The data in the log can also be used to identify trends in wildlife presence and the most effective management techniques.

Obtain Necessary Permits to Control Hazardous Wildlife

A federal depredation permit must be obtained from the United States Fish and Wildlife Service to perform the lethal control of migratory bird species (e.g., Canada geese and raptors), and a state depredation is required from the California Department of Fish and Wildlife to perform the lethal control of state-managed mammals (e.g., deer and coyotes). TTAD will be required to renew the permits annually with the proper federal and state agencies. TTAD may enter into a contract with USDA-WS to perform lethal management at the Airport.

Equip and Train Airport Personnel to Identify and Manage Hazardous Wildlife

Airport personnel may receive training in wildlife identification and management procedures, so they can respond to wildlife hazards appropriately and in accordance with federal and state regulations. Personnel should be equipped with the proper equipment needed to manage hazardous wildlife, including but not be limited to:

- binoculars,
- bird and mammal identification manuals,
- wildlife management logbook,
- personal protective equipment.

Report Wildlife Strikes and Record Observations

It is recommended that TTAD initiate practices to report all wildlife strikes that occur at TRK to the FAA Wildlife Strike Database. Strikes may be reported quickly using an online form that is available at: http://wildlife.faa.gov. Airport users should be encouraged to report strikes to airport staff and record strikes in FAA's Wildlife Strike Database.

Although the FAA maintains a voluntary reporting system for wildlife strikes, it is recommended that all wildlife strikes and observations be reported to better identify wildlife trends and monitor the effect of wildlife control measures. To do so, it is recommended TTAD establish a protocol for airport users, FBOs, pilots, and TRK staff to report wildlife sightings and strikes to TRK management who should maintain a log of those events. Wildlife records and management logs are routinely incorporated into WHMPs.

- **Instruct and Advise Pilots to Issue PIREPS**. Advise pilots to issue PIREPs via UNICOM or common traffic advisory frequency that pertain to wildlife hazards on or near the airport. Pilots should be encouraged to issue a PIREP whenever they observe wildlife that could pose a hazard to other aircraft in the airport vicinity.

- **Issue Notices to Airmen (NOTAMs).** It is recommended the Airport Operations Manager issue a NOTAM if consistent or persistent wildlife hazards are identified at specific times. NOTAMs can be beneficial during periods of peak wildlife activity, but the NOTAMs should be specific and not include generic phrases such as “wildlife on and in the vicinity of the airport.”

- **Post Signs and information to Increase Awareness of Hazardous Wildlife.** It is recommended TRK staff place posters and signs pertaining to hazardous wildlife and strike reporting throughout the airport property to increase the awareness of wildlife hazards. Posters are available from FAA, and newsletters or simple email notifications can be sent to all airport tenants and stakeholders to alert them to the presence of potentially hazardous wildlife, the potential effects of wildlife strikes, and strike reporting procedures.

5.4 Final Recommendations and Next Steps

The data obtained by a QAWB during recent field surveys and discussions with Airport staff and other airport users was sufficient to identify the presence of hazardous wildlife on and near TRK. Species-specific wildlife hazards, especially those posed by deer and coyotes, were evident.

Several tools are available to manage the wildlife hazards observed. For example, the use of alternative dispersal techniques as described in ACRP Report 23, Chapter 4 (**Appendix C**), and the consistent hazing of wildlife would help to discourage wildlife from the AOA. The construction and installation of a complete and secure wildlife fence would help to exclude large mammals from the AOA. Depredation permits should be obtained from the California Department of Fish and Wildlife and USDA-WS, to perform lethal management as part of an overall wildlife hazard management program.

This WHSV Report should serve as the final documentation for the assessment of wildlife hazards at the TRK Airport. A WHA is not recommended because the WHSV was conducted and reviewed by a QAWB, and the documentation is sufficient to identify the types of wildlife present and wildlife management measures necessary. Based on the findings and recommendations presented in this WHSV Report, a formal WHMP appears to be warranted for the TRK.

At the discretion of TTAD, this WHSV Report may be shared with the FAA for review. If the FAA reviews the WHSV Report and concurs with the recommendation presented, the WHMP may be eligible for federal funding. If FAA reviews and accepts the subsequent Management Plan, the measures identified in the Plan may also be eligible for federal funding.

Section 6
References

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WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

Appendix A: Author Accreditation

Mead & Hunt

RICK JONES, CWB
FAA-QUALIFIED AIRPORT WILDLIFE BIOLOGIST

Rick Jones is an FAA-qualified wildlife biologist and a certified wildlife biologist with 16 years of professional consulting experience, extensive wildlife hazard management expertise, and a strong working knowledge of the aviation industry. Rick has been responsible for developing and implementing wildlife hazard management programs across the western US. He has completed or is currently working on projects at more than 60 airports across the country. At these airports, he has been responsible for conducting wildlife hazard assessments (WHA), writing the wildlife hazard management plans (WHMP), and training airport personnel on wildlife management and hazards. He provides direction to airport personnel and tenants to support day-to-day compliance with regulations, protocols and procedures related to the implementation of 14 CFR Part 139.337 and other pertinent regulations. He has provided wildlife damage/hazard assistance to airport managers; consultants; federal, state, and local governments; trade groups; and individuals. He is skilled at interagency coordination associated with wildlife management and has budgeted, planned, and initiated a variety of wildlife management programs and helped resolve wildlife conflicts at airports and for municipalities. Rick understands the methods and tools used to avoid and minimize wildlife conflicts on and near airports.

Rick also works with airport personnel, US Fish and Wildlife Service, US Department of Agriculture, and state wildlife agencies to support airport wildlife management activities and permit renewal applications. As project manager, Rick coordinates with airlines, fixed-base operators (FBOs), city/county officials and other stakeholders to convey the importance of wildlife hazard management. Rick's ability to effectively and efficiently work with airports, project teams, regulatory agencies and various stakeholders, along with his strong problem solving and communication skills, have resulted in a proven record of successful projects.

To date, Rick has been involved in Wildlife Hazard Assessments (WHAs), Wildlife Hazard Management Plans (WHMPs), or Wildlife Hazard Site Visits, or wildlife hazard management training projects at the following airports:

- Yampa Valley Regional Airport, Hayden, CO
- Cortez Municipal Airport, Cortez, CO
- Pueblo Memorial Airport, Pueblo, CO
- Four Corners Regional Airport, Farmington, NM
- Denton Municipal Airport, Denton, TX
- Lone Star Executive Airport, Conroe, TX
- Athens Municipal Airport, Athens, TX
- Jackson Hole Airport, Jackson, WY
- Sherwood Airport, Plentywood, MT
- Sandpoint Airport, Sandpoint, ID
- Klamath Regional Airport, Klamath Falls, OR
- Fresno Yosemite International Airport, Fresno, CA
- Livermore Municipal Airport, Livermore, CA
- Fullerton Municipal Airport, Fullerton, CA
- San Carlos Airport, San Carlos, CA

Areas of Expertise

- Wildlife damage management
- Wildlife hazard assessments
- Wildlife hazard management plans
- NEPA regulations
- Environmental planning
- Project management
- Regulatory compliance
- Financial management

Education

- MS, Wildlife Ecology, Texas State University, 2008
- BS, Field Biology, University of Northern Colorado, 2003

Registration/Certification

- Certified Wildlife Biologist (CWB)
- FAA Qualified Airport Wildlife Biologist

Memberships

- The Wildlife Society (National Chapter)
- Colorado Chapter of the Wildlife Society
- Association of Field Ornithologist
- Pheasants/Quail Forever
- Rocky Mountain Elk Foundation
- Wildlife Damage Management Working Group (The Wildlife Society)

Training and Seminars

- The Wildlife Society's Leadership Institute, 2010
- Airport Wildlife Hazard Management Training, ERAU, 2010
- Airport Wildlife Trainer's Course, ERAU, 2010
- Bird Strike Committee USA Annual Conference, 2009-2019
- Embry-Riddle Aeronautical University: Wildlife Hazard Training Session
- AAAE, Airport Wildlife Trainer's Course
- Basic/Advanced NEPA Training, NWETC, 2018

- Hayward Executive Airport, Hayward, CA
- Palo Alto Airport, Palo Alto, CA
- Salinas Municipal Airport, Salinas, CA
- Watsonville Airport, Watsonville, CA
- Chino Municipal Airport, Chino, CA
- Whiteman Municipal Airport, Pacoima, CA
- Hawthorne Municipal Airport, Hawthorne, CA
- Riverside Municipal Airport, Riverside, CA
- Cable Airport, Upland, CA
- Brackett Field, La Verne, CA
- William J. Fox Field, Lancaster, CA
- El Monte Airport, El Monte, CA
- Camarillo Airport, Camarillo, CA
- Boulder City Municipal Airport, Boulder City, NV
- Auburn Municipal Airport, Auburn, WA
- Dallas Executive Airport, Dallas, TX
- Inyokern Airport, Inyokern, CA
- San Bernardino International Airport, San Bernardino, CA
- Stockton Metropolitan Airport, Stockton, CA
- Grand Canyon National Park Airport, Tusayan, AZ
- Goodyear Airport, Goodyear, AZ
- Falcon Field, Falcon, AZ
- Deer Valley Airport, Phoenix, AZ
- Scottsdale Airport, Scottsdale, AZ
- Glendale Airport, Glendale, AZ
- Chandler Airport, Phoenix, AZ
- Casa Grande Airport, Casa Grande, AZ
- Marana Regional Airport, Marana, AZ
- Coeur D' Alene Airport, Coeur D' Alene, ID
- Nampa Municipal Airport, Nampa, ID
- Sand Point Airport, Sand Point, ID
- Bremerton National Airport, Bremerton, WA
- Napa County Airport, Napa, CA
- French Valley Airport, Murrieta, CA
- Hemet-Ryan Airport, Hemet, CA
- Oakdale Municipal Airport, Oakdale, CA
- Jacqueline Cochran Airport, Thermal, CA
- Corvallis Municipal Airport, Corvallis, OR
- Eastern Oregon Regional Airport, Pendleton, OR
- Scappoose Industrial Airpark, Scappoose, OR
- New Ulm Municipal Airport, New Ulm, MN
- Provo Municipal Airport, Provo, UT
- Ogden Municipal Airport, Ogden, UT
- Cache County-Logan Airport, Logan, UT

Past Employment

- Kleinfelder, Inc.
  10 years, Wildlife Biologist
- Mead & Hunt, Inc.
  7 years, Senior Wildlife Biologist

WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

Appendix B: FAA Advisory Circular 150/5200-33B Hazardous Wildlife Attractants on or Near Airports

Mead & Hunt

U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

Date: 8/28/2007

AC No: 150/5200-33B

Initiated by: AAS-300

Change:

1. PURPOSE. This Advisory Circular (AC) provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. It also discusses airport development projects (including airport construction, expansion, and renovation) affecting aircraft movement near hazardous wildlife attractants. Appendix 1 provides definitions of terms used in this AC.

2. APPLICABILITY. The Federal Aviation Administration (FAA) recommends that public-use airport operators implement the standards and practices contained in this AC. The holders of Airport Operating Certificates issued under Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports, Subpart D (Part 139), may use the standards, practices, and recommendations contained in this AC to comply with the wildlife hazard management requirements of Part 139. Airports that have received Federal grant-in-aid assistance must use these standards. The FAA also recommends the guidance in this AC for land-use planners, operators of non-certificated airports, and developers of projects, facilities, and activities on or near airports.

3. CANCELLATION. This AC cancels AC 150/5200-33A, *Hazardous Wildlife Attractants on or near Airports*, dated July 27, 2004.

4. PRINCIPAL CHANGES. This AC contains the following major changes, which are marked with vertical bars in the margin:

a. Technical changes to paragraph references.

b. Wording on storm water detention ponds.

c. Deleted paragraph 4-3.b, *Additional Coordination.*

5. BACKGROUND. Information about the risks posed to aircraft by certain wildlife species has increased a great deal in recent years. Improved reporting, studies, documentation, and statistics clearly show that aircraft collisions with birds and other wildlife are a serious economic and public safety problem. While many species of wildlife can pose a threat to aircraft safety, they are not equally hazardous. Table 1 ranks the wildlife groups commonly involved in damaging strikes in the United States according to their relative hazard to aircraft. The ranking is based on the 47,212 records in the FAA National Wildlife Strike Database for the years 1990 through 2003. These hazard rankings, in conjunction with site-specific Wildlife Hazards Assessments (WHA), will help airport operators determine the relative abundance and use patterns of wildlife species and help focus hazardous wildlife management efforts on those species most likely to cause problems at an airport.

Most public-use airports have large tracts of open, undeveloped land that provide added margins of safety and noise mitigation. These areas can also present potential hazards to aviation if they encourage wildlife to enter an airport's approach or departure airspace or air operations area (AOA). Constructed or natural areas—such as poorly drained locations, detention/retention ponds, roosting habitats on buildings, landscaping, odor-causing rotting organic matter (putrescible waste) disposal operations, wastewater treatment plants, agricultural or aquaculture activities, surface mining, or wetlands—can provide wildlife with ideal locations for feeding, loafing, reproduction, and escape. Even small facilities, such as fast food restaurants, taxicab staging areas, rental car facilities, aircraft viewing areas, and public parks, can produce substantial attractions for hazardous wildlife.

During the past century, wildlife-aircraft strikes have resulted in the loss of hundreds of lives worldwide, as well as billions of dollars in aircraft damage. Hazardous wildlife attractants on and near airports can jeopardize future airport expansion, making proper community land-use planning essential. This AC provides airport operators and those parties with whom they cooperate with the guidance they need to assess and address potentially hazardous wildlife attractants when locating new facilities and implementing certain land-use practices on or near public-use airports.

6. MEMORANDUM OF AGREEMENT BETWEEN FEDERAL RESOURCE AGENCIES. The FAA, the U.S. Air Force, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture - Wildlife Services signed a Memorandum of Agreement (MOA) in July 2003 to acknowledge their respective missions in protecting aviation from wildlife hazards. Through the MOA, the agencies established procedures necessary to coordinate their missions to address more effectively existing and future environmental conditions contributing to collisions between wildlife and aircraft (wildlife strikes) throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety while protecting the Nation's valuable environmental resources.

DAVID L. BENNETT
Director, Office of Airport Safety
and Standards

Table 1. Ranking of 25 species groups as to relative hazard to aircraft (1=most hazardous) based on three criteria (damage, major damage, and effect-on-flight), a composite ranking based on all three rankings, and a relative hazard score. Data were derived from the FAA National Wildlife Strike Database, January 1990–April 2003.[1]

	Ranking by criteria				
Species group	Damage[4]	Major damage[5]	Effect on flight[6]	Composite ranking[2]	Relative hazard score[3]
Deer	1	1	1	1	100
Vultures	2	2	2	2	64
Geese	3	3	6	3	55
Cormorants/pelicans	4	5	3	4	54
Cranes	7	6	4	5	47
Eagles	6	9	7	6	41
Ducks	5	8	10	7	39
Osprey	8	4	8	8	39
Turkey/pheasants	9	7	11	9	33
Herons	11	14	9	10	27
Hawks (buteos)	10	12	12	11	25
Gulls	12	11	13	12	24
Rock pigeon	13	10	14	13	23
Owls	14	13	20	14	23
H. lark/s. bunting	18	15	15	15	17
Crows/ravens	15	16	16	16	16
Coyote	16	19	5	17	14
Mourning dove	17	17	17	18	14
Shorebirds	19	21	18	19	10
Blackbirds/starling	20	22	19	20	10
American kestrel	21	18	21	21	9
Meadowlarks	22	20	22	22	7
Swallows	24	23	24	23	4
Sparrows	25	24	23	24	4
Nighthawks	23	25	25	25	1

[1] Excerpted from the *Special Report for the FAA, "Ranking the Hazard Level of Wildlife Species to Civil Aviation in the USA: Update #1, July 2, 2003".* Refer to this report for additional explanations of criteria and method of ranking.
[2] Relative rank of each species group was compared with every other group for the three variables, placing the species group with the greatest hazard rank for ≥ 2 of the 3 variables above the next highest ranked group, then proceeding down the list.
[3] Percentage values, from Tables 3 and 4 in Footnote 1 of the *Special Report*, for the three criteria were summed and scaled down from 100, with 100 as the score for the species group with the maximum summed values and the greatest potential hazard to aircraft.
[4] Aircraft incurred at least some damage (destroyed, substantial, minor, or unknown) from strike.
[5] Aircraft incurred damage or structural failure, which adversely affected the structure strength, performance, or flight characteristics, and which would normally require major repair or replacement of the affected component, or the damage sustained makes it inadvisable to restore aircraft to airworthy condition.
[6] Aborted takeoff, engine shutdown, precautionary landing, or other.

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SECTION 1.

GENERAL SEPARATION CRITERIA FOR HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS.

1-1. INTRODUCTION. When considering proposed land uses, airport operators, local planners, and developers must take into account whether the proposed land uses, including new development projects, will increase wildlife hazards. Land-use practices that attract or sustain hazardous wildlife populations on or near airports can significantly increase the potential for wildlife strikes.

The FAA recommends the minimum separation criteria outlined below for land-use practices that attract hazardous wildlife to the vicinity of airports. Please note that FAA criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA). (See the discussion of the synergistic effects of surrounding land uses in Section 2-8 of this AC.)

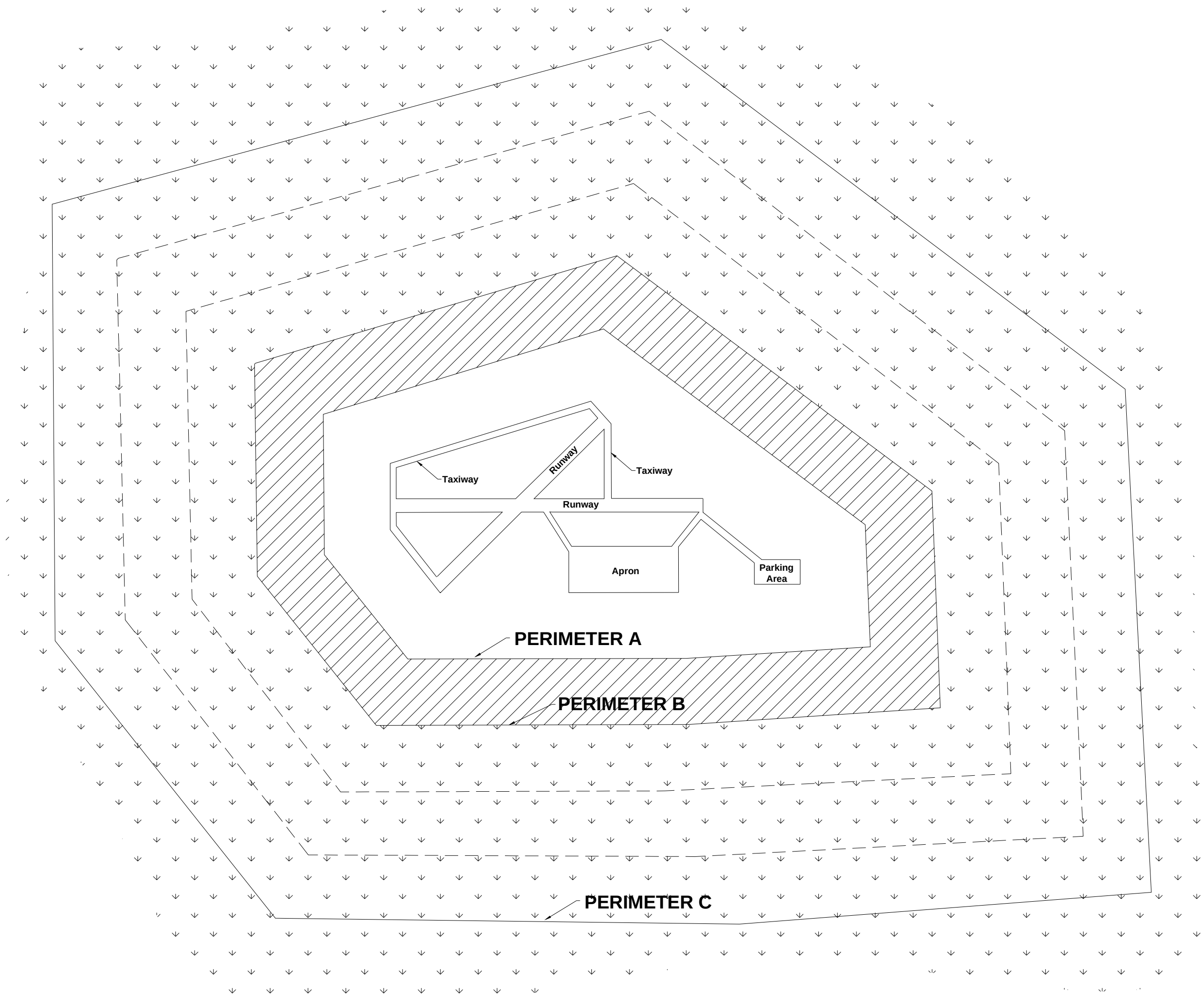
The basis for the separation criteria contained in this section can be found in existing FAA regulations. The separation distances are based on (1) flight patterns of piston-powered aircraft and turbine-powered aircraft, (2) the altitude at which most strikes happen (78 percent occur under 1,000 feet and 90 percent occur under 3,000 feet above ground level), and (3) National Transportation Safety Board (NTSB) recommendations.

1-2. AIRPORTS SERVING PISTON-POWERED AIRCRAFT. Airports that do not sell Jet-A fuel normally serve piston-powered aircraft. Notwithstanding more stringent requirements for specific land uses, the FAA recommends a separation distance of 5,000 feet at these airports for any of the hazardous wildlife attractants mentioned in Section 2 or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA and the hazardous wildlife attractant. Figure 1 depicts this separation distance measured from the nearest aircraft operations areas.

1-3. AIRPORTS SERVING TURBINE-POWERED AIRCRAFT. Airports selling Jet-A fuel normally serve turbine-powered aircraft. Notwithstanding more stringent requirements for specific land uses, the FAA recommends a separation distance of 10,000 feet at these airports for any of the hazardous wildlife attractants mentioned in Section 2 or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA and the hazardous wildlife attractant. Figure 1 depicts this separation distance from the nearest aircraft movement areas.

1-4. PROTECTION OF APPROACH, DEPARTURE, AND CIRCLING AIRSPACE. For all airports, the FAA recommends a distance of 5 statute miles between the farthest edge of the airport's AOA and the hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace.

Figure 1. Separation distances within which hazardous wildlife attractants should be avoided, eliminated, or mitigated.



PERIMETER A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest air operations area.

PERIMETER B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest air operations area.

PERIMETER C: 5-mile range to protect approach, departure and circling airspace.

SECTION 2.

LAND-USE PRACTICES ON OR NEAR AIRPORTS THAT POTENTIALLY ATTRACT HAZARDOUS WILDLIFE.

2-1. GENERAL. The wildlife species and the size of the populations attracted to the airport environment vary considerably, depending on several factors, including land-use practices on or near the airport. This section discusses land-use practices having the potential to attract hazardous wildlife and threaten aviation safety. In addition to the specific considerations outlined below, airport operators should refer to *Wildlife Hazard Management at Airports,* prepared by FAA and U.S. Department of Agriculture (USDA) staff. (This manual is available in English, Spanish, and French. It can be viewed and downloaded free of charge from the FAA's wildlife hazard mitigation web site: http://wildlife-mitigation.tc.FAA.gov.). And, *Prevention and Control of Wildlife Damage,* compiled by the University of Nebraska Cooperative Extension Division. (This manual is available online in a periodically updated version at: ianrwww.unl.edu/wildlife/solutions/handbook/.)

2-2. WASTE DISPOSAL OPERATIONS. Municipal solid waste landfills (MSWLF) are known to attract large numbers of hazardous wildlife, particularly birds. Because of this, these operations, when located within the separations identified in the siting criteria in Sections 1-2 through 1-4, are considered incompatible with safe airport operations.

a. Siting for new municipal solid waste landfills subject to AIR 21. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106-181) (AIR 21) prohibits the construction or establishment of a new MSWLF within 6 statute miles of certain public-use airports. Before these prohibitions apply, both the airport and the landfill must meet the very specific conditions described below. These restrictions do not apply to airports or landfills located within the state of Alaska.

The airport must (1) have received a Federal grant(s) under 49 U.S.C. § 47101, et. seq.; (2) be under control of a public agency; (3) serve some scheduled air carrier operations conducted in aircraft with less than 60 seats; and (4) have total annual enplanements consisting of at least 51 percent of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats.

The proposed MSWLF must (1) be within 6 miles of the airport, as measured from airport property line to MSWLF property line, and (2) have started construction or establishment on or after April 5, 2001. Public Law 106-181 only limits the construction or establishment of some new MSWLF. It does not limit the expansion, either vertical or horizontal, of existing landfills.

NOTE: Consult the most recent version of AC 150/5200-34, *Construction or Establishment of Landfills Near Public Airports,* for a more detailed discussion of these restrictions.

b. Siting for new MSWLF not subject to AIR 21. If an airport and MSWLF do not meet the restrictions of Public Law 106-181, the FAA recommends against locating MSWLF within the separation distances identified in Sections 1-2 through 1-4. The separation distances should be measured from the closest point of the airport's AOA to the closest planned MSWLF cell.

c. Considerations for existing waste disposal facilities within the limits of separation criteria. The FAA recommends against airport development projects that would increase the number of aircraft operations or accommodate larger or faster aircraft near MSWLF operations located within the separations identified in Sections 1-2 through 1-4. In addition, in accordance with 40 CFR 258.10, owners or operators of existing MSWLF units that are located within the separations listed in Sections 1-2 through 1-4 must demonstrate that the unit is designed and operated so it does not pose a bird hazard to aircraft. (See Section 4-2(b) of this AC for a discussion of this demonstration requirement.)

d. Enclosed trash transfer stations. Enclosed waste-handling facilities that receive garbage behind closed doors; process it via compaction, incineration, or similar manner; and remove all residue by enclosed vehicles generally are compatible with safe airport operations, provided they are not located on airport property or within the Runway Protection Zone (RPZ). These facilities should not handle or store putrescible waste outside or in a partially enclosed structure accessible to hazardous wildlife. Trash transfer facilities that are open on one or more sides; that store uncovered quantities of municipal solid waste outside, even if only for a short time; that use semi-trailers that leak or have trash clinging to the outside; or that do not control odors by ventilation and filtration systems (odor masking is not acceptable) do not meet the FAA's definition of fully enclosed trash transfer stations. The FAA considers these facilities incompatible with safe airport operations if they are located closer than the separation distances specified in Sections 1-2 through 1-4.

e. Composting operations on or near airport property. Composting operations that accept only yard waste (e.g., leaves, lawn clippings, or branches) generally do not attract hazardous wildlife. Sewage sludge, woodchips, and similar material are not municipal solid wastes and may be used as compost bulking agents. The compost, however, must never include food or other municipal solid waste. Composting operations should not be located on airport property. Off-airport property composting operations should be located no closer than the greater of the following distances: 1,200 feet from any AOA or the distance called for by airport design requirements (see AC 150/5300-13, *Airport Design*). This spacing should prevent material, personnel, or equipment from penetrating any Object Free Area (OFA), Obstacle Free Zone (OFZ), Threshold Siting Surface (TSS), or Clearway. Airport operators should monitor composting operations located in proximity to the airport to ensure that steam or thermal rise does not adversely affect air traffic. On-airport disposal of compost by-products should not be conducted for the reasons stated in 2-3f.

f. **Underwater waste discharges.** The FAA recommends against the underwater discharge of any food waste (e.g., fish processing offal) within the separations identified in Sections 1-2 through 1-4 because it could attract scavenging hazardous wildlife.

g. **Recycling centers.** Recycling centers that accept previously sorted non-food items, such as glass, newspaper, cardboard, or aluminum, are, in most cases, not attractive to hazardous wildlife and are acceptable.

h. **Construction and demolition (C&D) debris facilities.** C&D landfills do not generally attract hazardous wildlife and are acceptable if maintained in an orderly manner, admit no putrescible waste, and are not co-located with other waste disposal operations. However, C&D landfills have similar visual and operational characteristics to putrescible waste disposal sites. When co-located with putrescible waste disposal operations, C&D landfills are more likely to attract hazardous wildlife because of the similarities between these disposal facilities. Therefore, a C&D landfill co-located with another waste disposal operation should be located outside of the separations identified in Sections 1-2 through 1-4.

i. **Fly ash disposal.** The incinerated residue from resource recovery power/heat-generating facilities that are fired by municipal solid waste, coal, or wood is generally not a wildlife attractant because it no longer contains putrescible matter. Landfills accepting only fly ash are generally not considered to be wildlife attractants and are acceptable as long as they are maintained in an orderly manner, admit no putrescible waste of any kind, and are not co-located with other disposal operations that attract hazardous wildlife.

Since varying degrees of waste consumption are associated with general incineration (not resource recovery power/heat-generating facilities), the FAA considers the ash from general incinerators a regular waste disposal by-product and, therefore, a hazardous wildlife attractant if disposed of within the separation criteria outlined in Sections 1-2 through 1-4.

2-3. WATER MANAGEMENT FACILITIES. Drinking water intake and treatment facilities, storm water and wastewater treatment facilities, associated retention and settling ponds, ponds built for recreational use, and ponds that result from mining activities often attract large numbers of potentially hazardous wildlife. To prevent wildlife hazards, land-use developers and airport operators may need to develop management plans, in compliance with local and state regulations, to support the operation of storm water management facilities on or near all public-use airports to ensure a safe airport environment.

a. **Existing storm water management facilities.** On-airport storm water management facilities allow the quick removal of surface water, including discharges related to aircraft deicing, from impervious surfaces, such as pavement and terminal/hangar building roofs. Existing on-airport detention ponds collect storm water, protect water quality, and control runoff. Because they slowly release water after storms, they create standing bodies of water that can attract hazardous wildlife. Where the airport has developed a Wildlife Hazard Management Plan (WHMP) in accordance with Part 139, the FAA requires immediate correction of any wildlife hazards arising from existing storm water facilities located on or near airports, using appropriate wildlife hazard mitigation techniques. Airport operators should develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

Where possible, airport operators should modify storm water detention ponds to allow a maximum 48-hour detention period for the design storm. The FAA recommends that airport operators avoid or remove retention ponds and detention ponds featuring dead storage to eliminate standing water. Detention basins should remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom may remain wet, the detention facility should include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that may provide nesting habitat.

When it is not possible to drain a large detention pond completely, airport operators may use physical barriers, such as bird balls, wires grids, pillows, or netting, to deter birds and other hazardous wildlife. When physical barriers are used, airport operators must evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, airport operators must get approval from the appropriate FAA Regional Airports Division Office.

The FAA recommends that airport operators encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into storm water treatment facility operating practices when their facility is located within the separation criteria specified in Sections 1-2 through 1-4.

b. New storm water management facilities. The FAA strongly recommends that off-airport storm water management systems located within the separations identified in Sections 1-2 through 1-4 be designed and operated so as not to create above-ground standing water. Stormwater detention ponds should be designed, engineered, constructed, and maintained for a maximum 48–hour detention period after the design storm and remain completely dry between storms. To facilitate the control of hazardous wildlife, the FAA recommends the use of steep-sided, rip-rap lined, narrow, linearly shaped water detention basins. When it is not possible to place these ponds away from an airport's AOA, airport operators should use physical barriers, such as bird balls, wires grids, pillows, or netting, to prevent access of hazardous wildlife to open water and minimize aircraft-wildlife interactions. When physical barriers are used, airport operators must evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, airport operators must get approval from the appropriate FAA Regional Airports Division Office. All vegetation in or around detention basins that provide food or cover for hazardous wildlife should be eliminated. If soil conditions and other requirements allow, the FAA encourages the use of underground storm water infiltration systems, such as French drains or buried rock fields, because they are less attractive to wildlife.

c. Existing wastewater treatment facilities. The FAA strongly recommends that airport operators immediately correct any wildlife hazards arising from existing wastewater treatment facilities located on or near the airport. Where required, a WHMP developed in accordance with Part 139 will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should encourage wastewater treatment facility operators to incorporate measures, developed in consultation with a wildlife damage management biologist, to minimize hazardous wildlife attractants. Airport operators should also encourage those wastewater treatment facility operators to incorporate these mitigation techniques into their standard operating practices. In addition, airport operators should consider the existence of wastewater treatment facilities when evaluating proposed sites for new airport development projects and avoid such sites when practicable.

d. New wastewater treatment facilities. The FAA strongly recommends against the construction of new wastewater treatment facilities or associated settling ponds within the separations identified in Sections 1-2 through 1-4. Appendix 1 defines wastewater treatment facility as “any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes.” The definition includes any pretreatment involving the reduction of the amount of pollutants or the elimination of pollutants prior to introducing such pollutants into a publicly owned treatment works (wastewater treatment facility). During the site-location analysis for wastewater treatment facilities, developers should consider the potential to attract hazardous wildlife if an airport is in the vicinity of the proposed site, and airport operators should voice their opposition to such facilities if they are in proximity to the airport.

e. Artificial marshes. In warmer climates, wastewater treatment facilities sometimes employ artificial marshes and use submergent and emergent aquatic vegetation as natural filters. These artificial marshes may be used by some species of flocking birds, such as blackbirds and waterfowl, for breeding or roosting activities. The FAA strongly recommends against establishing artificial marshes within the separations identified in Sections 1-2 through 1-4.

f. Wastewater discharge and sludge disposal. The FAA recommends against the discharge of wastewater or sludge on airport property because it may improve soil moisture and quality on unpaved areas and lead to improved turf growth that can be an attractive food source for many species of animals. Also, the turf requires more frequent mowing, which in turn may mutilate or flush insects or small animals and produce straw, both of which can attract hazardous wildlife. In addition, the improved turf may attract grazing wildlife, such as deer and geese. Problems may also occur when discharges saturate unpaved airport areas. The resultant soft, muddy conditions can severely restrict or prevent emergency vehicles from reaching accident sites in a timely manner.

2-4. WETLANDS. Wetlands provide a variety of functions and can be regulated by local, state, and Federal laws. Normally, wetlands are attractive to many types of wildlife, including many which rank high on the list of hazardous wildlife species (Table 1).

NOTE: If questions exist as to whether an area qualifies as a wetland, contact the local division of the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, or a wetland consultant qualified to delineate wetlands.

a. Existing wetlands on or near airport property. If wetlands are located on or near airport property, airport operators should be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations. At public-use airports, the FAA recommends immediately correcting, in cooperation with local, state, and Federal regulatory agencies, any wildlife hazards arising from existing wetlands located on or near airports. Where required, a WHMP will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

b. New airport development. Whenever possible, the FAA recommends locating new airports using the separations from wetlands identified in Sections 1-2 through 1-4. Where alternative sites are not practicable, or when airport operators are expanding an existing airport into or near wetlands, a wildlife damage management biologist, in consultation with the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the state wildlife management agency should evaluate the wildlife hazards and prepare a WHMP that indicates methods of minimizing the hazards.

c. Mitigation for wetland impacts from airport projects. Wetland mitigation may be necessary when unavoidable wetland disturbances result from new airport development projects or projects required to correct wildlife hazards from wetlands. Wetland mitigation must be designed so it does not create a wildlife hazard. The FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in Sections 1-2 through 1-4.

(1) Onsite mitigation of wetland functions. The FAA may consider exceptions to locating mitigation activities outside the separations identified in Sections 1-2 through 1-4 if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge, which cannot be replicated when moved to a different location. Using existing airport property is sometimes the only feasible way to achieve the mitigation ratios mandated in regulatory orders and/or settlement agreements with the resource agencies. Conservation easements are an additional means of providing mitigation for project impacts. Typically the airport operator continues to own the property, and an easement is created stipulating that the property will be maintained as habitat for state or Federally listed species.

Mitigation must not inhibit the airport operator’s ability to effectively control hazardous wildlife on or near the mitigation site or effectively maintain other aspects of safe airport operations. Enhancing such mitigation areas to attract hazardous wildlife must be avoided. The FAA will review any onsite mitigation proposals to determine compatibility with safe airport operations. A wildlife damage management biologist should evaluate any wetland mitigation projects that are needed to protect unique wetland functions and that must be located in the separation criteria in Sections 1-2 through 1-4 before the mitigation is implemented. A WHMP should be developed to reduce the wildlife hazards.

(2) Offsite mitigation of wetland functions. The FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in Sections 1-2 through 1-4 unless they provide unique functions that must remain onsite (see 2-4c(1)). Agencies that regulate impacts to or around wetlands recognize that it may be necessary to split wetland functions in mitigation schemes. Therefore, regulatory agencies may, under certain circumstances, allow portions of mitigation to take place in different locations.

(3) Mitigation banking. Wetland mitigation banking is the creation or restoration of wetlands in order to provide mitigation credits that can be used to offset permitted wetland losses. Mitigation banking benefits wetland resources by providing advance replacement for permitted wetland losses; consolidating small projects into larger, better-designed and managed units; and encouraging integration of wetland mitigation projects with watershed planning. This last benefit is most helpful for airport projects, as wetland impacts mitigated outside of the separations identified in Sections 1-2 through 1-4 can still be located within the same watershed. Wetland mitigation banks meeting the separation criteria offer an ecologically sound approach to mitigation in these situations. Airport operators should work with local watershed management agencies or organizations to develop mitigation banking for wetland impacts on airport property.

2-5. DREDGE SPOIL CONTAINMENT AREAS. The FAA recommends against locating dredge spoil containment areas (also known as Confined Disposal Facilities) within the separations identified in Sections 1-2 through 1-4 if the containment area or the spoils contain material that would attract hazardous wildlife.

2-6. AGRICULTURAL ACTIVITIES. Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, the FAA recommends against the used of airport property for agricultural production, including hay crops, within the separations identified in Sections 1-2 through 1-4. . If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport shall follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design*, Appendix 17. The cost of wildlife control and potential accidents should be weighed against the income produced by the on-airport crops when deciding whether to allow crops on the airport.

a. Livestock production. Confined livestock operations (i.e., feedlots, dairy operations, hog or chicken production facilities, or egg laying operations) often attract flocking birds, such as starlings, that pose a hazard to aviation. Therefore, The FAA recommends against such facilities within the separations identified in Sections 1-2 through 1-4. Any livestock operation within these separations should have a program developed to reduce the attractiveness of the site to species that are hazardous to aviation safety. Free-ranging livestock must not be grazed on airport property because the animals may wander onto the AOA. Furthermore, livestock feed, water, and manure may attract birds.

b. Aquaculture. Aquaculture activities (i.e. catfish or trout production) conducted outside of fully enclosed buildings are inherently attractive to a wide variety of birds. Existing aquaculture facilities/activities within the separations listed in Sections 1-2 through 1-4 must have a program developed to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Airport operators should also oppose the establishment of new aquaculture facilities/activities within the separations listed in Sections 1-2 through 1-4.

c. Alternative uses of agricultural land. Some airports are surrounded by vast areas of farmed land within the distances specified in Sections 1-2 through 1-4. Seasonal uses of agricultural land for activities such as hunting can create a hazardous wildlife situation. In some areas, farmers will rent their land for hunting purposes. Rice farmers, for example, flood their land during waterfowl hunting season and obtain additional revenue by renting out duck blinds. The duck hunters then use decoys and call in hundreds, if not thousands, of birds, creating a tremendous threat to aircraft safety. A wildlife damage management biologist should review, in coordination with local farmers and producers, these types of seasonal land uses and incorporate them into the WHMP.

2-7. GOLF COURSES, LANDSCAPING AND OTHER LAND-USE CONSIDERATIONS.

a. Golf courses. The large grassy areas and open water found on most golf courses are attractive to hazardous wildlife, particularly Canada geese and some species of gulls. These species can pose a threat to aviation safety. The FAA recommends against construction of new golf courses within the separations identified in Sections 1-2 through 1-4. Existing golf courses located within these separations must develop a program to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Airport operators should ensure these golf courses are monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be immediately implemented.

b. Landscaping and landscape maintenance. Depending on its geographic location, landscaping can attract hazardous wildlife. The FAA recommends that airport operators approach landscaping with caution and confine it to airport areas not associated with aircraft movements. A wildlife damage management biologist should review all landscaping plans. Airport operators should also monitor all landscaped areas on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be immediately implemented.

Turf grass areas can be highly attractive to a variety of hazardous wildlife species. Research conducted by the USDA Wildlife Services' National Wildlife Research Center has shown that no one grass management regime will deter all species of hazardous wildlife in all situations. In cooperation with wildlife damage management biologist, airport operators should develop airport turf grass management plans on a prescription basis, depending on the airport's geographic locations and the type of hazardous wildlife likely to frequent the airport

Airport operators should ensure that plant varieties attractive to hazardous wildlife are not used on the airport. Disturbed areas or areas in need of re-vegetating should not be planted with seed mixtures containing millet or any other large-seed producing grass. For airport property already planted with seed mixtures containing millet, rye grass, or other large-seed producing grasses, the FAA recommends disking, plowing, or another suitable agricultural practice to prevent plant maturation and seed head production. Plantings should follow the specific recommendations for grass management and seed and plant selection made by the State University Cooperative Extension Service, the local office of Wildlife Services, or a qualified wildlife damage management biologist. Airport operators should also consider developing and implementing a preferred/prohibited plant species list, reviewed by a wildlife damage management biologist, which has been designed for the geographic location to reduce the attractiveness to hazardous wildlife for landscaping airport property.

c. Airports surrounded by wildlife habitat. The FAA recommends that operators of airports surrounded by woodlands, water, or wetlands refer to Section 2.4 of this AC. Operators of such airports should provide for a Wildlife Hazard Assessment (WHA) conducted by a wildlife damage management biologist. This WHA is the first step in preparing a WHMP, where required.

d. Other hazardous wildlife attractants. Other specific land uses or activities (e.g., sport or commercial fishing, shellfish harvesting, etc.), perhaps unique to certain regions of the country, have the potential to attract hazardous wildlife. Regardless of the source of the attraction, when hazardous wildlife is noted on a public-use airport, airport operators must take prompt remedial action(s) to protect aviation safety.

2-8. SYNERGISTIC EFFECTS OF SURROUNDING LAND USES. There may be circumstances where two (or more) different land uses that would not, by themselves, be considered hazardous wildlife attractants or that are located outside of the separations identified in Sections 1-2 through 1-4 that are in such an alignment with the airport as to create a wildlife corridor directly through the airport and/or surrounding airspace. An example of this situation may involve a lake located outside of the separation criteria on the east side of an airport and a large hayfield on the west side of an airport, land uses that together could create a flyway for Canada geese directly across the airspace of the airport. There are numerous examples of such situations;

therefore, airport operators and the wildlife damage management biologist must consider the entire surrounding landscape and community when developing the WHMP.

SECTION 3.

PROCEDURES FOR WILDLIFE HAZARD MANAGEMENT BY OPERATORS OF PUBLIC-USE AIRPORTS.

3.1. INTRODUCTION. In recognition of the increased risk of serious aircraft damage or the loss of human life that can result from a wildlife strike, the FAA may require the development of a Wildlife Hazard Management Plan (WHMP) when specific triggering events occur on or near the airport. Part 139.337 discusses the specific events that trigger a Wildlife Hazard Assessment (WHA) and the specific issues that a WHMP must address for FAA approval and inclusion in an Airport Certification Manual.

3.2. COORDINATION WITH USDA WILDLIFE SERVICES OR OTHER QUALIFIED WILDLIFE DAMAGE MANAGEMENT BIOLOGISTS. The FAA will use the Wildlife Hazard Assessment (WHA) conducted in accordance with Part 139 to determine if the airport needs a WHMP. Therefore, persons having the education, training, and expertise necessary to assess wildlife hazards must conduct the WHA. The airport operator may look to Wildlife Services or to qualified private consultants to conduct the WHA. When the services of a wildlife damage management biologist are required, the FAA recommends that land-use developers or airport operators contact a consultant specializing in wildlife damage management or the appropriate state director of Wildlife Services.

NOTE: Telephone numbers for the respective USDA Wildlife Services state offices can be obtained by contacting USDA Wildlife Services Operational Support Staff, 4700 River Road, Unit 87, Riverdale, MD, 20737-1234, Telephone (301) 734-7921, Fax (301) 734-5157 *(http://www.aphis.usda.gov/ws/)*.

3-3. WILDLIFE HAZARD MANAGEMENT AT AIRPORTS: A MANUAL FOR AIRPORT PERSONNEL. This manual, prepared by FAA and USDA Wildlife Services staff, contains a compilation of information to assist airport personnel in the development, implementation, and evaluation of WHMPs at airports. The manual includes specific information on the nature of wildlife strikes, legal authority, regulations, wildlife management techniques, WHAs, WHMPs, and sources of help and information. The manual is available in three languages: English, Spanish, and French. It can be viewed and downloaded free of charge from the FAA's wildlife hazard mitigation web site: http://wildlife-mitigation.tc.FAA.gov/. This manual only provides a starting point for addressing wildlife hazard issues at airports. Hazardous wildlife management is a complex discipline and conditions vary widely across the United States. Therefore, qualified wildlife damage management biologists must direct the development of a WHMP and the implementation of management actions by airport personnel.

There are many other resources complementary to this manual for use in developing and implementing WHMPs. Several are listed in the manual's bibliography.

3-4. WILDLIFE HAZARD ASSESSMENTS, TITLE 14, CODE OF FEDERAL REGULATIONS, PART 139. Part 139.337(b) requires airport operators to conduct a Wildlife Hazard Assessment (WHA) when certain events occur on or near the airport.

Part 139.337 (c) provides specific guidance as to what facts must be addressed in a WHA.

3-5. WILDLIFE HAZARD MANAGEMENT PLAN (WHMP). The FAA will consider the results of the WHA, along with the aeronautical activity at the airport and the views of the airport operator and airport users, in determining whether a formal WHMP is needed, in accordance with Part 139.337. If the FAA determines that a WHMP is needed, the airport operator must formulate and implement a WHMP, using the WHA as the basis for the plan.

The goal of an airport's Wildlife Hazard Management Plan is to minimize the risk to aviation safety, airport structures or equipment, or human health posed by populations of hazardous wildlife on and around the airport.

The WHMP must identify hazardous wildlife attractants on or near the airport and the appropriate wildlife damage management techniques to minimize the wildlife hazard. It must also prioritize the management measures.

3-6. LOCAL COORDINATION. The establishment of a Wildlife Hazards Working Group (WHWG) will facilitate the communication, cooperation, and coordination of the airport and its surrounding community necessary to ensure the effectiveness of the WHMP. The cooperation of the airport community is also necessary when new projects are considered. Whether on or off the airport, the input from all involved parties must be considered when a potentially hazardous wildlife attractant is being proposed. Airport operators should also incorporate public education activities with the local coordination efforts because some activities in the vicinity of your airport, while harmless under normal leisure conditions, can attract wildlife and present a danger to aircraft. For example, if public trails are planned near wetlands or in parks adjoining airport property, the public should know that feeding birds and other wildlife in the area may pose a risk to aircraft.

Airport operators should work with local and regional planning and zoning boards so as to be aware of proposed land-use changes, or modification of existing land uses, that could create hazardous wildlife attractants within the separations identified in Sections 1-2 through 1-4. Pay particular attention to proposed land uses involving creation or expansion of waste water treatment facilities, development of wetland mitigation sites, or development or expansion of dredge spoil containment areas. At the very least, airport operators must ensure they are on the notification list of the local planning board or equivalent review entity for all communities located within 5 miles of the airport, so they will receive notification of any proposed project and have the opportunity to review it for attractiveness to hazardous wildlife.

3-7 COORDINATION/NOTIFICATION OF AIRMEN OF WILDLIFE HAZARDS. If an existing land-use practice creates a wildlife hazard and the land-use practice or wildlife hazard cannot be immediately eliminated, airport operators must issue a Notice to Airmen (NOTAM) and encourage the land–owner or manager to take steps to control the wildlife hazard and minimize further attraction.

SECTION 4.

FAA NOTIFICATION AND REVIEW OF PROPOSED LAND-USE PRACTICE CHANGES IN THE VICINITY OF PUBLIC-USE AIRPORTS

4-1. FAA REVIEW OF PROPOSED LAND-USE PRACTICE CHANGES IN THE VICINITY OF PUBLIC-USE AIRPORTS.

a. The FAA discourages the development of waste disposal and other facilities, discussed in Section 2, located within the 5,000/10,000-foot criteria specified in Sections 1-2 through 1-4.

b. For projects that are located outside the 5,000/10,000-foot criteria but within 5 statute miles of the airport's AOA, the FAA may review development plans, proposed land-use changes, operational changes, or wetland mitigation plans to determine if such changes present potential wildlife hazards to aircraft operations. The FAA considers sensitive airport areas as those that lie under or next to approach or departure airspace. This brief examination should indicate if further investigation is warranted.

c. Where a wildlife damage management biologist has conducted a further study to evaluate a site's compatibility with airport operations, the FAA may use the study results to make a determination.

4-2. WASTE MANAGEMENT FACILITIES.

a. **Notification of new/expanded project proposal.** Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106-181) limits the construction or establishment of new MSWLF within 6 statute miles of certain public-use airports, when both the airport and the landfill meet very specific conditions. See Section 2-2 of this AC and AC 150/5200-34 for a more detailed discussion of these restrictions.

The Environmental Protection Agency (EPA) requires any MSWLF operator proposing a new or expanded waste disposal operation within 5 statute miles of a runway end to notify the appropriate FAA Regional Airports Division Office and the airport operator of the proposal (40 CFR 258, *Criteria for Municipal Solid Waste Landfills*, Section 258.10, *Airport Safety*). The EPA also requires owners or operators of new MSWLF units, or lateral expansions of existing MSWLF units, that are located within 10,000 feet of any airport runway end used by turbojet aircraft, or within 5,000 feet of any airport runway end used only by piston-type aircraft, to demonstrate successfully that such units are not hazards to aircraft. (See 4-2.b below.)

When new or expanded MSWLF are being proposed near airports, MSWLF operators must notify the airport operator and the FAA of the proposal as early as possible pursuant to 40 CFR 258.

b. Waste handling facilities within separations identified in Sections 1-2 through 1-4. To claim successfully that a waste-handling facility sited within the separations identified in Sections 1-2 through 1-4 does not attract hazardous wildlife and does not threaten aviation, the developer must establish convincingly that the facility will not handle putrescible material other than that as outlined in 2-2.d. The FAA strongly recommends against any facility other than that as outlined in 2-2.d (enclosed transfer stations). The FAA will use this information to determine if the facility will be a hazard to aviation.

c. Putrescible-Waste Facilities. In their effort to satisfy the EPA requirement, some putrescible-waste facility proponents may offer to undertake experimental measures to demonstrate that their proposed facility will not be a hazard to aircraft. To date, no such facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible-waste landfill began operating. For this reason, demonstrations of experimental wildlife control measures may not be conducted within the separation identified in Sections 1-2 through 1-4.

4-3. OTHER LAND-USE PRACTICE CHANGES. As a matter of policy, the FAA encourages operators of public-use airports who become aware of proposed land use practice changes that may attract hazardous wildlife within 5 statute miles of their airports to promptly notify the FAA. The FAA also encourages proponents of such land use changes to notify the FAA as early in the planning process as possible. Advanced notice affords the FAA an opportunity (1) to evaluate the effect of a particular land-use change on aviation safety and (2) to support efforts by the airport sponsor to restrict the use of land next to or near the airport to uses that are compatible with the airport.

The airport operator, project proponent, or land-use operator may use FAA Form 7460-1, *Notice of Proposed Construction or Alteration*, or other suitable documents similar to FAA Form 7460-1 to notify the appropriate FAA Regional Airports Division Office. Project proponents can contact the appropriate FAA Regional Airports Division Office for assistance with the notification process.

It is helpful if the notification includes a 15-minute quadrangle map of the area identifying the location of the proposed activity. The land-use operator or project proponent should also forward specific details of the proposed land-use change or operational change or expansion. In the case of solid waste landfills, the information should include the type of waste to be handled, how the waste will be processed, and final disposal methods.

a. Airports that have received Federal grant-in-aid assistance. Airports that have received Federal grant-in-aid assistance are required by their grant assurances to take appropriate actions to restrict the use of land next to or near the airport to uses that are compatible with normal airport operations. The FAA recommends that airport operators to the extent practicable oppose off-airport land-use changes or practices within the separations identified in Sections 1-2 through 1-4 that may attract hazardous wildlife. Failure to do so may lead to noncompliance with applicable grant assurances. The FAA will not approve the placement of airport development projects pertaining to aircraft movement in the vicinity of hazardous wildlife attractants without appropriate mitigating measures. Increasing the intensity of wildlife control efforts is not a substitute for eliminating or reducing a proposed wildlife hazard. Airport operators should identify hazardous wildlife attractants and any associated wildlife hazards during any planning process for new airport development projects.

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APPENDIX 1. DEFINITIONS OF TERMS USED IN THIS ADVISORY CIRCULAR.

1. GENERAL. This appendix provides definitions of terms used throughout this AC.

1. **Air operations area.** Any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft. An air operations area includes such paved areas or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiways, or apron.

2. **Airport operator.** The operator (private or public) or sponsor of a public-use airport.

3. **Approach or departure airspace.** The airspace, within 5 statute miles of an airport, through which aircraft move during landing or takeoff.

4. **Bird balls.** High-density plastic floating balls that can be used to cover ponds and prevent birds from using the sites.

5. **Certificate holder.** The holder of an Airport Operating Certificate issued under Title 14, Code of Federal Regulations, Part 139.

6. **Construct a new MSWLF.** To begin to excavate, grade land, or raise structures to prepare a municipal solid waste landfill as permitted by the appropriate regulatory or permitting agency.

7. **Detention ponds.** Storm water management ponds that hold storm water for short periods of time, a few hours to a few days.

8. **Establish a new MSWLF.** When the first load of putrescible waste is received on-site for placement in a prepared municipal solid waste landfill.

9. **Fly ash.** The fine, sand-like residue resulting from the complete incineration of an organic fuel source. Fly ash typically results from the combustion of coal or waste used to operate a power generating plant.

10. **General aviation aircraft.** Any civil aviation aircraft not operating under 14 CFR Part 119, Certification: Air Carriers and Commercial Operators.

11. **Hazardous wildlife.** Species of wildlife (birds, mammals, reptiles), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard

12. **Municipal Solid Waste Landfill (MSWLF).** A publicly or privately owned discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. An MSWLF may receive

other types wastes, such as commercial solid waste, non-hazardous sludge, small-quantity generator waste, and industrial solid waste, as defined under 40 CFR § 258.2. An MSWLF can consist of either a stand alone unit or several cells that receive household waste.

13. **New MSWLF.** A municipal solid waste landfill that was established or constructed after April 5, 2001.

14. **Piston-powered aircraft.** Fixed-wing aircraft powered by piston engines.

15. **Piston-use airport.** Any airport that does not sell Jet-A fuel for fixed-wing turbine-powered aircraft, and primarily serves fixed-wing, piston-powered aircraft. Incidental use of the airport by turbine-powered, fixed-wing aircraft would not affect this designation. However, such aircraft should not be based at the airport.

16. **Public agency.** A State or political subdivision of a State, a tax-supported organization, or an Indian tribe or pueblo (49 U.S.C. § 47102(19)).

17. **Public airport.** An airport used or intended to be used for public purposes that is under the control of a public agency; and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned (49 U.S.C. § 47102(20)).

18. **Public-use airport.** An airport used or intended to be used for public purposes, and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft may be under the control of a public agency or privately owned and used for public purposes (49 U.S.C. § 47102(21)).

19. **Putrescible waste.** Solid waste that contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds (40 CFR §257.3-8).

20. **Putrescible-waste disposal operation.** Landfills, garbage dumps, underwater waste discharges, or similar facilities where activities include processing, burying, storing, or otherwise disposing of putrescible material, trash, and refuse.

21. **Retention ponds.** Storm water management ponds that hold water for several months.

22. **Runway protection zone (RPZ).** An area off the runway end to enhance the protection of people and property on the ground (see AC 150/5300-13). The dimensions of this zone vary with the airport design, aircraft, type of operation, and visibility minimum.

23. **Scheduled air carrier operation.** Any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier or commercial

operator for which the air carrier, commercial operator, or their representative offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR Part 119 or as a public charter operation under 14 CFR Part 380 (14 CFR § 119.3).

24. Sewage sludge. Any solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment process; and a material derived from sewage sludge. Sewage does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works. (40 CFR 257.2)

25. Sludge. Any solid, semi-solid, or liquid waste generated form a municipal, commercial or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect. (40 CFR 257.2)

26. Solid waste. Any garbage, refuse, sludge, from a waste treatment plant, water supply treatment plant or air pollution control facility and other discarded material, including, solid liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or by product material as defined by the Atomic Energy Act of 1954, as amended, (68 Stat. 923). (40 CFR 257.2)

27. Turbine-powered aircraft. Aircraft powered by turbine engines including turbojets and turboprops but excluding turbo-shaft rotary-wing aircraft.

28. Turbine-use airport. Any airport that sells Jet-A fuel for fixed-wing turbine-powered aircraft.

29. Wastewater treatment facility. Any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-576) and the Water Quality Act of 1987 (P.L. 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. (See 40 CFR Section 403.3 (q), (r), & (s)).

30. Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring thereof (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this AC, wildlife includes feral animals and domestic animals out of the control of their owners (14 CFR Part 139, Certification of Airports).

31. Wildlife attractants. Any human-made structure, land-use practice, or human-made or natural geographic feature that can attract or sustain hazardous wildlife within the landing or departure airspace or the airport's AOA. These attractants can include architectural features, landscaping, waste disposal sites, wastewater treatment facilities, agricultural or aquaculture activities, surface mining, or wetlands.

32. Wildlife hazard. A potential for a damaging aircraft collision with wildlife on or near an airport.

33. Wildlife strike. A wildlife strike is deemed to have occurred when:

a. A pilot reports striking 1 or more birds or other wildlife;

b. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;

c. Personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;

d. Bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified;

e. The animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (Transport Canada, Airports Group, *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

2. RESERVED.

WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

Appendix C: ACRP Report 32 (Chapter 4), Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports

Mead & Hunt

Bird Harassment, Repellent, and Deterrent Techniques for Use on and Near Airports (2011)

DETAILS

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CHAPTER FOUR

HARASSMENT, REPELLENT, AND DETERRENT TECHNIQUES

We begin this section with a tabular summary of relative efficacy of harassment, repellent, and deterrent techniques for birds at airports. Table 1 is a synthesized literature review providing examples of relative efficacy of each technique.

AUDITORY DETERRENTS

Ultrasonic

Ultrasonic devices likely will not be a viable option as a deterrent for birds. Erickson et al. (1992) surmised that high-frequency sound (>20,000 Hz or cycles per second) devices generally were not effective in repelling birds. Griffiths (1987) tested a commercial ultrasonic unit against numerous bird species in the mid-Atlantic United States and found no apparent effect on bird activity. Martin and Martin (1984) found another ultrasonic device to be ineffective. Woronecki (1988) reported that an ultrasonic device (Ultrason UET-360) was not effective in reducing rock dove activity during a 20-day treatment period. However, he reported that a combination of a visual device (tested as Deva-Spinning Eyes) and a sonic device (tested as Deva-Megastress II) did temporarily alter rock dove behavior during a 10-day treat-

TABLE 1
RELATIVE EFFECTIVENESS OF AVIAN REPELLENT TECHNIQUES

	Deterrent						Harassment									Exclusion	
	4-AP	Methyl anthranilate	Anthraquinone	Tactiles	Effigies	Reflecting Tape, Flags	Lights and Mirrors	Predator models	Gas Exploders	Pyrotechnics	Biosonics	Ultrasonic	Lasers	Falconry	Dogs	Overhead wires	Anti-perching devices
Crows/Jays/Magpies		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Blackbirds	G	G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Starlings	G	G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Cormorants/Anhingas		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Ducks	F	G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Geese	F	G	G	F/G	G	P	F	F	F/G	G	G	N	P	F	G	G	G
Swans	F	G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Gulls	F	G	G	F/G	G	F	F	F	F/G	G	F	N	P	F	G	F	G
Herons		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	F	G
Egrets		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	F	G
Cranes		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	F	G
Pigeons/Doves	F	G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Vultures		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Hawks		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Falcons		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Eagles		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Osprey/Kites		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Owls		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Gallinaceous Birds		G	G	F/G	G	P	F	F	F/G	G	P	N	P	F	G	F	G
Shorebirds		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G		G
Thrushes		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G
Sparrows		G	G	F/G	G	P	F	F	F/G	G		N	P	F	G	G	G

Source: Adapted from Cleary and Dickey (2010).
Effectiveness: G = Good; F = Fair; P = Poor; N = Not Recommended.

ment period and reduced the rock dove population present during the onset of treatment. However, this study was not conducted in an airport environment but in a vacant building. Also, the study was not replicated, nor were paired non-treated sites used for comparisons.

Gas Exploders

Gas-operated exploders, sometimes referred to as gas or propane cannons, offer temporary efficacy for deterring birds from airfields. They have been commonly used to repel pest birds in agriculture and around airports since the late 1940s (Gilsdorf et al. 2002). These devices produce extremely loud, intermittent explosions, usually at fixed 1- to 10-minute intervals as desired, that exceed the blast of a 12-gauge shotgun. Present-day exploders consist of a bottled gas supply, separate pressure and combustion chambers, an igniting mechanism, and a barrel to direct and intensify the noise of the explosion. To alleviate habituation, exploders should be moved periodically (e.g., every 1 to 3 days) within the area needing protection (Littauer et al. 1997; Reinhold and Sloan 1997).

Washburn et al. (2006) conducted an experiment with propane exploders at John F. Kennedy International Airport. These authors did not find a significant difference in bird behavior in response to the exploder. Furthermore, the addition of lethal removal did not enhance effectiveness. Conover (1984a) reported a 77% reduction in bird damage within cornfields in response to exploders. Propane exploders were more cost-effective compared with a chemical technique (tested as Avitrol FC-99) and a visual technique (tested as hawk-kites). In the Mississippi alluvial plain, Mott et al. (1998) described that harassing double-crested cormorants roosting at night was successful in dispersing cormorants and reducing depredation rates at nearby catfish farms, suggesting that it may work on stormwater ponds around airports. Also, Cummings et al. (1986) described that a combination of a gas exploder and a CO2 driven pop-up scarecrow was effective sporadically in a row crop agriculture setting; however, habituation was likely occurring in later tests.

Biosonics: Alarm and Distress Calls

Biosonic calls, including alarm and distress calls, appear to have some efficacy for deterring birds. However, additional research involving rigorous experimental design is necessary to understand efficacy more fully. Biosonics as a repelling technique is based on acoustical signals emitted by birds and other animals to convey information to other individuals of the same species (Boudreau 1968; Conover and Perito 1981; Bomford and O'Brien 1990). Two audible bird-warning stimuli, distress and alarm calls, have been explored or used for acoustically repelling birds from urban and rural roosts (Pearson et al. 1967; Brough 1969), fish-rearing ponds (Spanier 1980; Andelt et al. 1997), airport runways (Blokpoel 1976), agricultural settings, and other locations (Baxter 2000).

From the Field…Golden Triangle Airport (GTR)

The Golden Triangle Regional Airport Authority was established in 1971 through a partnership with the cities of Columbus, Starkville, and West Point, and the counties of Lowndes and Oktibbeha, Mississippi. The airport property consists of 1,000 acres and has approximately 40,000 airplane movements a year. Bird harassment is conducted by the airport firemen, who dedicate approximately 10% of their time to wildlife management. Seasonal influxes of geese in the winter and raptors in the summer are the main problems that arise with wildlife. The staff uses pyrotechnics to move birds from problem areas. Additionally, in the fall, flocks of sparrows and other small flocking birds can create potential hazards. In these instances, personnel have used fire trucks to apply high volume and pressure of water to disperse birds with good success. Mike Hainsey, airport executive director, noted, "Habitat management is a primary line of defense."

Mott and Timbrook (1988) examined the effect of alarm and distress calls on Canada geese. They found a 71% decrease in goose numbers in response to the calls. Additionally, they found a 96% reduction in goose observations when the distress calls were coupled with pyrotechnics (tested as racket bombs, a noise-making pyrotechnic shot from a pistol launcher). Unfortunately, recolonization of the study area occurred shortly after the treatments stopped. In an urban setting, Gorenzel and Salmon (1993) experimented with distress and alarm calls in an effort to deter crows. Initially, crows from nearby roosts were attracted to the calls, but after 30 seconds the crows left the immediate vicinity.

Cook et al. (2008) used a modeling approach to assess the effectiveness of nine techniques, including pyrotechnics, handheld distress calls, static distress calls, blank ammunition, a combination of blank and lethal use of ammunition, falcons (*Falco* spp.), hawks (*Accipiter* spp.), wailers, and kites. These techniques were employed on three species of gulls at landfill sites. Distress calls were among the most effective; however, when habituation was considered, distress calls were not as effective as other techniques with lethal consequences. Conklin et al. (2009) tested bioacoustic deterrents for nesting cliff swallows (*Petrochelidon pyrrhonota*). Eight unique recordings of alarm and distress calls were used together in a mix played through an acoustical broadcast unit. Random playback order was used to delay or reduce habitation by swallows. The presence of calls reduced nesting activity by more than 50%. Coates et al. (2010) evaluated bioacoustics as a deterrent to wild turkeys in California vineyards. Broadcast calls of three different types were used independently: wild turkey alarm call, domestic turkey alarm, and crow distress call. No differences in damage rates were found in treated versus untreated plots.

Pyrotechnics

Pyrotechnics have long been used as deterrents to birds in a variety of settings (Neff and Mitchell 1955; Zajanc 1962; Mott 1980; Tipton et al. 1989; Mott and Boyd 1995; Andelt et al. 1997; Littauer et al. 1997; Mott and Brunson 1997) and can be effective in deterring birds. These devices rely on an explosion or other type of loud noise to deter birds from an area (Mott 1980) and can produce visual stimuli such as a flash of light or burst of smoke. Devices include rifles and shotguns firing live ammunition or blanks and 12-gauge shotguns and flare pistols that shoot exploding or noisy projectiles, including shell crackers, bird bombs, bird whistles, whistle bombs, or racket bombs (Booth 1994; Harris and Davis 1998). Signal flares also have been used at some airports but are more expensive than the other devices (Lefebvre and Mott 1987). An example of these devices is shown in Figure 4.

FIGURE 4 Pyrotechnics (*Source*: USDA/APHIS/WS Ohio Field Station).

Aguilera et al. (1991) reported that screamer shells were effective in dispersing flocks of Canada geese; also, no habituation was reported after treatment. Mott (1980) tested scare cartridges and noise bombs simultaneously to disperse roosting red-winged blackbirds and European starlings in Kentucky and Tennessee. Roosting bird populations of about 1 million birds in five roosts were reduced 96% to 100% during 3 to 8 evenings of harassment. Mott et al. (1992) tested the effectiveness of pyrotechnics as a dispersant for roosting double-crested cormorants (*Phalacrocorax auritis*) in the Delta region of Mississippi. Bird-bangers and screamer-sirens were fired from single-shot pistol launchers on 4 consecutive evenings. Cormorant numbers were decreased from approximately 8,000 birds to 6 during the harassment period. However, Mott et al. (1992) stated that this technique would be less effective if multiple roost sites were available to birds in an immediate area. Logistically and financially, harassing birds in this fashion may not be efficacious. Most bird species become habituated to noises produced by pyrotechnics if used repeatedly over time (Littauer et al. 1997; Reinhold and Sloan 1997; Stevens et al. 2000; Ronconi et al. 2004; Ronconi and Clair 2006; Cook et al. 2008).

From the field…Sacramento International Airport (FAA code--SMF)

Approximately 152,000 operations occur annually at Sacramento International Airport, including commercial, cargo, general aviation, and military operations. Sacramento International Airport is located within the Natomas basin of California, situated in the Pacific migratory flyway for numerous waterfowl and other bird species. Greg Rowe, senior environmental analyst, described their style of wildlife management as a holistic approach that integrates harassment techniques and animal removal, but most important, working with land use and habitat management to reduce use of the airport landscape by hazardous birds. The airport employs two full-time biologists, and two other employees spend approximately half of their time to reduce hazardous wildlife. Waterfowl are by far the most common problem species, but other birds such as vultures, ibis species, and swallows are also problematic. Additionally, raptors are a growing problem. The most commonly employed deterrent technique is pyrotechnics and electronic sound emission devices. These are typically used to scare birds from ponds located near the runway. Greg notes, "Our biologists typically have to apply these techniques to the same group of birds on a daily basis in order to be effective." Greg also stressed that land management is key and other techniques are secondary in the mission to reduce hazards.

VISUAL REPELLENTS

Vision-based deterrents present a visual stimulus that is novel, startling, or that the birds associate with danger. The danger can be a predator, a simulated predator, the result of a predator attack, or some unusual object that birds avoid because it is unfamiliar. Lights, scarecrows, dyes, reflecting tape, predator decoys, kites, balloons, smoke, and dead or live birds are visual stimuli that may disperse birds.

Effigies

Effigies have been demonstrated to reduce bird use of target areas; however, their efficacy varies markedly depending on type of effigy used, species being deterred, and resource (nest site, loafing site, foraging area) from which birds are being deterred. Effigies include devices such as scarecrows, scary-eyes, and predator-mimicking devices (e.g., hawk or owl) (Harris and Davis 1998). Scarecrows are one of the oldest devices that have been used to control birds (Frings and Frings 1967). Most scarecrows are human-shaped effigies constructed from various inexpensive materials, including grain sacks or old clothes stuffed with straw. The more realistic the facial features and the human shape, the more effective scarecrows are likely to be (Gilsdorf et al. 2002). Painting scarecrows a bright color can increase their detectability (Littauer 1990).

Stickley et al. (1995) demonstrated that a pop-up human effigy reduced double-crested cormorant use of catfish ponds; however, the device was only tried for 7 days. It is unclear if habituation would have occurred later. Nomsen (1989) reported that a humanlike scarecrow that popped up from a double propane cannon when fired was highly successful in keeping blackbirds from feeding over 4 to 6 acres of sunflowers. Ducks and geese were observed to be much easier to frighten from the site than blackbirds. Coniff (1991) reported that this kind of scarecrow placed near a catfish pond effectively frightened cormorants. Numbers of great blue herons (*Ardea herodias*) and black-crowned night-herons (*Nycticorax nycticorax*) initially decreased at a fish hatchery following implementation of two human effigies (tested as Scary Man Fall Guy), but the herons quickly habituated to the devices and numbers increased after the first 4 nights (Andelt et al. 1997). Boag and Lewin (1980) found that a human effigy was effective in deterring dabbling and diving ducks from small natural ponds. When the effigy was present, the number of ducks on the ponds declined by 95%. Over the same interval there was only a 20% decline on adjacent control ponds, indicating that the effigy was quite effective.

Cummings et al. (1986) used a propane cannon and a CO_2 pop-up scarecrow to deter blackbirds from sunflowers. They found that most birds were frightened away by the scarecrows; fewer birds returned during the treatment period than were observed during the control period. Cummings et al. (1986) speculated that the birds that returned had become habituated to the scarecrow in some cases, and in other cases, that feeding patterns were too well established to allow effective deterrence of the birds.

Seamans (2004) reported the effective use of a vulture effigy to deter vultures from a tower in northern Ohio. However, the author reported seasonal differences in effectiveness; in the summer there was no difference in vulture use of the tower during pre-and posttreatment periods. Seamans and Bernhardt (2004) conducted field evaluations of Canada goose effigies. They found an initial decrease in goose abundance; however, during a second treatment period no difference was detected. Geese were likely habituated to the effigies after a short time. Figure 5 shows an example of a visual repellent in the form of a dead Canada goose.

FIGURE 5 Dead goose effigy (*Source*: USDA/APHIS/WS Ohio Field Station).

Ball (2009) described in an anecdotal note that effigies appeared to be effective in reducing vulture use of the airfield at Cherry Point Air Force Base in North Carolina. Similarly, Tillman et al. (2002) reported that effigies were effective in dispersing vultures from roost sites near livestock production facilities. Additionally, the authors tested waterfowl decoys painted to resemble dead vultures. They report a continued effectiveness upon switching from the taxidermy effigies to the mock-up decoys. Avery et al. (2002) corroborated Tillman et al. (2002) in the context of vulture [black vulture (*Coragyps atratus*) and turkey vulture (*Cathartes aura*)] use of communication towers. They found a 93% to 100% decline in vulture numbers immediately following installation of the effigies. The authors also noted that effectiveness was independent of species composition of the vulture flock or the vulture species used for the effigy. Most important, Avery et al. (2002) found that the effectiveness was maintained 5 months posttreatment. Effigies appear to be an effective tool to reduce use of an area by both species of vultures.

Predator Models

Decoys or models have been used to repel birds for decades in agricultural crops, and should be similar in the airport environment (Conover, 1979, 1982a, 1984a, 1985a; Hothem and DeHaven 1982) (Table 1). Conover (1979, 1982a) found that stationary, mounted hawks and hawk-kites deterred birds from feeding stations and cornfields but that their effectiveness was short-term. Conover (1984a) elucidated that hawk-kites reduced red-winged blackbird (*Aegaeileus phonecius*) damage by 83% in an agriculture setting. Belant et al. (1998) found plastic, hand-painted effigies of great horned owls (*Bubo virginianus*) and merlins (*Falco columbarius*) ineffective in reducing starling use of nest boxes. There was no significant difference in starling activity among nest boxes with or without the effigies. Conover (1983) found that blackbirds and crows often mob owls or owl models, increasing use of an area by hazardous birds. However, Conover (1982b, 1985b) found that an animated plastic owl model clutching a plastic crow in its talons repelled crows from gardens and small fields, while a stationary version of the same model was not effective.

Seamans and Helon (2006) tested a lightweight plastic device that forms a spiral when suspended and contains pigments that allow the device to change color depending on viewing angle (tested as the ChormaFlair™ Crow Buster) to repel starlings at nest sites. There was no difference in the presence of nest material between treated and control nest boxes. Also, clutch size was similar between treated and controls, but a slight delay in egg laying was observed in the treated boxes.

Balloons or modified balloons have been tested on numerous occasions as a deterrent for birds in various settings (Conover 1982a; Avery et al. 1988; McLennan et al. 1995; Nakamura et al. 1995; Mott et al. 1998). Seamans et al. (2002) tested a balloon with a kite and stabilizer attached to deter gulls near a landfill in New York. Under various circumstances the device was effective in decreasing gull use. However, Seamans et al. (2002) reported high maintenance costs and time requirements to deploy such devices. They maintained that devices such as these should be used as a part of an integrated management program for gulls. Figure 6 shows an example of a visual repellent in the form of a balloon.

FIGURE 6 Helikites in action (*Source*: USDA/APHIS/WS Ohio Field Station).

Lasers

Lasers (such as the device shown in Figure 7) have been demonstrated to deter birds; however, efficacy varies across species and with wavelength (i.e., color) of transmitted light. Relative efficacy increases with decreasing ambient light. The use of lasers to disperse birds is relatively new (Lustick 1973; Gilsdorf et al. 2002). Glahn et al. (2000) tested the efficacy of lasers to disperse double-crested cormorants from night roosts in the Mississippi Alluvial Valley during winter. Two types of lasers were tested: the Desman™ laser [red (632.8 nm) helium-neon laser] and a Dissuader™ laser security device that is also a red beam (650 nm) but is a diode laser (Glahn et al. 2000). The authors pretested the lasers on wild-trapped cormorants, but results of that study were inconclusive. However, the field trial portion demonstrated significant reductions in cormorant populations by ≥90%. No difference was found between laser types.

FIGURE 7 Laser used for dispersing birds (*Source*: USDA/APHIS/WS Ohio Field Station).

Blackwell et al. (2002) tested the efficacy of a 10-mW continuous-wave, 633-nm laser to repel brown-headed cowbirds and European starlings while perching. They tested a 68-mW, continuous-wave, 650-nm laser in dispersing starlings and rock doves from perches; also, they tested this laser on Canada geese and mallards in grass plots. There were mixed results; brown-head cowbirds or European starlings were not repelled from their perch, whereas rock doves demonstrated avoidance during the first 5 min of the 80-min dispersal periods, suggesting weak efficacy. Geese demonstrated the strongest avoidance behavior, 96% of birds dispersed from the laser-treated plots. Mallards were dispersed initially but habituated to the beam after 20 min.

Gorenzel et al. (2002) found similar results with American crows. Most crows were dispersed from roosts by the laser, but returned within 15 min. Lasers are a relatively unobtrusive device to humans and show promise as a repellent for birds, but results are species specific (Blackwell et al.

2002; Gilsdorf et al. 2002; Gorenzel et al. 2002). Although green and blue lasers were ineffective at deterring white-tailed deer (*Odocoileus virginianus*) (VerCauteren et al. 2006), they have not yet been tested for efficacy in repelling birds. However, qualitative evidence at some airports suggests green lasers can be highly effective at dispersing birds such as rock doves and European starlings.

Reflecting Tape, Reflectors, and Flags

Reflecting tape and similar devices appear to have limited efficacy in most circumstances. Summers and Hillman (1990) tested a red fluorescent tape (20 mm wide) in fields of winter wheat in the United Kingdom to deter brant. The tape proved more successful than the cannon and scarecrows in repelling brant. Compared with control fields, a 1% reduction in grain yield in the taped field was found compared with a 6% reduction in the untaped field. Belant and Ickes (1997) tested mylar flags (reflective material) for their effectiveness as gull deterrents. Flags were tested at two nesting colonies and two loafing sites at a landfill near Lake Erie. The authors concluded that the reflecting tape was unsuccessful in deterring herring gulls from nesting colonies but can reduce herring and ring-billed gull use of loafing areas. Reflecting tape was ineffective in deterring birds from ripening blueberries (Tobin et al. 1988). In this study habituation was considered likely, and reportedly not enough tape was used to elicit a response. Conover and Dolbeer (1989) found similar results with red-winged blackbirds in cornfields. Fields treated with reflector tape had similar damage rates to untreated fields. These results contrasted with those of Dolbeer (1981), Bruggers et al. (1986), and Dolbeer et al. (1986), who found reflective tapes to be effective in grain fields. Conover and Dolbeer (1989) attributed the possible differences to variation in row spacing of tape. Gilsdorf et al. (2002) further suggest that closer spacing of ribbons of tape may be more effective, but likely not cost-effective.

Lights and Mirrors

Lights and mirrors appear to have application for dispersing birds from airport environments, but additional research is necessary before specific recommendations can be made. Few studies have evaluated the effectiveness of mirrors to deter birds. Seamans et al. (2001) evaluated mirrors to deter nesting starlings in northern Ohio. Various combinations of mirror types and the addition of lights (green and red flashing) were tested. Fewer nests were found in treated nest boxes in the first year of study. During the second year lower occupancy rates of nest boxes were also found, specifically in the mirror and light combination treatment. The authors concluded that even though slight reduction in starling use was found, mirrors were not a practical repellent. Seamans et al. (2003) followed up the previous study with a similar experiment testing rotating mirrors as a deterrent for decoy traps. Capture rates did not differ between treated (rotating mirror) and untreated traps for blackbirds. However, red mirrors reduced the capture rate compared with the control. Furthermore, more brown-headed cowbirds (*Molothrus ater*) and common grackles (*Quiscalus quiscula*) were captured more often in control traps versus treated traps with mirrors.

Numerous types of lights have been used to deter birds at feeding, roosting, and loafing sites (Koski et al. 1993; Seamans et al. 2001). Larkin et al. (1975) observed that migrating birds reacted to searchlight beams at distances of 200–300 m. In the same study, birds took evasive action to approaching small aircraft with landing lights. Blackwell and Bernhardt (2004) tested the efficacy of pulsing white and wavelength-specific aircraft-mounted light during daylight hours. Their experiments involved captive brown-head cowbirds, Canada geese, European starlings, herring gulls, and mourning doves. Cowbirds were the only species that exhibited a response to the landing lights, but responses were sporadic. Blackwell and Bernhardt (2004) contended that more research was needed on specific light wavelengths and pulse frequencies. Specifically, understanding object lighting in the context of avian antipredator responses, and how antipredator behavior varies among bird species, may improve efficacy of lighting as a control technique (Blackwell et al. 2009).

Dogs and Falconry

The use of dogs to deter and haze birds is promising and generally appears effective, but more experimental research is needed. The use of dogs has received attention and research as a tool to deter birds from airports (Carter 2000a,b; Castelli and Sleggs 2000; Patterson 2000). Castelli and Sleggs (2000) reported a retrospective analysis of the efficacy of a border collie program to repel and haze geese. At the local scale of the airport, the program was effective at reducing geese overabundance, but at the larger regional scale it did not contribute to the solution. Carter (2000b) reported several case studies on the use of border collies. Most strikingly, in Delaware the use of dogs reduced bird numbers by 99.9%, and damage was reduced from $600,000/year to $24,000/year. Figure 8 shows an example of a dog on bird-deterrent duty at an airport.

FIGURE 8 Border collie at work in Florida [*Source*: Marc Beaudin, The *News-Press* (Ft. Myers, Fla.)].

The use of falconry has received some attention as a bird deterrent and appears to have limited efficacy. Some falconry is employed in the United States, but it has mostly occurred in the United Kingdom (Blokpoel 1976; Hild 1984; Erickson et al. 1990; Dolbeer 1998; Walker 2003; Bryant 2005; Kitowski et al. 2010;). Peregrine falcons (*Falco pereqrinus*), gyrfalcons (*Falco rusticolus*), and goshawks (*Accipiter gentilis*) are the species most frequently used (Blokpoel 1976). At John F. Kennedy International Airport, Dolbeer (1998) tested the use of falconry to reduce laughing gull use and strikes to aircraft. Falconry in this case did not provide additional efficacy to a shooting program, but did provide increased public acceptance of the management program at the airport.

CHEMICAL REPELLENTS

Chemical aversion agents have been used to control birds in a wide range of settings (Guarino 1972; Rogers 1974; Crase and Dehaven 1976; Conover 1984b; Greig-Smith and Rowney 1987; Bomford and O'Brien 1990; Clark and Shah 1991, 1993; Clark et al. 1991; Avery and Decker 1994). Their efficacy is highly variable and depends on chemical use, mode of action, species being deterred, and resource (e.g., loafing site, feeding area) being protected.

4-aminopyridine and 3,5-dimethyl-4-(methylthio)phenyl methylcarbamate

Chemical frightening agents and repellents such as 4-aminopyridine (4-AP) (e.g., tested as Avitrol) and 3,5-dimethyl-4-(methylthio)phenyl methylcarbamate (e.g., tested as methiocarb) are poisons that, in sublethal doses, may cause disorientation and erratic behavior. They are usually added to bait. Typically only a portion of a bait presentation (e.g., 10% of corn kernels) is treated with the chemical so that only a small number of the birds to be dispersed are affected. When the treated bait is ingested, a distress response occurs (DeFusco and Nagy 1983; White and Weintraub 1983). Distress calls from affected birds can start 15 min after ingestion, and can last up to 30 min after first effect. Besides emitting distress calls, affected birds may become disoriented and exhibit erratic behavior, often flopping about on the ground. This behavior often alarms other birds and causes them to fly away. If too high a dose is ingested, the bird will die. Tremors and convulsions occur before death if birds receive an overdose of the aversion agent, and these may induce other birds to leave the area.

Dolbeer et al. (1976) and Woronecki et al. (1989) tested the effectiveness of 2 aminopyridine (chemically similar to 4-AP) in sweet corn fields. Overall, no reduction in damage was observed. However, Avitrol has been proven useful in dispersing birds (Goodhue and Baumgartner 1965; Woronecki et al. 1989; Gadd 1992; Swindle 2002). 4-AP, tested as Avitrol, has been effective against gulls, starlings, crows, rock doves, and house sparrows (*Passer domesticus*) (Seamans 1970). Avitrol also has been used successfully on loafing gulls and pigeons (Blokpoel 1976). Sweeney and McLaren (1987) demonstrated its effectiveness on gulls at landfills. However, Dolbeer (1981) found Avitrol not to be cost-effective in grain crops. Knittle et al. (1988) found 4-AP to be effective for reducing blackbird damage to sunflowers, but it was mostly ineffective in fields greater than 2 miles from a roost. Avitrol is toxic and can be difficult to administer in a dose sufficient to cause the desired effect but not to kill the bird immediately (Harris and Davis 1998). Death may be delayed and affected individuals may be able to fly away before dying elsewhere (Holler and Schafer 1982).

Methyl Anthranilate

Methyl anthranilate (MA) has been tested on numerous occasions as a deterrent for birds in a variety of settings (Avery 1992; Cummings et al. 1992, 1995; Dolbeer et al. 1992; Vogt 1994; Avery et al. 1995; Belant et al. 1995, 1996, 1997). Both dimethyl and MA were strongly avoided by captive mallards and Canada geese when birds were offered both treated and untreated grain (Cummings et al. 1992). When offered only treated grain, both ducks and geese reduced their food intake, but mallards, and to a lesser extent, Canada geese, gradually increased consumption during the 2 to 4 days of the experiment. Cummings et al. (1992) assumed that the birds were habituating to the chemical, but they were not given an alternative food source, and the increased consumption may have been caused by increased hunger. Cummings et al. (1995) tested another formulation of MA, REJEX-IT AG-36, as a grazing repellent for Canada geese. In the pen trial, 59 kg/ha of the chemical applied reduced goose activity on treated grass plots for less than 4 days. Similarly, Cummings et al. (1995) evaluated the effectiveness of MA, tested as ReJex-iT AG-36, as a deterrent for blueberries. In Michigan, MA applied at 16.1 kg/ha did not reduce overall damage by birds, but did offer ephemeral control for 7 days. In the same study, Cummings et al. (1995) tested MA at a rate of 32 kg/ha in Florida to caged cedar waxwings (*Bombycilla cedrorum*). Results were similar for waxwings in Florida to those in Michigan—berry consumption did not differ. Belant et al. (1995) tested two formulations of MA (tested as AP-50 and TP-40) to repel gulls and mallards from water. Overall, gull activity was reduced in pools treated with the MA (tested as AP-50, a free-flowing powder) formulation compared with untreated pools. The MA formulation tested as TP-40 (containing a surfactant), with 1.6-3.0 times greater concentration of MA at the water surface, was slightly more effective in reducing bird activity. Conversely, Belant et al. (1996) found MA in a 14.5% vol/vol formulation was ineffective in reducing geese foraging activity. Also, Belant (1997) found MA ineffective in reducing woodpecker activity on wood siding of residential buildings. Dolbeer et al. (1992) investigated MA (tested as ReJeX-iT) at two different concentrations. Both concentrations were effective in repelling mallards and ring-billed gulls. Stevens and Clark (1998) tested MA in an aerosol form as an irritant for captive starlings. The MA aerosol was effective as an irritant and starlings did not habituate to repeated exposure. Aerosols may hold promise as a hazing technique for some species of birds; however, more research is needed on their effectiveness and proper application concentrations.

Anthraquinone

Dolbeer et al. (1998) evaluated an anthraquinone formulation [tested as Flight Control™ (FC)] as a feeding repellent for Canada geese and brown-headed cowbirds. The formulation was applied to turf within small pens housing captive geese. They found 2.5 times more bill contacts/min observed on untreated plots compared with treated plots during a 7-day trial. Presented with untreated millet or millet treated with FC, caged cowbirds avoided the treated seed and lost body mass during the 3- to 4-day trials. Cummings et al. (2002) conducted a field evaluation of anthraquinone (tested as FC) in newly planted rice fields. Seed was treated with FC at a 2% (g/g) concentration at day of planting. Blackbird abundance and seed damage were significantly lower in treated fields compared with untreated fields. Blackwell et al. (1999) tested the possible enhancement of anthraquinone (tested as FC) with the addition of a plant growth regulator [tested as Stronghold™ (SH)]. The plant growth regulator alone was not effective in reducing herbivory of grass by geese. However, a combination of anthraquinone and the plant growth regulator reduced geese presence by 62% and reduced foraging activity by 88%. Blackwell et al. (1999) also reported a continued effect of the treatments 22 days after initiation. The plant growth regulator (tested as SH) greatly enhanced anthraquinone (tested as FC) as a repellent for geese on turf grass. Blackwell et al. (2001) again used anthraquinone (tested as FC) and methyl anthranilate (tested as ReJeX-iT AG-36), but in this instance sandhill cranes (*Grus canadensis*) were used in pen trials with corn. Both chemicals were effective in reducing corn consumption by cranes. Cranes consumed 8.6 times more corn in the untreated pens compared with corn treated with MA (tested as FC) and consumed 9.8 times more untreated corn compared with corn treated with MA (tested as ReJex-iT AG-36). Methyl anthranilate applied with a plant regulator appears to provide repellency against birds at food sources for up to several weeks (Blackwell et al. 1999).

Miscellaneous Chemicals

Dolbeer et al. (1988) tested the effectiveness of naphthalene as a repellent for starlings around structures. No differential use was found in treated or untreated nest boxes. No recent investigations of napthalene as a repellent have been conducted.

Belant et al. (1997a) compared the effectiveness of d-pulegone and mangone, both taste aversives, on captive brown-headed cowbirds. The 0.01% d-pulegone lowered cowbird feeding activity, but at lower rates did not. Mangone was slightly more effective at lower concentrations, but consumption of mangone-treated millet was similar among one-choice tests.

Dolomitic limestone has been hypothesized as a taste aversive for birds (Clark and Belant 1998). Belant et al. (1997) tested if adding limestone in the form of a dry substance or slurry reduced consumption of grain. Results were mixed, as reductions of total food intake decreased for both cowbirds and geese during one-choice tests with lime and grain. However, body mass was not affected during two-choice tests. In treated grass plots, goose feeding was reduced for 2 to 3 days after application of lime in both forms. Similarly, tests of dolomitic lime, activated charcoal, a silica-based compound (tested as Nutra-lite), and white quartz sand as taste aversives on cowbirds and Canada geese revealed that lime and charcoal showed potential as repellents (Belant et al. 1997b). However, Belant et al. (1997b) reported short-lived efficacy of the silica-based compound for geese.

Chemical-based Tactile Deterrents

Tactile deterrents are perhaps the least studied bird deterrent approach. Most tactile repellents are sticky substances that deter birds from sitting on perches, such as building ledges, antennas, and airfield lights and signs. Reidinger and Libay (1979) tested glue applied on perches to deter birds near rice-fields. The authors found the glue to be effective during the short treatment period (5 to 8 days). Clark (1997) tested several dermal contact repellents to deter starlings from using structures. In theory, these repellents cause irritation to the bird through contact with the dermis on the foot and birds avoid such areas subsequently. Starlings demonstrated agitation in response to 5% oil extracts of cumin, rosemary, and thyme (Clark 1997). Furthermore, starlings avoid perches treated with R-limonene, S-limonene, or ß-pinene.

Conklin et al. (2009) tested surface modifications in an effort to deter cliff-swallows from nesting on highway structures. Polyethylene sheeting proved to be effective in reducing nesting activity; however, swallows were still able to build nests.

EXCLUSION METHODS

Various devices and materials have been used to provide perceived or actual barriers to exclude birds from unwanted areas to prevent loafing, nesting, foraging, and other activities. Exclusion methods used include razor wire, overhead wires, netting, covers (floating and other), and floating balls such as those shown in Figure 9 (Harris and Davis 1998). Total exclusion measures for birds are generally impractical and cost prohibitive; therefore, other partial exclusory techniques and “virtual” barriers are more typically employed.

FIGURE 9 Bird balls at Heathrow (*Source*: USDA/APHIS/WS Ohio Field Station).

Overhead Wires

Overhead wires, such as those shown in Figure 10, are likely the most researched and used exclusion method for birds (Amling 1980; Blokpoel and Tessier 1984; Laidlaw et al. 1984; Lefebvre and Mott 1987; Agüero et al. 1991; Belant and Ickes 1996) and can be highly effective. The use of overhead wires is typically effective at deterring use of an area by birds; however, most tests have been conducted on small water bodies or rooftops. The logistics and costs associated with using this technique on larger areas will likely limit its application at airports. McAtee and Piper (1936) produced the initial work on excluding birds from water resources in the early part of the last century; subsequently, several other authors have published material on overhead wires (McLaren et al. 1984; Pochop et al. 1990; Agüero et al. 1991; Clark et al. 2004); in many cases wires proved to be effective. Belant and Ickes (1996) evaluated the effectiveness of overhead wires to reduce roof-nesting by ring-billed (*Larus delawarensis*) and herring gulls (*Larus argentatus*). In this instance, wires were configured in a spoke-like pattern at a maximum of 16 m spacing on a food warehouse roof. Nesting by ring-billed and herring gulls was reduced by 76% and 100% in the first year and 99% and 100% in the second year, respectively, compared with pretreatment data.

FIGURE 10 Overhead wires on water source (*Source*: USDA/APHIS/WS Mississippi Field Station).

Clark et al. (2004) experimentally tested how overhead lines affected red-winged blackbird nest survival. Collectively, the presence of overhead wires decreased daily nest survival probabilities, but inferences on line spacing could not be elucidated. Lowney (1993) tested overhead wires as a deterrent to Canada geese around water sources. An 8.3 m grid was placed over small ponds on multiple sites. This system was successful in deterring geese from water sources.

Antiperching Wire or Metal

Antiperching devices, such as that shown in Figure 11, appear to be effective for large birds, but less so for smaller species. As larger birds are generally more hazardous to aircraft (Dolbeer et al. 2000), use of antiperching devices

Netted/Bottom-Lined Ponds Mitigate Attractiveness of Stormwater Ponds to Hazardous Birds at Seattle-Tacoma Airport

The Seattle–Tacoma International Airport (SEA) uses netted/bottom-lined stormwater detention ponds to minimize vegetation growth, reduce attracting hazardous waterfowl, and lower long-term maintenance costs. The use of netting and pond liners is preferred to use of a floating ball or blanket cover because unrestricted access to the ponds was an important design criterion for these facilities. Research was needed to ensure that this practice did not compromise aircraft safety by causing birds to repeatedly fly over ponds when attempting to get below the netting. During fall 2008, 1,000 hours of sampling effort was archived from three avian radars and postprocessed to compare the average time (seconds) targets spent over each of three netted/bottom-lined ponds compared with a paired control site. Paired sites were located an equal distance from the radar antenna. Radar data collected from altitudes 0–450 ft above runway level suggested bird use of netted/bottom-lined ponds was similar or less than control sites.

An 80 mil HDPE liner system was used along the sides of stormwater detention ponds at SEA to prevent aquatic plant growth and waterfowl habitat created by the presence of open-water and emergent/submergent vegetation. In larger ponds, the stainless steel cables that support the nets are attached to a collar that can slide down the pre-corroded steel pipe, when needed to reduce the damaging effects of snow and ice buildup on the netting. Once melted, the counter weights inside the pipe pull the collars and net back to their original position. Each pipe is capped with a daddy long leg type deterrent device to prevent use by perching birds above the net.

is common. Birds perching on fences, signposts, light fixtures, ledges, or any structure in the airport environment can lead to problems with aircraft (Federal Aviation Administration 2007, 2008). Avery and Genchi (2004) tested antiperching devices in an effort to deter birds from perching on the FAA's Low Level Wind-shear System (LLWAS). Six different antiperch devices were tested on five bird species. No single device proved effective for all species involved in tests. Categorically, larger birds such as owls and vultures require different devices than do smaller species [e.g., cowbirds and fish crows (*Corvus ossifragus*)]. The combination device (Figure 11) provided the best protection for all species; however, 100% deterrence was not achieved. Seamans et al. (2007) tested an antiperching device to deter brown-headed cowbirds, European starlings, red-winged blackbirds, rock pigeons, and common grackles. In this case a commercial antiperching device (tested as Birdwire™) was tested in an aviary setting. The device was effective in reducing perch use by all species. Blackbirds and starlings were, however, capable of using the perches, but only for a short time.

Miscellaneous Techniques

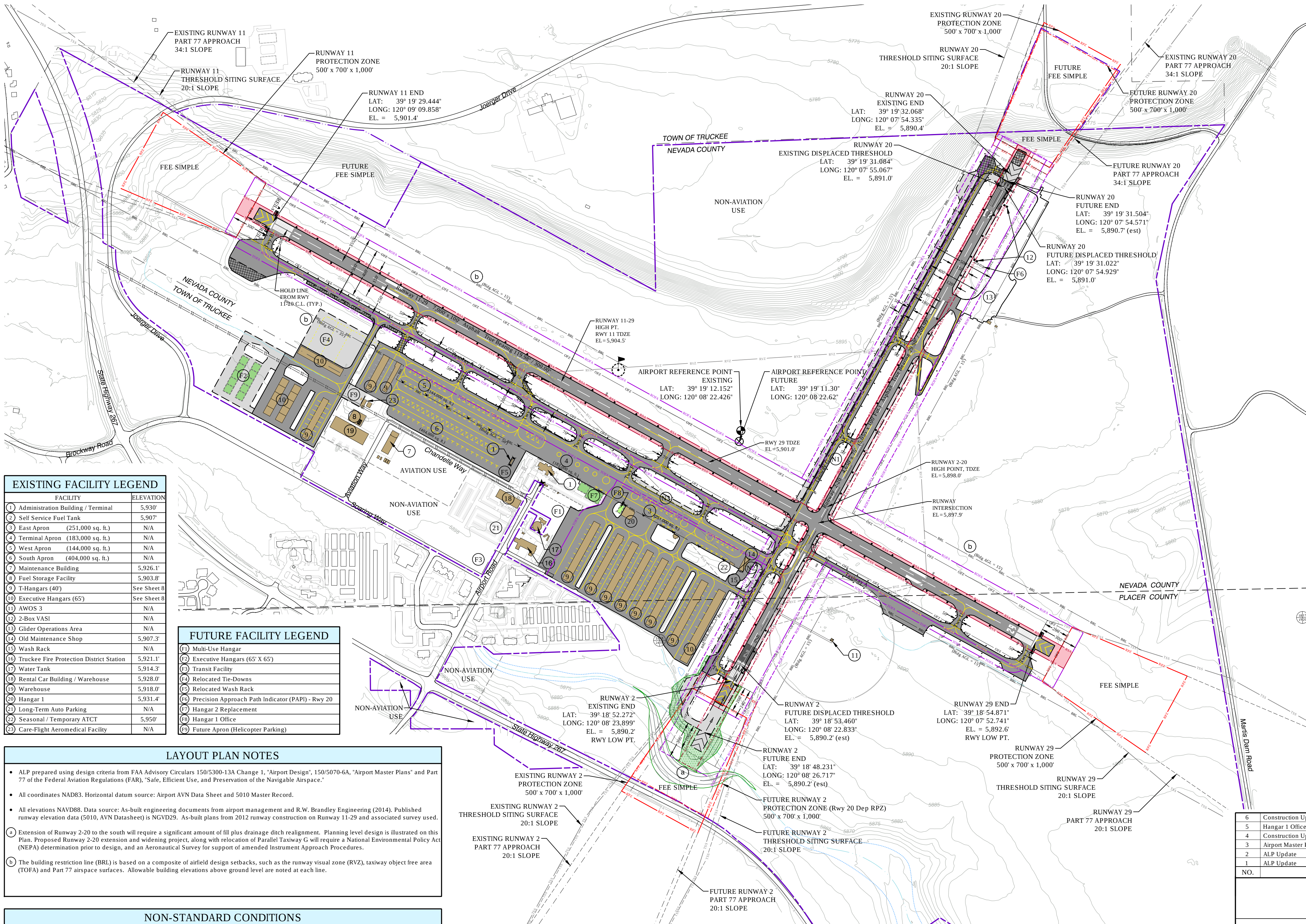
A wide variety of control techniques have been employed to reduce bird use of airports but not formally evaluated. Examples include use of remote-controlled vehicles such as radio-operated model aircraft and boats, in addition to many varieties of nonlethal projectiles, including rubber slugs and paint balls. Also, lasers emitting green beams, personnel in vehicles, and various forms of netting have been used. Although several of these techniques may actually be effective in reducing bird use, the lack of quantitative and rigorous assessments precludes categorizing their utility and application to wildlife damage application.

FIGURE 11 Antiperching devices used to deter birds from a low level windshear alert system (*Source*: Steve Osmek).

WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

Appendix D: TRK Airport Layout Plan

Mead & Hunt



DRAWING LEGEND

	EXISTING	FUTURE
ACTIVE AIRFIELD PAVEMENT		
PAVEMENT TO BE REMOVED	N/A	
AIRPORT PROPERTY		
AIRPORT REFERENCE POINT		
COUNTY BOUNDARY		N/A
TOWN OF TRUCKEE BOUNDARY		N/A
RUNWAY SAFETY AREA (RSA)		
RUNWAY PROTECTION ZONE (RPZ)		
RUNWAY OBJECT FREE AREA (ROFA)		
TAXIWAY OBJECT FREE AREA (TOFA)		
OBSTACLE FREE ZONE (OFZ)		
AWOS CRITICAL AREA (ACA)		N/A
BUILDING RESTRICTION LINE (BRL) (b)		N/A
RUNWAY VISIBILITY ZONE (RVZ)		
FAR PART 77 APPROACH SURFACE		
THRESHOLD SITING SURFACE (TSS)		
BUILDING - ON AIRPORT		
BUILDING - ON AIRPORT - TO BE RELOCATED		N/A
BUILDING - OFF AIRPORT		N/A
TAXIWAY MARKING (C.L. / TIE-DOWNS)		
BEACON		N/A
VISUAL APPROACH SLOPE INDICATOR (VASI)		N/A
PRECISION APPROACH PATH INDICATOR (PAPI)	N/A	
WIND CONE		N/A
RUNWAY LIGHTS (EDGE/THRESHOLD/REIL/TWY)		N/A
RUNWAY / TAXIWAY SIGN		
UTILITY / LIGHT POLE		N/A
PUBLIC ROAD / PARKING LOT		
FENCE		N/A
FILL FOR RUNWAY AND RSA EXTENSION	N/A	
CHANNEL / STREAM / DITCH		N/A
TERRAIN CONTOUR		
CENTER SECTION MARKER		N/A

EXISTING FACILITY LEGEND

FACILITY	ELEVATION
(1) Administration Building / Terminal	5,930'
(2) Self Service Fuel Tank	5,907'
(3) East Apron (251,000 sq. ft.)	N/A
(4) Terminal Apron (183,000 sq. ft.)	N/A
(5) West Apron (144,000 sq. ft.)	N/A
(6) South Apron (404,000 sq. ft.)	N/A
(7) Maintenance Building	5,926.1'
(8) Fuel Storage Facility	5,903.8'
(9) T-Hangars (40')	See Sheet 8
(10) Executive Hangars (65')	See Sheet 8
(11) AWOS 3	N/A
(12) 2-Box VASI	N/A
(13) Glider Operations Area	N/A
(14) Old Maintenance Shop	5,907.3'
(15) Wash Rack	N/A
(16) Truckee Fire Protection District Station	5,921.1'
(17) Water Tank	5,914.3'
(18) Rental Car Building / Warehouse	5,928.0'
(19) Warehouse	5,918.0'
(20) Hangar 1	5,931.4'
(21) Long-Term Auto Parking	N/A
(22) Seasonal / Temporary ATCT	5,950'
(23) Care-Flight Aeromedical Facility	N/A

FUTURE FACILITY LEGEND

(F1)	Multi-Use Hangar
(F2)	Executive Hangars (65' X 65')
(F3)	Transit Facility
(F4)	Relocated Tie-Downs
(F5)	Relocated Wash Rack
(F6)	Precision Approach Path Indicator (PAPI) - Rwy 20
(F7)	Hangar 2 Replacement
(F8)	Hangar 1 Office
(F9)	Future Apron (Helicopter Parking)

LAYOUT PLAN NOTES

- ALP prepared using design criteria from FAA Advisory Circulars 150/5300-13A Change 1, "Airport Design", 150/5070-6A, "Airport Master Plans" and Part 77 of the Federal Aviation Regulations (FAR), "Safe, Efficient Use, and Preservation of the Navigable Airspace."
- All coordinates NAD83. Horizontal datum source: Airport AVN Data Sheet and 5010 Master Record.
- All elevations NAVD88. Data source: As-built engineering documents from airport management and R.W. Brandley Engineering (2014). Published runway elevation data (5010, AVN Datasheet) is NGVD29. As-built plans from 2012 runway construction on Runway 11-29 and associated survey used.

(a) Extension of Runway 2-20 to the south will require a significant amount of fill plus drainage ditch realignment. Planning level design is illustrated on this Plan. Proposed Runway 2-20 extension and widening project, along with relocation of Parallel Taxiway G will require a National Environmental Policy Act (NEPA) determination prior to design, and an Aeronautical Survey for support of amended Instrument Approach Procedures.

(b) The building restriction line (BRL) is based on a composite of airfield design setbacks, such as the runway visual zone (RVZ), taxiway object free area (TOFA) and Part 77 airspace surfaces. Allowable building elevations above ground level are noted at each line.

NON-STANDARD CONDITIONS

EXISTING CONDITION	DISPOSITION
(N1) Runway 2-20 to parallel Taxiway G centerline separation is 180 feet. Standard runway to parallel taxiway separation for runway design code B-I is 225 feet.	Taxiway G to be realigned for taxiway centerline to runway centerline separation of 240 feet. Taxiway G will then conform to B-II standards, which Runway 2-20 is projected to become.
(N2) Structure and aircraft tie-downs on East Apron located within the runway visibility zone (RVZ), blocking line of sight between intersecting runways.	Building, wash rack and tie-downs to be relocated to account for ultimate RVZ associated with proposed Runway 2-20 extension.
(N3) Aircraft parking positions on Terminal Apron are located within the apron taxilane object free area (TOFA).	Add pavement to edge of apron to allow taxilane to shift away from parking positions and provide proper centerline to fixed / movable object separation.

SUBMITTED BY:
Truckee Tahoe Airport Board

By ______________________ Date

FAA Approval Space

NO.	REVISION	SPONSOR	DATE
6	Construction Update (Executive hangars) and future Heli. Apron and Wash Rack	Mead & Hunt, Inc.	2019
5	Hangar 1 Office	Mead & Hunt, Inc.	2018
4	Construction Update (connector txwys. maint. bldg. expansion, box hangar relocation)	Mead & Hunt, Inc.	2017
3	Airport Master Plan Update (Rwy 2-20 extension, 13A requirements)	Mead & Hunt, Inc.	2015
2	ALP Update	PBS&J	2009
1	ALP Update	PBS&J	2007

TRUCKEE-TAHOE AIRPORT
TRUCKEE, CALIFORNIA

AIRPORT LAYOUT PLAN

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TRUCKEE TAHOE AIRPORT

DESIGN: BM | DRAWN: TE/BM | DATE: MARCH 2017 | SHEET 2 OF 11

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WILDLIFE HAZARD SITE VISIT SUMMARY REPORT

Mead & Hunt