# Brookings Regional Airport 2010 Wildlife Hazard Assessment

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## 1. Introduction and Background

Wildlife strikes and wildlife hazard management at airports were once topics unfamiliar to the general public. This changed on January 15, 2009, when the incident now commonly referred to as "The Miracle on the Hudson" occurred. Shortly after takeoff from LaGuardia International Airport in New York City, a US Airways Airbus A320 struck a flock of Canada geese (*Branta canadensis*), causing both engines to fail. A remarkable and highly publicized landing in the Hudson River saved the lives of the 155 people on board. If the plane had crashed in the city, not only would the 155 people on board likely have perished, additional casualties on the ground could have surpassed that number. Without the professionalism of the captain and crew, the incident could have been the worst bird-related plane crash in history.

Unfortunately, aircraft collisions with wildlife have occurred since shortly after airplanes were invented. The first recorded bird strike was by Orville Wright in 1905, and was probably with a red-winged blackbird (*Agelaius phoeniceus*). The first person to pilot an aircraft across the United States was Calbraith Rogers; on April 3, 1912, he also became the first person to die as the result of a bird strike. Rogers crashed into the ocean and drowned after hitting a gull at Long Beach, California (Cleary and Dolbeer 2005).

Several examples of other wildlife strikes from Cleary and Dolbeer are listed below. These examples were selected because all of the wildlife species reported in the incidents can be found on the Brookings Regional Airport.

**October 4, 1960.** A Lockheed Electra turbo-prop ingested European starlings (*Sturnus vulgaris*) into all four engines during takeoff from Boston Logan Airport. The plane crashed into Boston Harbor, killing 62 people and seriously injuring nine of the other ten persons on board. Among the dead and injured were 15 newly sworn-in marines en route to training at Ellis Island.

**February 26, 1973.** A Learjet 24 departing from the Peachtree-Dekalb Airport in Atlanta, Georgia, struck a flock of brown-headed cowbirds (*Molothrus ater*). The aircraft crashed as a result of engine failure, killing seven people on the Learjet and seriously injuring one person on the ground.

**July 25, 1978.** A Convair 580 departing from Kalamazoo Airport in Michigan ingested an American kestrel (*Falco sparverius*) into an engine on takeoff. The aircraft crashed, injuring three of the passengers.

**December 30, 1991.** A Citation 550, taking off from Angelina County Airport (TX) struck a turkey vulture (*Cathartes aura*). The cost of repairs was $550,000 plus downtime.

**September 22, 1995.** A U.S. Air Force modified Boeing 707 crashed during takeoff from Elmendorf Air Force Base after ingesting four Canada geese (*Branta canadensis*) into two engines, resulting in the deaths of all 24 personnel on board.

**October 16, 2005**. A BE-1900 struck a coyote (*Canis latrans*) during takeoff at Ogdensburg International Airport in New York. The nose gear collapsed, causing further damage to the plane. The cost of repairs was estimated at $1.5 million.

As a result of these and thousands of other strikes, the Federal Aviation Administration (FAA), the U.S. Department of Agriculture (USDA), and the U.S. Department of Defense (DOD) are working in cooperation with a multitude of governmental entities, airports, corporations, and individuals to reduce the annual toll inflicted on aircraft and passengers by collisions with wildlife. According to the Bird Strike Committee USA, current estimates of the cost to civil aircraft in the United States are over $600 million per year. Of greater importance is the fact that more than 219 lives have been lost worldwide since 1988 as a result of wildlife strikes (http://www.birdstrike.org/ last accessed January 20, 2011).

One important facet of the work being done to reduce wildlife hazards is to conduct Wildlife Hazard Assessments at airports. A Wildlife Hazard Assessment (WHA) is required by the Code of Federal Regulations, Title 14-Part 139.337 (14 CFR 139.337), when any of the following events occurs on or near an airport:

(1) An air carrier aircraft experiences a multiple-bird strike or engine ingestion.

(2) An air carrier aircraft experiences a damaging collision with wildlife other than birds.

(3) Wildlife of a size or in numbers capable of causing an event described in (1) or (2) is observed to have access to any airport flight pattern or movement area.

The Wildlife Hazard Assessment for the Brookings Regional Airport (also referred to as BKX) was mandated by the FAA because of a multiple bird strike with damage that occurred on November 5, 2003. The event met criteria (1) and (3) above.

## 1.1 Requirements of a Wildlife Hazard Assessment

14 CFR 139.337 requires a qualified airport wildlife biologist to set up and manage a study to determine the species of wildlife using the airport, their numbers, locations, local movements, and daily and seasonal occurrences. The WHA will include both day and night surveys using methods and procedures determined by the biologist running the study.

Additionally, the WHA includes small-mammal sampling, identification of vegetation, soils, and water sources in the airport vicinity, interviews with employees of the airport and airlines, meetings with other personnel, and monthly inspection of airport lands and structures for wildlife attractants,

The WHA must also include an analysis of the event prompting the study.

Most importantly, the WHA must identify the features attracting wildlife to or near the airport, describe the wildlife hazards to air-carrier operations, and include an analysis and writing of a final report with recommendations for mitigating identified hazardous wildlife attractants.

## 1.2 Requirements for a Wildlife Hazard Management Plan

The WHA is often a precursor to a Wildlife Hazard Management Plan (WHMP). The FAA Administrator may determine a WHMP is needed as per 14 CFR 139.337(d)(1-6) after considering a variety of factors, including the findings of the WHA, aircraft usage at the airport, and views of the airport operator and airport users.

The goal of an airport WHMP is to minimize wildlife populations on and around the airport that pose a threat to aviation safety or to structures, equipment, and human health. The WHMP should:

- Identify those responsible for implementing the plan,
- Identify and provide information on hazardous wildlife attractants on or near the airport,
- Identify appropriate wildlife management techniques to minimize the wildlife hazard,
- Prioritize appropriate management measures,
- Recommend necessary equipment and supplies, and
- Identify training requirements for the airport personnel who will implement the plan.

Specific requirements as to what must be addressed in a Wildlife Hazard Management Plan are provided by Title 14 CFR 139.337(e) and (f). The WHMP is a working document subject to

change as conditions change. The plan should be reviewed and updated by a Wildlife Hazards Working Group (WHWG).

The WHWG is a committee consisting of personnel integral to the mitigation of wildlife hazards at the airport. The group is tasked with reviewing the WHMP and the progress made on completing the recommendations of the WHA. The plan should be reviewed at least annually and also at any time a significant strike occurs on the airport.

## 1.3 BKX Wildlife Hazard Assessment Style and Terminology

Standard English measurements have been used in this report in the interests of clarity and in keeping with the characteristics of FAA and USDA documents such as *Wildlife Hazard Management at Airports* (Cleary and Dolbeer 2005) and with various references pertaining to BKX, including maps, documents and the *Brookings Regional Airport Draft Environmental Assessment* (HNTB Corporation 2009).

In addition, the common names of the plant and wildlife species have been used throughout the text. Their respective scientific names, to include genus and species, have been included after the first usage in the text and when otherwise deemed necessary to avoid any confusion caused by the use of common or colloquial names.

A compiled list of wildlife and plants found at the Brookings Regional Airport is included in Appendix 5. The wildlife and plant species have been further categorized according to taxonomic orders or families.

Acronyms used in this report are clarified at the first usage and in Appendix 1.

All photographs in this document were taken by the author at or near the Brookings Regional Airport. Photos taken by means of trail cams are so noted. The cover photo is of Canada geese at a gravel pit east of Brookings.

The “Literature Cited” section has been organized to be user friendly. All citations have an Internet URL to make it easy for the reader to find further information. This feature is especially useful because many of the most-used reference books and manuals are frequently updated and are no longer published in written editions. The “Internet Resources” page allows quick access to a variety of resources. A section with links to Advisory Circulars (ACs) and CertAlerts for airports is also included.

# 2. Methodology and Surveys

## 2.1 On-Site Methods and Surveys

A stated purpose of the WHA is to document the daily and seasonal movements of all wildlife in the area. Site visits to the Brookings Regional Airport were conducted, starting in August of 2009, to determine potential hazards and formulate a survey plan. A standardized on-site survey route was established after several trial runs. Twenty-four stationary survey points were selected on and adjacent to the airport to adequately cover all areas on the airport grounds and in the Runway Protection Zones (RPZs) both on and off the airport. The primary habitat attractants at each location were noted as the survey work progressed (Appendix 4).

The route required approximately l2 miles of travel and was designed to allow access to areas that were normally open year-round. Each point could generally be checked from a distance with the aid of binoculars or a spotting scope if conditions did not permit the observer to travel to the exact point. Each survey required 1½ to 2 hours to complete.

Standardized surveys were conducted during daytime and nighttime hours from October 2009 through October 2010, with additional survey work until December 25, 2010, to reassess recommendations.

Occasionally, surveys could not be completed or the results were skewed because of unforeseen circumstances. Ideally, a researcher would ignore wildlife hazards when gathering empirical data to avoid influencing results. However, the safety of the public must take precedence over data collection. Surveys were interrupted on multiple occasions so the author could assist with the removal of hazardous wildlife from the RPZs. White-tailed deer (*Odocoileus virginianus*), Franklin's gulls (*Leucophaeus pipixcan*), ring-billed gulls (*Larus delawarensis*), giant Canada geese (*Branta Canadensis maxima*), large flocks of cliff swallows (*Petrochelidon pyrrhonota*), turkey vultures (*Cathartes aura*), and other species of wildlife were dispersed when hazard levels were too high to overlook. When the time or actions involved to disperse hazardous wildlife were believed to influence the data collected, the survey information was not entered into a standardized database. However, the data was used as corroborating information.

Wildlife species documented during surveys are listed in Appendix 5.

### 2.1.1 Daylight Surveys

Standardized daytime surveys were conducted an average of 4.5 days per month on the airport. The number of surveys averaged 5.8 per month, and included morning, afternoon and dusk surveys. Each of the 24 points was surveyed for approximately three minutes. Binoculars were used to aid in the identification of wildlife species. Wildlife was

documented as occurring at the survey point closest to where it was first seen by the researcher, regardless of where the researcher was actually located.

Time of day for each survey category was varied occasionally to document not only the most wildlife seen, but also the most hazardous species. For example, the total number of birds seen is generally higher shortly after sunrise than later in the morning or early afternoon. Total bird numbers do not necessarily reflect the actual hazards to aircraft; a hundred small birds scattered in various locations around the airport would generally present considerably less danger than a very few turkey vultures circling the airfield. Turkey vultures are considered to be a major hazard to aircraft, but were rarely noted on BKX property until after a dawn survey would be completed, and were usually dispersed by the time a midday or afternoon survey would start. Gulls, Canada geese and other hazardous species could be found at any time of the day.

The starting and ending location points of the survey were also randomized to avoid time-of-day biases. For example, roosting areas such as tree belts and cattail-choked wetlands are often seemingly devoid of birds at midday, but have substantial activity near dusk and dawn.

### 2.1.2 Spotlight Surveys

Spotlight surveys were conducted monthly at various times of the night. The route covered the same points as the on-site daylight surveys inside the perimeter fence of the airport, and was designed primarily to determine nocturnal medium- to large-sized mammal presence and movement patterns in locations where strikes were possible. Areas outside the fence were not routinely surveyed.

### 2.1.3 Rodent Surveys

Not all wildlife using an area will be seen on survey routes due to an animal's size, habitat or secretive nature. Rodent populations are an important element in wildlife hazard assessments. Rodents are not generally a direct threat to aircraft, unless they enter a plane and build nests or damage wiring, or destroy underground wiring important to the operation of the airport. However, the holes and mounds of earth left by the burrowing activities of pocket gophers and ground squirrels make airfields hazardous not only to aircraft leaving the tarmac, but to maintenance workers and equipment.

Rodents are also a major attractant to raptors and carnivorous mammals, which may pose grave hazards to aircraft. American badgers (*Taxidea taxus*) and other predators digging in search of pocket gophers and ground squirrels can also damage underground wiring and leave additional holes and mounds of earth.

A variety of traps and sampling techniques were used at various times throughout the survey period to sample rodents and shrews. Traps included ordinary Victor mouse and rat snap

traps, Victor Museum Special mouse traps, small single-coil jump traps, pocket gopher traps, and drowning sets. The snap traps were baited with a mixture of peanut butter and oatmeal. The other traps were not baited, but were placed in holes and burrows to intercept small mammals as they passed.

Snap traps were set in strings of 15 to 25, generally four to six feet apart. Habitat types included cropland, mowed grass, un-hayed grassland, fence lines, weedy areas, around buildings, on and around hay bales, in shrub rows, and adjacent to wetlands. Traps were left in place for at least 24 hours and for as long as 96 hours, but were checked daily. Any snapped traps were reset. A total of 1615 trap days—every trap set for 24 hours counts as one trap day—were completed during the WHA.

### 2.1.4 Other Mammal Surveys

Spotlight and daytime surveys were the primary methods used to determine the presence and movements of medium- to large-sized mammals. However, a variety of other methods were also used. Simple observation of scat and tracks confirmed the presence of some species. Live (box) traps (pictured left) were set to further sample carnivorous species such as red fox (*Vulpes vulpes*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis)*, domestic cats (*Felis catus)*, and Virginia opossums (*Didelphis virginiana*). Baits used included canned and dry cat and dog food, peanut butter and eggs.

Two brands of automatic cameras (trail cams) were used throughout the survey period. The trail cams were able to capture pictures day and night, although functionality was limited in times of extreme cold or heavy precipitation. Trail cams can captures images of animals not often seen, such as the coyote pictured right. A time and date stamp allows the researcher to also determine the time of day the animals are most active.

In addition to the targeted species, multiple photographs of pheasants, ducks, crows, vultures, rabbits, and other wildlife species were taken.

### 2.1.5 Fish Sampling

Fish are not a direct threat to aircraft, although one strike with a fish apparently occurred on March 30, 1987, near Juneau, Alaska. A bald eagle (*Haliaeetus leucocephalus*) carrying a fish crossed paths with a Boeing 737-200QC. The eagle dropped its prey, which hit the plane. While not a direct threat, fish do attract a number of hazardous wildlife species. Bald eagles, ospreys (*Pandion haliaetus*), and a variety of herons, cranes and other fish-eating birds and mammals are known to occur on or near BKX. In addition, waters suitable for fish are also suitable for other prey species attractive to hazardous wildlife.

Wetlands and drainages on the airport were occasionally sampled during months with open water using standard minnow traps either un-baited or baited with dry dog food or bread. The sampling was done primarily to determine the presence or absence of fish that could attract hazardous wildlife such as herons, grebes and other fish-eating birds. Six Mile Creek was not sampled. Extensive research has been done on the creek, and the species composition is known. (See 8.1.1.1 Six Mile Creek and Associated Wetlands.) Species of fish, crustaceans and amphibians sampled during the WHA are included in the list of wildlife noted on the Brookings Regional Airport (Appendix 5).

## 2.2 Off-Site Surveys

The vast majority of bird strikes occur on or near an airport, when aircraft are at a low altitude while landing, during takeoff or when circling. Approximately 72% of bird strikes occur at or below 500 feet above ground level (AGL), and 92% occur at or below 3000 feet AGL. The statistics also show 94% of strikes occur on or near airports while the aircraft is landing or taking off (Dolbeer et al. 2009). Work to reduce wildlife collisions with aircraft must begin at airports, but cannot stop at the airport boundaries. Attractants near the airport must also be located and mitigated.

AC 150/5200-33B is a comprehensive document covering subjects such as general separation criteria for hazardous wildlife attractants, land-use practices on or near airports which could potentially attract hazardous wildlife, and procedures for wildlife hazard management by operators of public-use airports. The latest version of the AC is readily available on the FAA website at http://www.faa.gov/airports/resources/advisory_circulars/. (See also “Advisory Circulars and CertAlerts” on page 103.)

The AC specifically addresses three safety zones around an airport. For operations serving piston-powered aircraft only, hazardous wildlife attractants must be 5000 feet from the nearest Airport Operations Area (AOA). For airports such as BKX, which also serve turbine-powered aircraft, wildlife attractants must be 10,000 feet from the AOA.

In addition, the FAA recommends a minimum separation criterion of five statute miles between the AOA and the hazardous wildlife attractant if the attractant could cause wildlife movement into, on, or across the approach or departure airspace. The five-mile perimeter is often referred to in FAA documents as the "general zone" (Figure l6 and Appendix 3).

Approximately 57% of strikes occur on approach or climb (Dolbeer et al. 2009). Aircraft on approach at a 3-degree glide slope are within 5 miles of the airport at 1500 feet AGL. Aircraft on departure are generally much closer to the airport when they reach 1500 feet AGL.

Off-site surveys were designed to locate and evaluate potential wildlife attractants within or near the separation distances identified by AC 150/5200-33B.

### 2.2.1 Off-Site Survey Methods

Potential attractants were identified through the use of aerial photos, written documents, and interviews with BKX employees, fixed-base operators (FBOs), pilots, and others with knowledge about the area. In addition, the author traveled many hundreds of miles prior to and during the WHA to locate potential hazards not yet identified.

Multiple potential wildlife attractants were identified in or near the general zone. The number of times each attractant was surveyed depended in part on the season and wildlife abundance. The major attractants were surveyed on as many as 67 days during the WHA, with multiple surveys per day during certain periods.

The results of those surveys are discussed later in this document.

## 3. General Description of the Area

### 3.1 Population

The population of Brookings County in 2008 was 29,668, according to figures from the U. S. Census Bureau. The city of Brookings itself had just over 20,000 residents. South Dakota State University (SDSU), with over 11,000 students, adds considerably to the economic base. Other communities in Brookings County include Aurora, Bruce, Sinai, Elkton, Nunda, Bushnell, Volga, White, and part of Arlington. The population of Brookings County is 95% Caucasian. Brookings County is primarily a farming community, although Brookings itself is becoming more industrialized and less dependent on agriculture-related businesses.

### 3.2 Topography and Soils

Brookings County is located in eastern South Dakota and encompasses about 800 square miles. It is bordered to the north by Duel and Hamlin Counties, to the west by Kingsbury

County, and to the south by Lake and Moody Counties. The state of Minnesota lies directly to the east of Brookings County.

The county lies entirely in the Coteau des Prairies region of South Dakota. Brookings County has four distinct geographical regions (Schaefer 2004). The portion of the county lying west of the Big Sioux River is a silty, glacial till plain and moraine with many wetlands and lakes. This section of the county is level to gently rolling, with the smaller drainages poorly defined.

The Big Sioux River and its associated tributaries and flood plains serve as a separate physiographic region and divide the western third of the county from the eastern two-thirds. This portion of the county is characterized by mostly level, very poorly to moderately well-drained soils, except in the well-drained outwash plains.

The eastern portion of the county is primarily categorized by level to gently rolling loamy glacial till. Drainage patterns are relatively well defined. Deer, North Deer, Medary and Six Mile Creeks flow in a southwesterly direction to the Big Sioux River.

The northeastern region of Brookings County consists of loamy glacial plain and moraine, and contains many small wetlands and lakes. The area is generally flat to gently rolling, and has poorly defined drainage patterns.

BKX lies on the very eastern edge of the Big Sioux River floodplain, and has characteristics associated with the floodplains of the Big Sioux River and tributaries to the west and the upland to the east. The dominant ecological rating is rangeland. Six Mile Creek meanders through the north and northwest portions of the airport and plays an especially important role in the management of the area. Soil and Ecological Use maps and information specific to BKX can be found in Appendix 8 and Appendix 9.

## 3.3 Weather

According to data from the state climate website (http://climate.sdstate.edu), Brookings has averaged 22.8” of precipitation per year from 1931 through 2009. The average daily temperature during those same years was 43° Fahrenheit, with extremes ranging from a high of 109 °F in July of 1940 to a low of minus 40 °F in February of 1962. There are approximately 100 days per year with at least one inch of snow on the ground.

Precipitation during the 2010 WHA was almost double the annual average. Brookings received 40.83 inches in 2010. Two inches or more of rain fell on June 11, June 27, July 18, August 31, September 2, and September 23, 2010. Measurable precipitation was received on at least 16 days in September, for a monthly total of 8.43 inches. The only September on record with close to the amount received in 2010 was September 1963, with 8.23 inches.

### 3.4 Vegetation

A variety of vegetation attracts a variety of wildlife. Information regarding vegetation on the Brookings Regional Airport is included in this report, particularly in the sections dealing with wetlands and land and grass management. A list of over 150 plant species documented on BKX is attached in Appendix 5.

## 4. Strike Reports

### 4.1 FAA Bird/Other Wildlife Strike Database

In 1990, the FAA instituted a standardized system to report wildlife strikes as a step toward understanding the causes and effects of aircraft collisions with wildlife. Analysis of the data collected contributes to a greater understanding of the problem, a necessary first step before solutions can be found. The data are collected through the use of FAA Form 5200-7, *Bird/Other Wildlife Strike Form* (Appendix 10). Pilots, airport personnel, and other persons who have knowledge of a wildlife strike are asked to report the incident using the standard form. Information on how to collect remains for identification is given in Appendix 11.

The commonly accepted definition of a wildlife strike comes from the Bird Strike Committee Canada. A wildlife strike has occurred when any of the following criteria are met:

- A pilot reports striking one or more birds or other wildlife;
- Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;
- Personnel on the ground report seeing an aircraft strike one or more birds or other wildlife;
- 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;
- An animal's presence on the airport had a significant negative effect on a flight, such as aborted takeoff, aborted landing, high-speed emergency stop, or an aircraft leaving the pavement area to avoid a collision with animals.

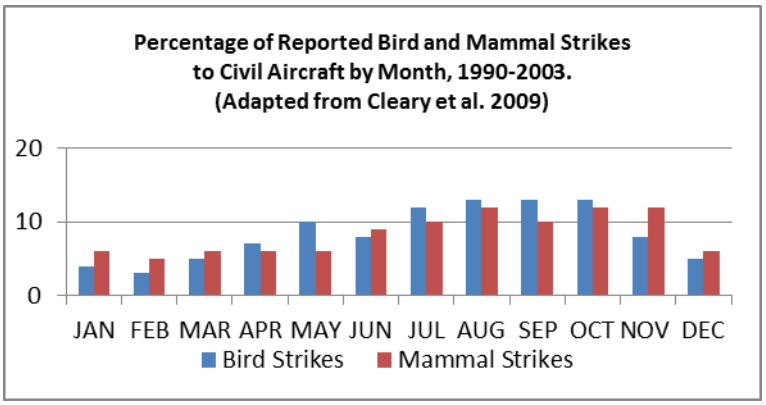



**Figure 1**

Reporting is voluntary, and Cleary and Dolbeer (2005) estimate only 20% of strikes are reported nationwide. Still, over 90,000 records have been entered into the database and have yielded some highly useful statistics:

- Birds were involved in 97% of all strikes; mammals in only 3%.
- 58% of bird strikes occurred on approach or landing; 39% during takeoff and climb.
- 40% of bird strikes occurred when the airplane was at ground level.
- 52% of mammal strikes occurred during landing, and 33% on the takeoff run. 90% of mammal strikes occurred at ground level. The other 10% of mammal strikes involved bats or happened when the plane was slightly above ground level.
- 63% of bird strikes occurred during the day; 64% of mammal strikes occurred at night.
- Bird strikes were highest between July and October; mammal strikes were highest between August and November. Deer strikes peaked in October and November.

The most sobering information is also contained in the FAA database: Nine wildlife strikes in the period from 1990 through 2009 resulted in the deaths of 16 humans.
In addition, 209 people were injured in 167 strikes.

## 4.2 Relative Hazard Ranking

Figures 2 and 3 on pages 13 and 14 give an indication of the relative hazards of certain bird groups to airplanes. The ranking in Figure 2 is based on the percent of reported strikes and percent of strikes causing damage from 1990-2008. The ranking in Figure 3 is based on the somewhat older information from 1990 to 2003, but it further breaks down the bird groups into more specific categories and includes mammals.

Neither chart factors in the relative abundance of a bird group or species at a particular airport. For any given airport, a low-ranking species group with a high population may actually pose more of a hazard than a high-ranking group that is rarely present. With the current conditions at BKX and based on collective data from the WHA, strike reports, wildlife incident logs, and interviews with airport personnel, the author would rank the top hazardous species as deer, vultures, geese, gulls, ducks, hawks, crows, blackbirds, herons, and swallows, although not necessarily in that order. Pigeons, sparrows, and nighthawks would be low on the list. Regardless of relative hazards, reasonable measures must be taken to avoid strikes with any of these species for the safety of the traveling public.

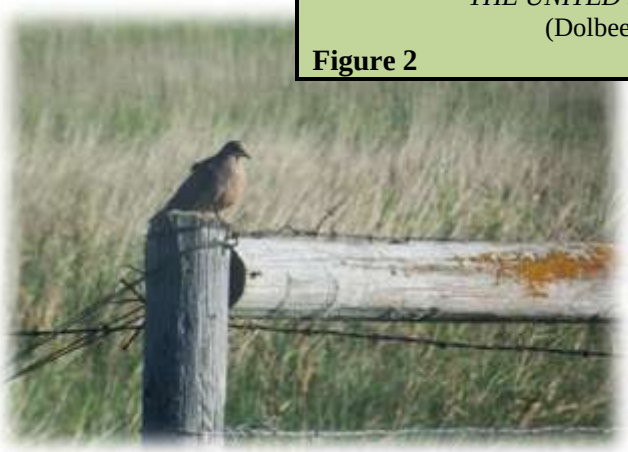
**Major Bird Groups Involved in Reported Bird Strikes to Civil Aircraft, USA, 1990-2008**

| Bird Group | Percentage of Total Known Strikes with Bird Identified | Percentage of all Known Strikes Causing Damage |
|---|---|---|
| Gulls | 30 | 18 |
| Doves and Pigeons | 15 | 17 |
| Raptors/Vultures | 13 | 16 |
| Waterfowl | 8 | 31 |

These four bird groups represented 82% of all strikes causing damage where the bird species was known.

Adapted from
*WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990–2008*
(Dolbeer et al. 2009)

**Figure 2**



The ranking of 25 wildlife species in Figure 3 below gives wildlife hazard management biologists and airport personnel statistical data to use as one factor in determining where best to allocate limited resources. However, the relative numbers of each species and the hazard levels may be different at each airport or geographical region. Some wildlife species may be a major hazard in certain places, but have not been shown to be a significant risk nationwide and may not appear on this list.

## Wildlife Hazards to Aviation
### Ranking by Species Group

| Hazard Ranking | Species/Group | Reports Noting Status of Damage | % with Damage | % with Major Damage |
|---|---|---|---|---|
| **1** | Deer | 598 | 86.3 | 44.1 |
| **2** | Vultures | 315 | 65.7 | 21.3 |
| **3** | Geese | 1,021 | 58.3 | 18.6 |
| **4** | Cormorants/Pelicans | 52 | 57.7 | 15.4 |
| **5** | Ducks | 685 | 42.9 | 13.0 |
| **6** | Eagles | 54 | 42.6 | 9.3 |
| **7** | Cranes | 47 | 42.6 | 14.9 |
| **8** | Ospreys | 42 | 38.1 | 16.7 |
| **9** | Turkey/Pheasants | 75 | 32.0 | 13.3 |
| **10** | Hawks (Buteos) | 826 | 26.9 | 7.1 |
| **11** | Herons | 322 | 22.0 | 6.2 |
| **12** | Gulls | 3,932 | 21.4 | 7.2 |
| **13** | Rock doves (Pigeons) | 626 | 19.2 | 8.8 |
| **14** | Owls | 268 | 17.5 | 7.1 |
| **15** | Crows/Ravens | 251 | 13.5 | 4.4 |
| **16** | Coyotes | 101 | 10.9 | 3.0 |
| **17** | Mourning doves | 505 | 10.7 | 4.0 |
| **18** | Horned larks/Snow buntings | 89 | 7.9 | 4.5 |
| **19** | Shorebirds | 451 | 7.8 | 2.2 |
| **20** | Blackbirds/Starlings | 1,603 | 7.5 | 1.9 |
| **21** | American kestrels | 173 | 5.8 | 3.5 |
| **22** | Meadowlarks | 118 | 3.4 | 2.5 |
| **23** | Nighthawks | 35 | 2.9 | 0.0 |
| **24** | Swallows | 416 | 2.6 | 0.7 |
| **25** | Sparrows | 1,154 | 2.6 | 0.3 |
| **Totals including reports of "No Damage"** | | 13,759 | 24.3 | 8.6 |

**Adapted from Dolbeer et al. July 2003**
**Based on data from the National Wildlife Strike Database, January 1990–April 2003.**

**Figure 3**

## 4.3 BKX Strike Data and Analysis

BKX has had seventeen strikes entered in the FAA bird/other wildlife strike database since the program's inception in 1990 (Figure 4). The first strike recorded was not until 2001, eleven years after the program started, and over half of the reported strikes occurred in the four years from 2007 through 2010. It is unlikely that no strikes occurred for eleven years and that far more than average occurred in the last four years. The most probable explanation for the increase in reported strikes is the aviation industry has become aware of the program and the benefits of obtaining the information. In addition, strike reporting can now be done online, making the process even easier.

Seventeen strike reports over a 20-year period are not adequate to complete an in-depth analysis. However, the BKX data do show some trends and are valuable when used in conjunction with other observations and documentation. Gulls account for 30% of the strikes to civil aircraft in the United States. Gulls are also responsible for the highest number of incidents (18%) in which damage occurred (Figure 2). At BKX, 41% of the strikes when the bird was identified have been with gulls, and 29% of these strikes have caused damage.

Two strikes at BKX involved geese. Nationwide, waterfowl are the fourth largest group of birds involved in reported strikes (8%) when the species is known, but the percentage of these strikes causing damage is very high (31%). At BKX, waterfowl were involved in 12% of strikes, and 100% of the strikes caused damage. Again, the number of strikes reported is too low to make broad assumptions, but the strike data on gulls and geese corroborate information obtained during the WHA. Further discussion of these and other species of concern can be found later in this report.

Two strikes with cliff swallows were reported, and at least one other strike (on July 14, 2010) may have been a cliff swallow. A strike involving one cliff swallow would not ordinarily be a major cause for concern. However, cliff swallows were noted in large numbers in tight flocks on BKX runways and taxiways during the WHA, and considerable efforts were expended to disperse the birds. A multiple strike with birds of any size is cause for concern. No wildlife species can be ignored.

Piston-powered aircraft are slower and noisier and less apt to have damaging collisions with wildlife. Jets and turbine-powered aircraft are faster and quieter, and the engine fan blades more susceptible to damage than are propellers. Substantial damage and human deaths caused by strikes involving multiple birds, even with small birds, are well documented.

# Brookings Regional Airport
## Reported Bird/Other Wildlife Strikes
## 1990 through 2010

| Date | Airline | Aircraft | Engine | Species Struck | Damage |
|---|---|---|---|---|---|
| 9/7/2001 | GREAT LAKES AIRLINES | BE-1900 | C | Unknown bird - small | N |
| 10/5/2002 | GREAT LAKES AIRLINES | BE-1900 | C | Gulls | M |
| 4/19/2003 | GREAT LAKES AIRLINES | BE-1900 | C | Gulls | M |
| 11/5/2003 | GREAT LAKES AIRLINES | BE-1900 | C | Geese | S |
| 9/23/2004 | BUSINESS | BE-200 KING | C | Gulls | N |
| 9/8/2005 | BUSINESS | PA-44 SEMINOLE | A | Gulls | N |
| 10/24/2006 | MESA AIRLINES | BE-1900 | C | Black-tailed jackrabbit | N |
| 8/15/2007 | UNKNOWN | UNKNOWN | | American goldfinch | |
| 8/15/2007 | UNKNOWN | UNKNOWN | | Killdeer | |
| 8/27/2007 | UNKNOWN | UNKNOWN | | Ring-billed gull | |
| 7/9/2008 | UNKNOWN | UNKNOWN | | Cliff swallow | |
| 9/2/2008 | UNKNOWN | UNKNOWN | | Franklin's gull | |
| 5/21/2009 | UNKNOWN | UNKNOWN | | Barn swallow | |
| 9/24/2009 | UNKNOWN | UNKNOWN | | Ring-billed gull | |
| 11/24/2009 | BUSINESS | PA-44 SEMINOLE | A | Canada goose | S |
| 7/14/2010 | BUSINESS | C-172 | A | Unknown bird - small | N |
| 7/16/2010 | UNKNOWN | UNKNOWN | | Cliff swallow | N |

Engine Type: A=Reciprocating, C=Turboprop

Damage Codes: N=None, M=Minor, S=Substantial. Blank usually means no damage.

Note: In many cases where the airline and aircraft are “unknown,” birds or other wildlife are simply found dead by airport personnel within 200 feet of the centerline of a runway, and no other cause of death is apparent. It is possible the pilot was not even aware he or she had hit a bird or other wildlife.

Adapted 1/18/2010 from the FAA on-line Wildlife Strike Database (http://wildlife-mitigation.tc.faa.gov/wildlife/database.aspx)

**Figure 4**

Wildlife strike summaries for BKX, which include comparisons with prior years and with airports of the same classification as BKX, are available from the FAA. The information is automatically generated, regardless of the number of entries into the database. At this point in time, there are simply insufficient data to make reliable comparisons, and the results may be misleading. The addition or deletion of even one or two strikes makes a substantial change in the statistical analysis when strike numbers are low or underreported.

The species involved is also of critical importance. For example, if five separate strikes involving giant Canada geese happen one year, and ten separate strikes with barn swallows (*Hirundo rustica*) happen the following year, the math will simply show the second-year strikes increased by 100%. While this is correct, the typical presumption that air travel was more dangerous the second year is not true. The danger to lives and property the first year when geese were involved was considerably higher than the year in which strikes were double in number, but only involved barn swallows.

The monthly breakdown shows 68.9% of all recorded BKX strikes occurred in July, August and September. Multiple factors account for these cyclical strike patterns. For instance, wildlife numbers are at their annual peak in late summer and early fall, when reproduction for most species has been completed for the year. The author hypothesizes that the number of young birds in the area is a more important factor in the increased number of strikes than is the total number of birds. Young birds have not fully developed their flying abilities, and may not have learned to avoid aircraft.

August and September are also peak times for migrations of these species. Like the young-of-the-year hatched on or near BKX property, birds migrating through the area and attracted to airport habitat may be inexperienced at avoiding aircraft traffic, increasing the probability of strikes.

Conversely, the reason for the relative lack of strikes in most other months is reflected in the wildlife surveys and routine wildlife logs; fewer birds are present, and those that are on BKX property are not inexperienced juveniles or migrating birds.

Strike reports can provide an early warning to any developing trends such as the cliff swallow strikes that occurred on at least two known occasions in 2008 and 2010. The primary causes can be identified and corrective action taken immediately when such trends are noticed. When reports indicate a long-term problem there may be a need for major habitat changes to reduce attractants.

It is important to note that if efforts to improve reporting rates result in even a small increase in the number of reports recorded at the Brookings Regional Airport, the average number of strikes will appear to increase by large percentages. This is an essential point to consider

when interpreting data, comparing strike rates, or determining the success or failure of hazardous wildlife reduction measures. Improved reporting could result in a perceived increase in wildlife strikes, when in reality there might actually be a decrease. In addition, wildlife management work might result in an increase of low-hazard species and more strikes, but considerably less danger of damage, injury, or loss of life by reducing the number of more hazardous species.

Good record keeping and analysis by a qualified airport wildlife biologist is required to obtain useful data. For this reason, it is recommended all wildlife strikes at BKX be reported on FAA Form 5200-7, *Bird/Other Wildlife Strike Form*. Routine wildlife hazard reports must be kept by BKX personnel, and must include the control techniques used. Additional survey work is also useful as a supplemental method of determining the effectiveness of the Wildlife Hazard Management Plan.

The newest version of FAA Form 5200-7, *Bird/Other Wildlife Strike Form* is attached (Appendix 10), and can also be downloaded and submitted online (http://wildlife-mitigation.tc.faa.gov/wildlife/default.aspx).

Identification of the species involved in a strike is important. Wildlife hazard mitigation techniques, especially habitat modification, are most effective when the hazardous species are known. Most species can be identified by local experts. Additionally, remains as small as a single feather or a swab of blood can be sent along with a copy of the strike report and other pertinent information to the Smithsonian Institution for analysis. There is no charge for the service. (See Appendix 11 or look online at http://wildlife-mitigation.tc.faa.gov/wildlife/speciesid.aspx for further information.)

Complete and accurate reports make the identification and notification process more efficient, and are the basis of gathering data, interpreting results, and applying the knowledge obtained from the bird-strike reporting process.

## 5. Analysis of the November 5, 2003, Bird Strike

The Wildlife Hazard Assessment for BKX was required by 14 CFR 139.337 because of a multiple-bird strike with damage that occurred on November 5, 2003. The strike met two of the three criteria outlined in Section 2.1. Minimal information on the strike was on file at BKX. However, a copy of the original strike form, known at that time as a *Bird Strike Incident/Ingestion Report*, was obtained directly from the manager of the FAA Wildlife Strike Database. A National Aviation Safety Data Analysis Center (NASDAC) report entitled *NASDAC Brief Report* (#20031105029549C) was also obtained from the same source. The pilot completed the report forms.

According to the strike report, the plane involved was a Beechcraft B1900D, registration number N1956L, operated by Great Lakes Aviation, Ltd. The Beechcraft 1900 is a 19-passenger, twin-engine turboprop airplane manufactured by the Raytheon Company. The pilot's and copilot's names were listed. (Crew members' names are not released to the general public as per current FAA policy.) Neither the strike report nor the NASDAC report indicates how many passengers were on board or the time of day the strike occurred.

The report did indicate the strike occurred 10 miles west of BKX at 4000 feet AGL, as the plane was starting its descent to the airport. Sky condition was indicated as "no clouds" and "no precipitation." Airspeed was listed as 200 knots.

The narrative section in the *NASDAC Brief Report* states:

> The aircraft was approximately 10 miles west of Brookings, SD descending to BKX. The aircraft hit multiple large birds. There was damage to the radome, right wing outboard leading edge and left wing inboard leading edge. Upon landing, the crew noticed a small fuel leak. The tank was de-fueled. No injuries. No emergency evacuation was necessary.

The *Bird Strike Incident/Ingestion Report* states the bird species was "geese," and boxes checked on the form indicate that between 11 and 100 birds were seen, and 2 to10 were struck. The remarks state that at least three birds were struck. The plane landed on Runway 30, and the "effect on flight" section was marked as "none." The checkbox indicating whether or not the pilot was warned was marked "yes." No other information was given.

Information was also obtained from persons who were employed at BKX at the time of the strike, and from handwritten notes and a newspaper clipping in the BKX file. According to this additional information, few if any passengers were on board the plane at the time of the strike. There was a published Notice to Airmen (NOTAM) in effect for large flocks of geese and gulls on and in the vicinity of the airport, and another published NOTAM for wildlife on and in the vicinity of the airport. After the strike, the plane was repaired on the ramp at BKX over a period of one to two weeks.

As is often the case when scrutinizing old strike information, incomplete or conflicting information was found. One person recalled the flight being the last of the day and the strike occurring after dark. Notes on file at BKX and conversations with another operations employee indicate the strike occurred with "geese" at 8 A.M., and the species involved was determined to be Canada geese, purportedly by feathers stuck to the aircraft. The newspaper clipping also stated the incident happened in the morning when the plane was en route from Huron, SD.

It is not clear who identified the birds as geese, or if they were positively identified as to species of geese. No records were found to indicate any feathers, blood or body parts were

salvaged to verify the identification of the birds. A pilot could easily misidentify birds, especially under the stress of a strike. For example, according to the Bird Strike Committee USA, on October 11, 2007 a CRJ-700 departing Denver International struck a flock of birds at 1500 feet AGL. The captain said several "geese" came at them, and they heard three or four thuds. The birds were later determined to be sandhill cranes (*Grus canadensis*), rather than geese.

Information concerning waterfowl populations three days prior to the BKX strike was obtained from William Schultze, a United States Fish and Wildlife Service (USFWS) Wildlife Biologist at Sand Lake National Wildlife Refuge in Brown County, SD. The refuge is approximately 115 miles northwest of the strike area. On November 2, 2003, snow goose (*Chen caerulescens*) numbers at the refuge peaked at 210,000. Canada goose numbers were 3000, and tundra swan (*Cygnus columbianus*) numbers were 800. Sandhill crane numbers were not recorded.

The area where the strike occurred is within flight distance of hundreds of lakes and other wetlands, including at least three waterfowl refuges capable of attracting flocks of geese.

Waterfowl numbers at the refuge are relevant because they reflect the number of birds in the general area. Waterfowl from the refuge would also likely migrate near or through the area where the strike occurred. Hundreds of lakes and wetlands capable of attracting flocks of geese are within a short flight distance from the strike zone.

The date of the BKX strike and the height of 4000 feet AGL at the point of impact indicate the birds were migrating, rather than simply moving between feeding and resting areas. Presuming the birds were in fact geese, population numbers at the time indicate the probability of hitting snow geese was higher than that of hitting Canada geese. Also presuming any feathers that may have been found on the airplane were primary wing feathers, the color and size would be similar for both snow geese and Canada geese. Canada geese were also in the area, so a strike involving either species was possible.

Regardless of the species of bird, in this particular case BKX could have done nothing to prevent the strike. At ten miles from the airport, the plane was well out of the general zone and was traveling through prime migratory waterfowl airspace during the peak of the migration. NOTAMs were issued, but commercial aircraft have little choice except to fly on schedule; the migration period can last six weeks or more each spring and fall.

# 6. Daily and Seasonal Movements of Wildlife

## 6.1 Overview of Surveys

Standardized wildlife surveys are an extremely important aspect of a Wildlife Hazard Assessment. The surveys give the researcher baseline data, which are invaluable when making recommendations. Without the survey data, the researcher would simply be operating with a series of random observations.

It is important to note a WHA is not a scientific experiment, even when using standardized surveys. In a true experiment, a scientist identifies a specific problem, researches the problem, formulates a hypothesis, and designs a protocol to test the hypothesis under tightly controlled conditions. In most experiments, only one variable is allowed to change, and a control group is established to ensure other factors (e.g. the placebo effect) are not at work. The data are analyzed and are subject to peer review. Experimental results can be replicated if the variables do not change.

A WHA is done under ever-changing conditions, with innumerable variables, and no control group. It has been said that wildlife hazard management is ½ science, ½ experience, and ½ magic. While the statement is intended to be "tongue in cheek," there is an element of truth. Standardized surveys are completed, but true replication of the data would be impossible. Changes in the weather, different land-use practices on and near the airport, normal variations in wildlife populations, human activity or lack thereof on or near the airport, the use of a different researcher, and a host of other variables can affect survey results.

Even the dew point makes a great deal of difference in the number and location of birds seen. Dew often forms in the morning, especially in late summer and early fall. Very few birds other than waterfowl and shorebirds will be noted in wet grass. Pheasants, for example, are easier to survey when the dew point is lower than the ambient temperature and the grass is wet; the birds have a tendency to move onto the tarmac, access roads, or even onto hay bales to keep dry. Blackbirds, grackles, starlings and other frequently seen birds were generally noted only on fences, emergent wetland vegetation, trees and buildings when heavy dew was present. Swallows, which feed on flying insects, were noted during periods of heavy dew but landed only on fences, access roads and the tarmac. Rain has much the same effect as dew.

Even though these and other variables will influence results, standardized surveys are invaluable when used in conjunction with other techniques to truly determine the species of wildlife using the airport, their numbers, locations, local movements, and daily and seasonal occurrences.

With the possibility of over 300 different bird species passing through BKX airspace (see Appendix 5), the task of determining and mitigating the bird strike hazard is daunting, not to mention the strike potential of other animals. Recommendations for mitigating identified hazardous wildlife attractants must take into account the possibility that any actions taken to reduce one species may result in increases in another. The relative hazard of each species currently present, the probability of causing a greater hazard by making management changes, and the best type of control techniques for each situation must be considered.

*Trail cameras are an additional tool to assist in determining daily and seasonal movements of wildlife, especially for highly secretive species.*

## 6.2 Time of Day and Year

Standardized surveys were conducted in the morning, afternoon, and at dusk, as described in Section 2. As shown in Figure 5, more birds were apt to be seen in the morning. Bird numbers were lower in the afternoon, and increased toward dusk. This is to be expected; any bird species are easily seen and heard in the morning and evening when they are establishing territories or exhibiting mating behavior through vocalizations and displays.

At midday, most birds are involved in less prominent activities such as feeding, resting or nesting.

Figure 6 shows a monthly breakdown of the numbers of birds seen during an average survey. The increases and decreases are normal variations caused primarily by migratory periods and increases in bird numbers due to young-of-the-year entering the population. Peak months will vary from airport to airport and from year to year depending in part on the migratory patterns of certain bird species.

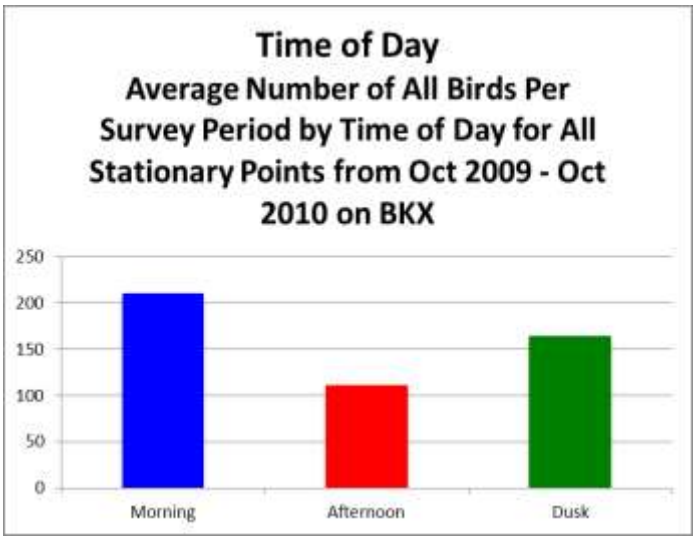



**Figure 5**

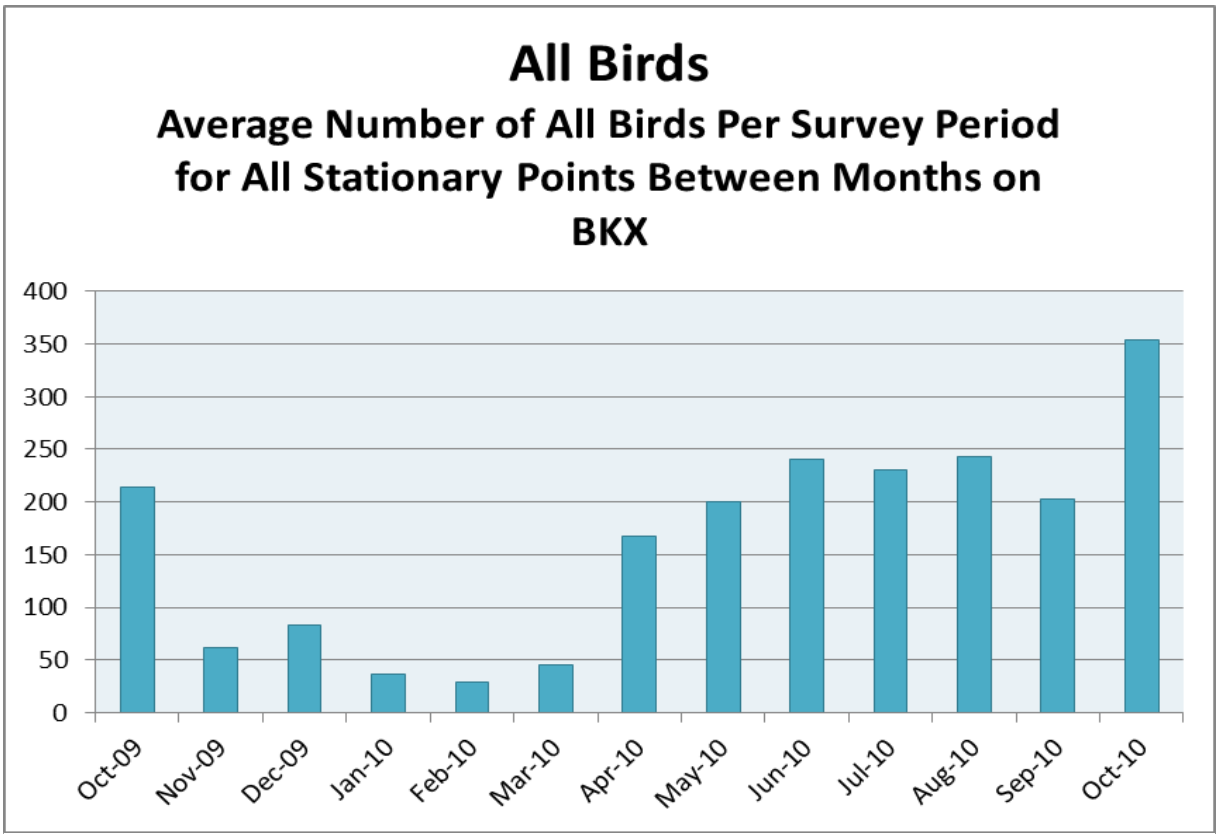



**Figure 6**

During the course of the 2010 Wildlife Hazard Assessment, very few snow geese were noted while running standardized on-site surveys at BKX. Had even a few flocks of a hundred or more geese been noted during the peak of the migratory periods, the numbers would have been very different. In all likelihood, either April or November would have had the highest average number of birds per survey.

The large flocks of blackbirds normally seen in late September and October were also lacking in number during this WHA, perhaps because much of the cattail roosting areas were temporarily destroyed by flooding, and better habitat was to be found elsewhere. Gulls were occasionally seen in large numbers at BKX in October, but not enough to offset the effect flocks of 5000 or more blackbirds can have.

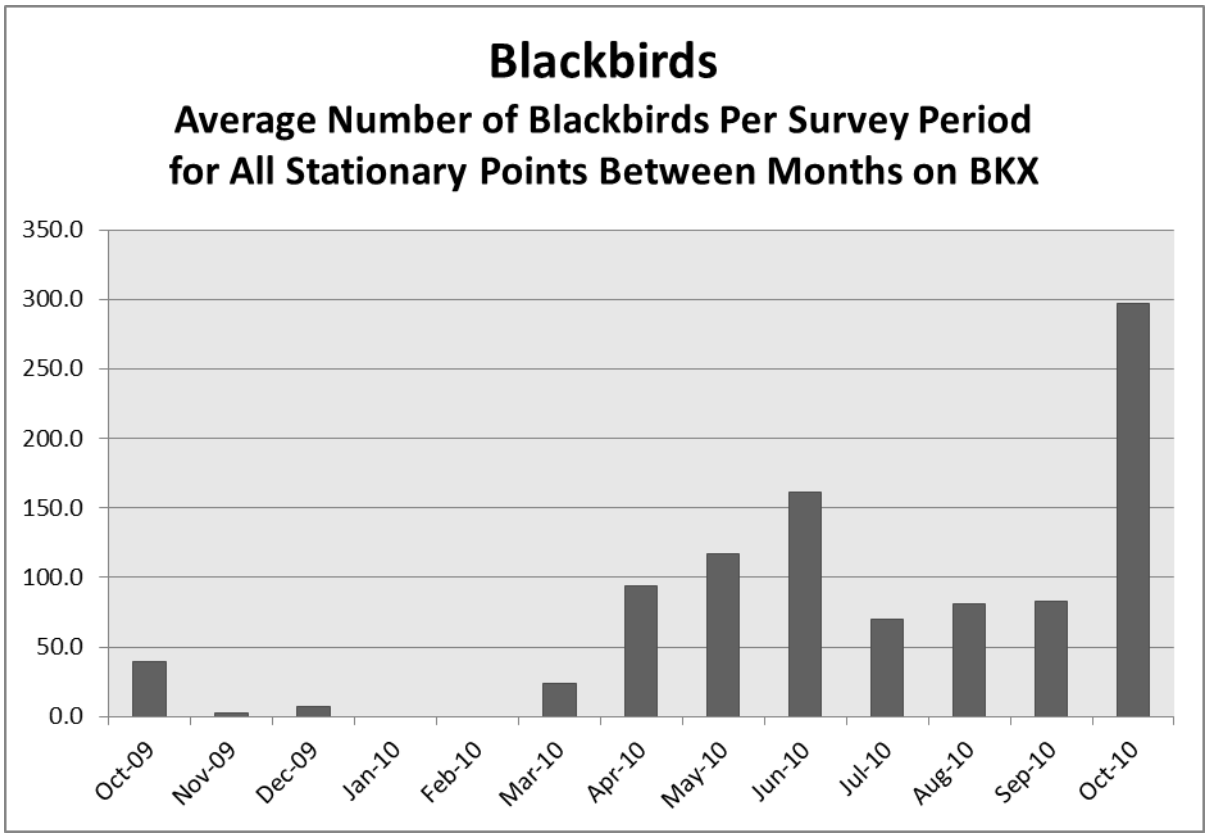



**Figure 7**

In essence, the numbers and charts are valuable aids in determining the time of day and month of the year when the numbers of birds are apt to be higher, but numbers are only one factor in the equation. Of greater importance than the amount of birds are the species, flocking behavior, and relative hazard level. For example, bird numbers were low in March, but included a high percentage of giant Canada geese. Although the strike threat was relatively low, the probability of any strike having damage was relatively high.

***Additional on-site survey information concerning the seasonal movements of particularly hazardous species is given in the charts below.***

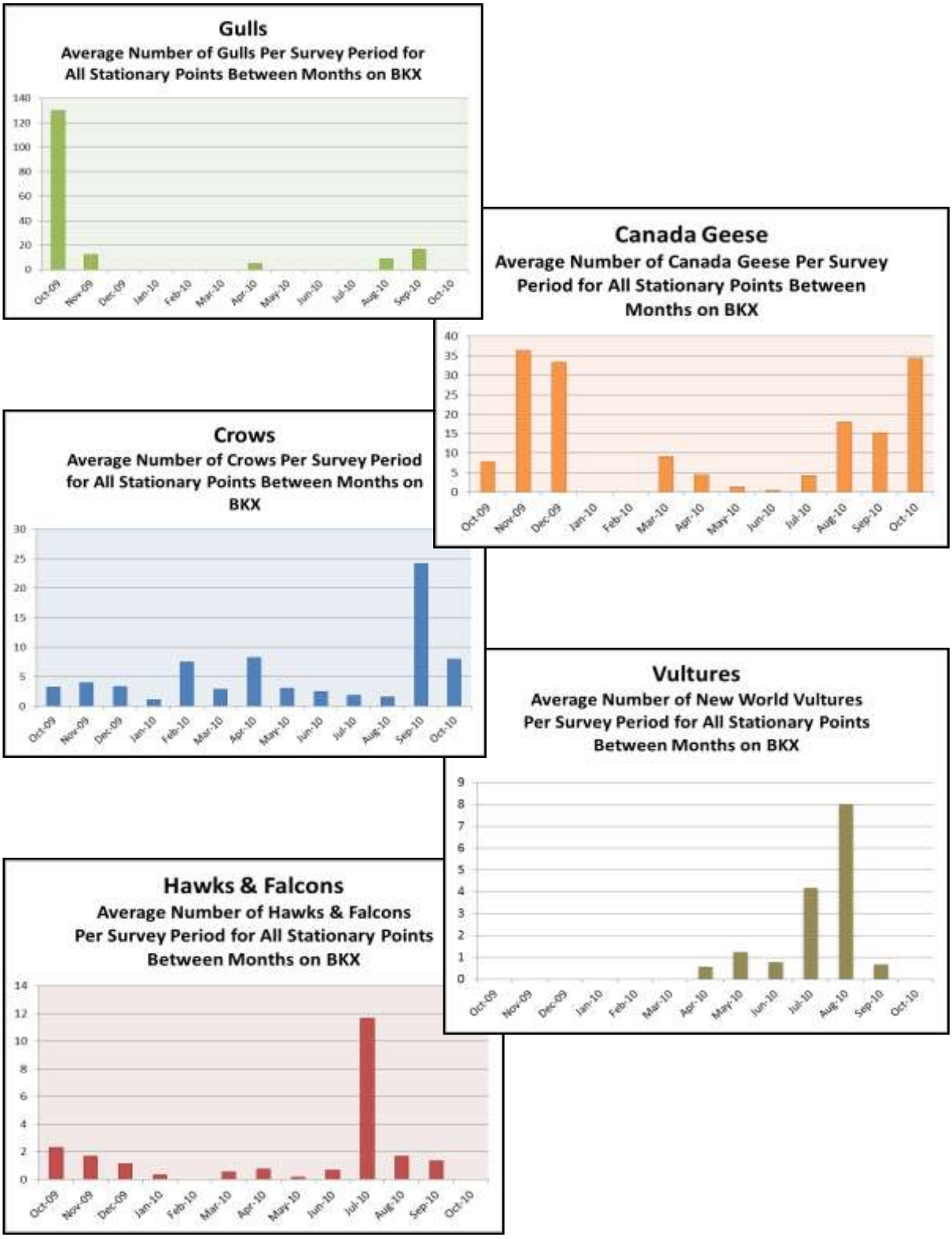



**Figure 8**

Birds were identified by genus and species during the surveys, but were also documented according to groups expected to be in the area. In addition, data concerning certain types of birds deemed to be most hazardous, or expected to be very numerous, were analyzed separately from the bird group they are generally associated with. For example, Canada geese were grouped separately from other waterfowl, and blackbirds were counted independently of other passerines (perching birds).

Figure 9 shows the 21 bird groups and the number of each of the groups present at each survey point. On average, about half the groups were noted during standardized daylight surveys at each on-site point. Seven of the groups had only zero to ten sightings during the entire survey period. This indicates the habitat for these species at BKX is lacking in one or more factors, or, as in some cases, the birds are uncommon almost anywhere; e.g. the "Near Passerine Birds" group was represented by one sighting of a belted kingfisher (*Ceryle alcyon*).

**Brookings Regional Airport Wildlife Hazard Assessment**

**Listing of Bird Groups and Number of Bird Groups Noted at Each Survey Point**

| Bird Groups | Survey Point | Number of Bird Groups |
|---|---|---|
| Giant Canada Geese<br>Other Waterfowl<br>Killdeer<br>Gulls<br>Other Shorebirds<br>Herons and Allies<br>Pelicans and Cormorants*<br>Cranes and Allies*<br>Grebes*<br>Owls*<br>Hawks and Falcons<br>Blackbirds<br>Crows<br>Horned Larks<br>Other Perching Birds<br>Near Passerine Birds*<br>Gallinaceous Birds<br>Goatsuckers*<br>Woodpeckers*<br>Pigeons and Doves<br>New World Vultures<br><br>* These Bird Groups had fewer than 10 individual bird sightings during the survey period. | 1 | 11 |
| | 2 | 8 |
| | 3 | 10 |
| | 4 | 7 |
| | 5 | 7 |
| | 6 | 9 |
| | 5 and 6** | 11 |
| | 7 | 11 |
| | 8 | 12 |
| | 9 | 9 |
| | 10 | 8 |
| | 11 | 12 |
| | 12 | 9 |
| | 13 | 11 |
| | 14 | 14 |
| | 15 | 14 |
| | 16 | 13 |
| | 17 | 8 |
| | 18 | 10 |
| | 19 | 12 |
| | 20 | 12 |
| | 21 | 8 |
| | 22 | 9 |
| | 23 | 15 |
| | 24 | 9 |
| | **Sites 5 and 6 together cover the living snow fence (shrub rows) area on the south end of the airport. | |
| | Average Number of Bird Groups Per Observation Point = 10.76 | |

**Figure 9**

All of the 15 bird groups with over ten documented sightings in each group were noted at sites 14, 15 and 23. These sites are in a line from the biosolids drying beds and flow equalization basins to the snow-drop area on the north side of the airport. This area includes a wide range of habitats suitable for many species of wildlife. Medium and large mammals, including deer, were also present in high numbers in these areas.

### 6.3 Spotlight Surveys

**Brookings Regional Airport 2010 WHA**
**On-Site Spotlight Surveys**

| Mammals | Number |
|---|---|
| Jackrabbits | 70 |
| Cottontails | 29 |
| Deer | 14 |
| Cats | 6 |
| Skunks | 4 |
| Canines (coyote/dog/fox) | 4 |
| Skunks | 4 |
| Raccoons | 2 |
| Opossums | 1 |
| **Total Mammals Seen All Night Surveys** | **134** |
| **Average Number of Mammals per Night Survey** | **5.0** |
| **Average Number of Mammals per Daylight Survey** | **1.2** |

| Birds | Number |
|---|---|
| Ducks | 75 |
| Killdeer | 50 |
| Horned larks | 7 |
| Owls | 3 |
| Sparrows | 2 |
| Pheasants | 1 |
| **Total** | **138** |

**Total numbers were obtained in 27 surveys conducted between sunrise and sunset. All spotlight survey work was completed inside the BKX perimeter fence.**

**Figure 10**

Spotlight surveys are used to determine the presence of and the daily and seasonal movements of mammals that are primarily nocturnal, and/or are seen in greater numbers at night. An average of 5.0 mammals was noted on each spotlight survey, as compared to an average of 1.2 mammals during each daylight survey (Figure 10). With the exception of ground squirrels, all mammals noted were more commonly seen at night.

For example, deer are crepuscular and nocturnal, meaning they are more active at twilight and night than during the day. Most deer were seen during the spotlight surveys, although during late afternoon surveys deer were occasionally noted at the edge of heavy cover or moving to cropland.

Over the course of the WHA, 134 mammals were identified during the spotlight surveys. Occasionally birds are also flushed during spotlight surveys. Two bird species frequently seen during these times were killdeer (*Charadrius vociferus*) and horned larks (*Eremophila alpestris*). Both species showed an affinity, day and night, for staying on or near the runways, taxi-ways and access roads.

In the case of BKX spotlight surveys, the major wildlife species surveyed were almost equally divided between mammals and birds. Approximately 75 ducks flushed on one occasion from Wetland 7 when a spotlight was shined over the water, and two flocks of 15-20 killdeer were noted roosting on cut soybean fields. These three abnormal sightings of flocks of birds heavily skewed the spotlight data, but did show that simply because birds are not often seen at night doesn't mean they are not present. Birds can potentially be a hazard at any time of day or night. Many birds, including certain waterfowl species, migrate almost exclusively at night, but would not ordinarily be seen in a spotlight survey.

Spotlight surveys should occasionally be performed by airport personnel to help keep track of mammal populations and to ensure runways and taxiways do not become prime roosting areas for certain birds.

Surveys can often be done in the normal course of other duties, such as airport lighting checks and looking for Foreign Object Debris (FOD).

Lethal control of species such as jackrabbits and skunks is easier at night, although special care must be taken to be certain of the target and the background. Only qualified personnel very familiar with the area should perform nighttime wildlife control.

*Even with a good spotlight and binoculars, it can be difficult to determine exactly what species or how many are present, as pictured above. Trail cams, traps, and other techniques help to ensure all species are documented. (Note trail cam photo of fox, right.)*

## 7. Basic Wildlife Management Concepts

Managing wild animal populations requires an understanding of basic wildlife biology. All animals need food, water, shelter, and space. Habitat can be defined as an area having all these needs in a suitable arrangement for a particular species. An effective program to decrease the number of birds and other animals using an area must deprive the animal of one or all of these basic needs.

While the idea is simple, the achievement of the goal is not necessarily so. Each species has the same basic needs (the aforementioned food, water, shelter and space), but what satisfies a need for one species may not satisfy the needs of another. Each species has a unique set of requirements as to what constitutes a suitable arrangement of the four basic needs. Some differences are obvious: herbivores eat plants, carnivores eat meat, insectivores eat insects and omnivores eat a variety of foods. Even then, not all herbivores eat the same plants, not all carnivores eat the same meat, and so on. Food requirements may also vary according to the age and sex of an animal and the time of year.

Rodents might obtain all the water they need from their food sources, while other mammals and most birds need a much more substantial open water source. Some animals use water simply to quench their thirst, while others use it as a source of all or nearly all of their needs.

What constitutes shelter (or cover) for one animal might be food for another. The type of shelter needed can vary even within the species according to age, sex and time of year. Good nesting habitat for birds is not necessarily adequate for winter cover. For instance, pheasants are attracted to taller grass and alfalfa fields in the nesting season, but when the grasslands are inundated with snow in the winter, wooded areas or cattail-choked wetlands are preferred cover.

Space requirements differ from species to species and from season to season. For example, most nesting birds require a certain amount of space between nests, as this ensures a plentiful supply of food for the chicks. In the late summer and fall after the young are fully-fledged and can move to food sources, the birds may flock together by the hundreds or thousands.

Each habitat need must be in a suitable arrangement for a species. Vultures commonly travel many miles each day to meet their needs, while pheasants are apt to spend most of their life within a section or two of land, and rodents may live their entire life in less than an acre of cover. If food, water, shelter and space are not available in an arrangement usable by an animal, the animal will either move on or perish. If any of the needs are available, the animal may use the area occasionally, but will move elsewhere to meet the rest of its needs.

Even very similar animals have differing habitat needs. Most duck species, for example, belong to one of two major groups: dabbling (or puddle) ducks, and diving ducks. Dabbling ducks, such as mallards (*Anas platyrhynchos*), gadwalls (*Anas strepera*), and northern pintails (*Anas acuta*) spend much of their time on shallow waters. These ducks are commonly seen "tipping," or probing the bottom of the wetland for invertebrates and aquatic plants without actually submersing their entire bodies. Dabbling ducks launch themselves directly upward from water or land. They are often attracted to cropland and short grasses.

Diving ducks such as redheads (*Aythya americana*) and lesser scaup (*Aythya affinis*) are more often seen on larger, deeper waters, where they dive completely under water to obtain food. Diving ducks also need more room to take off. The position of their feet, compact body shape, and relatively small wings require them to run over water to build up speed to become airborne. Diving ducks are not attracted to cropland unless the fields are flooded.

Mallards can be found almost anywhere, while other ducks are more selective regarding the habitat they use.

However, both types of ducks may be seen on the same wetland. Many wetlands, including wetlands found on BKX, have the proper combination of shallow and deep water necessary to sustain both dabbling ducks and divers. The ducks most often seen on BKX were dabblers, but the largest flock of ducks noted during the WHA was a mixed group of divers startled from a wetland during a nighttime spotlight survey.

Changing climatic conditions and seasons will also influence the wildlife using an area. Seasonal wetlands normally dry up as the summer progresses, the vegetation changes, and the wildlife using the wetlands changes. Water-depth fluctuations may determine the type and quantity of wetland vegetation available for use by wildlife. Sago pondweed (*Potamogeton pectinatus*), for example, becomes more predominant as the summer progresses. Mats of floating wetland vegetation may become so thick many passerines (perching birds) can seemingly walk upon the water and forage for invertebrates, minnows and seeds in shallow wetlands in a manner similar to shorebirds wading in shallow waters.

In 2010, most of the wetlands in the study area were full, even during the normally dry seasons. The time period during the WHA was exceptionally wet, with nearly double the average rainfall and multiple flooding events on and adjacent to the airport. In fact, flooding

was noted over much of eastern South Dakota. The heavy rainfalls experienced on at least six occasions (see Section 3.3) undoubtedly influenced the species and numbers of wildlife noted on the airport. Future researchers are advised to take the climatic conditions during the 2010 WHA into account when comparing wildlife species and population data.

## 7.1 Edge Effect

Edge effect is a wildlife attractant caused by the combination of contrasting environments in an ecosystem. In essence, edge effect occurs anywhere different types of habitat converge. The primary importance of edge effect is the biological diversity it provides. The edge, or ecotone, has a higher diversity of plants, and the result is a higher diversity and number of wildlife. Edge effect can result from something as simple as a fence line, a road, a mowed strip of grass adjacent to taller grass, or a field border. The edge may be very clear, such as where grassland meets a wooded area or a wetland. In some situations, however, the edge effect can be very difficult to detect.

Edge effect is created where two or more types of habitat converge. Pheasants and many other wildlife species are more abundant where the edge effect occurs.

For example, planting a large area with grass over a period of years rather than in the same growing season can produce edges, even if the grass species planted is identical. The older grass may have more duff or thatch (dead vegetation) on the ground, which makes it more attractive to rodents and nesting birds. The older grass stand may be thicker or sparser, taller or shorter, and may have more or fewer weeds than the newer stand. While the differences may be indiscernible to the casual observer, the wildlife species using the grasslands are well aware of the distinctions.

## 7.2 Synergistic Effects

Synergistic effects occur when the combination of two or more land management practices or ecosystems—any one of which alone would not ordinarily pose a significant hazard to an airport—attracts hazardous wildlife to the airport or through the airspace of the airport. The combined attraction is greater than the sum of the individual attractants. In other words, two plus two equals a number greater than four. With highly mobile species, synergistic effects are closely related to edge effect, in that two or more ecotones are readily available for use by the species.

Synergistic effects are a primary reason why the WHA focuses not only on the airport, but also on the general zone outside the airport environment. The surrounding landscape must be considered when developing a Wildlife Hazard Management Plan. During the 2010 WHA, the synergistic effect between the Brookings Landfill and Lake Campbell and other gull roosting areas was clear: gulls traveling to or from the landfill to roosting and resting areas often passed through BKX airspace. If either the landfill or the roosting areas were in a substantially different location, the corridor would either not exist or would be altered enough so the synergistic effect might not have been noticeable at the airport.

Totally eliminating synergistic effects is rarely possible. The attractants are not usually on airport-controlled property, and relocating or removing problem areas is often impractical, unreasonable or even impossible. However, knowing and understanding the synergistic effects may allow proactive measures to be taken, as discussed below.

## 8. Hazardous Wildlife Management Techniques and Recommendations

Hazardous wildlife management is an exceedingly complex vocation because too many variables exist to precisely calculate the outcome of a management decision, and an error in judgment may result in serious injuries or death. Because no single management technique will effectively remove all wildlife attractants, a combination of wildlife control techniques must be used and the results monitored to determine if certain methods are not effective or lose effectiveness, or if hazards have changed. Four major categories of wildlife hazard management techniques are used:

- habitat manipulation
- exclusionary devices
- scare tactics and hazing
- lethal control

The use of these four techniques at BKX is discussed below, along with specific recommendations.

### 8.1 Habitat Manipulation at BKX

Habitat manipulation is ultimately the least expensive and most effective method of wildlife management. A program designed to reduce the number of hazardous animals using an area must eliminate as many components of the required habitat as possible. If there is no attractant, there will be no wildlife and no need to exercise the other control methods. However, habitat manipulation comes with many caveats. First and foremost, a change detrimental to one species will very likely benefit another. All variables in habitat manipulation must be carefully considered, and it is prudent to consider that for every action, there is an equal and possibly unpredictable reaction.

Airport personnel must know the species present, understand the basic biology of each species, assess the hazard levels, make management recommendations to reduce those problematic species, and monitor the results to ensure the targeted hazards are reduced and an equal or greater hazard is not created.

*Hazardous wildlife populations can best be reduced by manipulating habitat to eliminate the availability of food, water, shelter and space. However, any change in habitat that is detrimental to one species may be beneficial to another.*

### 8.1.1 Wetland Management at BKX

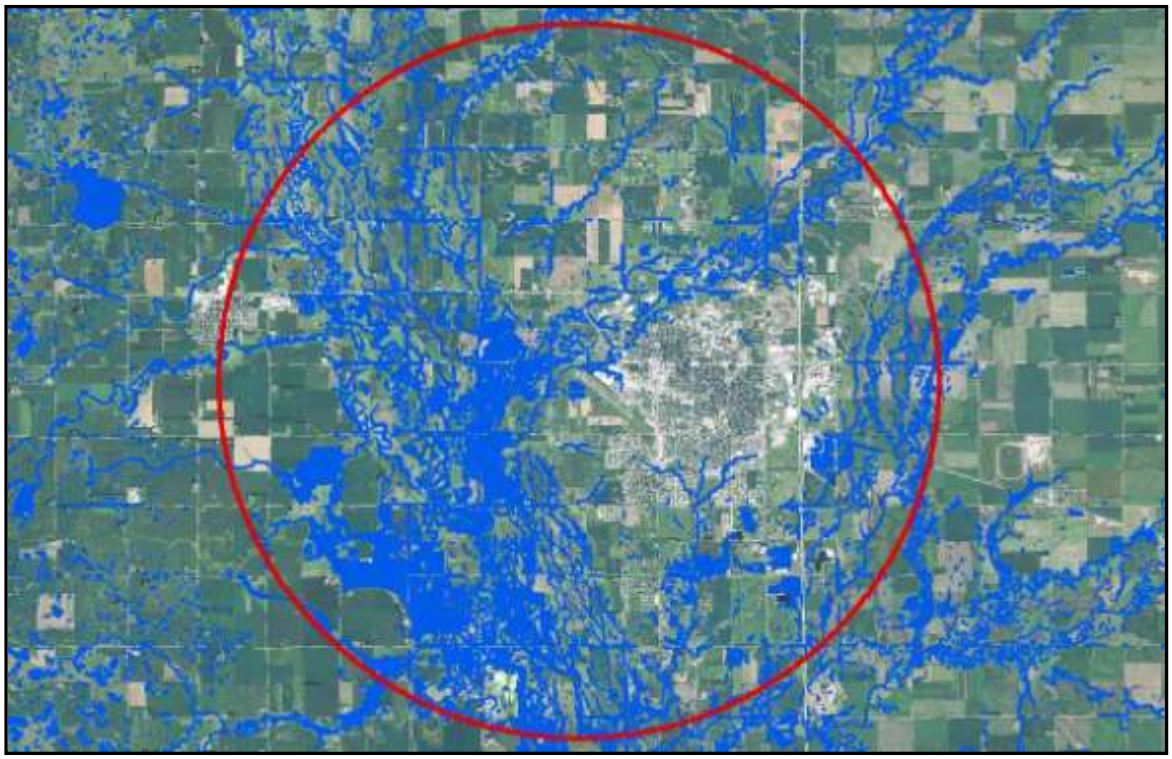
Wetlands and the associated vegetation are the major wildlife attractant to most wildlife species at BKX, including hazardous species. Wetlands provide one or more of the basic components of habitat—food, water, shelter and space—for most of the wildlife frequenting the airport, including many of the hazardous wildlife species.

Brookings County is in the midst of the prairie pothole region of the upper Great Plains. One of the more common methods to classify wetlands is to delineate them as temporary, seasonal, semi-permanent or permanent. According to *Eastern SD Wetlands* (Johnson and Higgins 1997), wetlands and deep-water habitats, including lakes, make up 9.8% of the eastern South Dakota landscape with a total of 2.2 million acres.

A basin is defined as a depression containing one or more wetlands. There are 932,929 wetland basins, only 603 of which are classified as permanent. The majority of permanent wetlands—384 of the 603— are man-made impoundments. The median acreage of eastern South Dakota wetlands is small, averaging less than 0.4 acres in size. Nearly 73% of the wetlands are an acre or less in size.

Like much of eastern South Dakota, the undeveloped areas surrounding the Brookings Regional Airport are heavily inundated with wetlands. The work of Johnson and Higgins is based in large part on National Wetland Inventory photography taken between the years of 1979 and 1986 under conditions when USFWS personnel felt the water conditions reflected the normal distribution of wetlands.

Johnson and Higgins also stated that in addition to numerous species of ducks, over 80 other bird species and over 100 fish, 25 mammal, 17 amphibian, and 10 reptile species depend on eastern South Dakota wetlands.



*The photograph used to create this map was taken in about 1983. At that time the 50,240 acres in the BKX General Zone (a five-mile circle around the Brookings Regional Airport as shown above) contained about 7117 acres of water, or 14% of the total area. Most of eastern SD has a ratio of about 9:1 upland (generally dry land) to wetland acres, or about 10% water. The BKX General Zone has a higher percentage of water due to the influence of the Big Sioux River and associated drainages. The percentage of water may vary substantially from year-to-year and season-to-season.*

(*Map and acreage information courtesy of the USFWS)*

Wetlands provide all four of the basic necessities—food, water, shelter and space—for much of the wildlife frequenting the Brookings Regional Airport, including the hazardous wildlife. It follows that one of the most efficient methods of reducing wildlife hazards is by eliminating or otherwise denying access to the wetlands. However, efficient does not necessarily mean easy (or even possible) when it comes to eliminating wetlands or denying wildlife access to them.

Wetlands are extremely valuable natural resources. In addition to their value to wildlife, wetlands contribute to the surface and groundwater supply, stabilize stream flows and provide flood control. Wetlands are important for pollution and sediment removal, are sources of livestock forage production in drier years, and provide for millions of hours of leisure activities ranging from hunting and fishing to bird watching and photography (Johnson et al. 1997). Because wetlands are such valuable natural resources, they are protected by municipal, state, and federal laws and regulations. It is important to have at least

a basic knowledge of the laws and regulations protecting wetlands, as those laws and regulations will impact if, how, and even when certain wildlife hazard attractants are eliminated at BKX.

One of the most restrictive and important regulations has been Section 404(a) of the Clean Water Act (CWA) passed by the Congress of the United States in 1972 and amended in 1977 and 1987. The CWA gave the U.S. Corps of Engineers (USCOE) and the Environmental Protection Agency (EPA) authority over "navigable waters," which was further defined in the act as "waters of the United States." Section 404(a) requires the USCOE to regulate the discharge of dredged or fill material into waters of the United States.

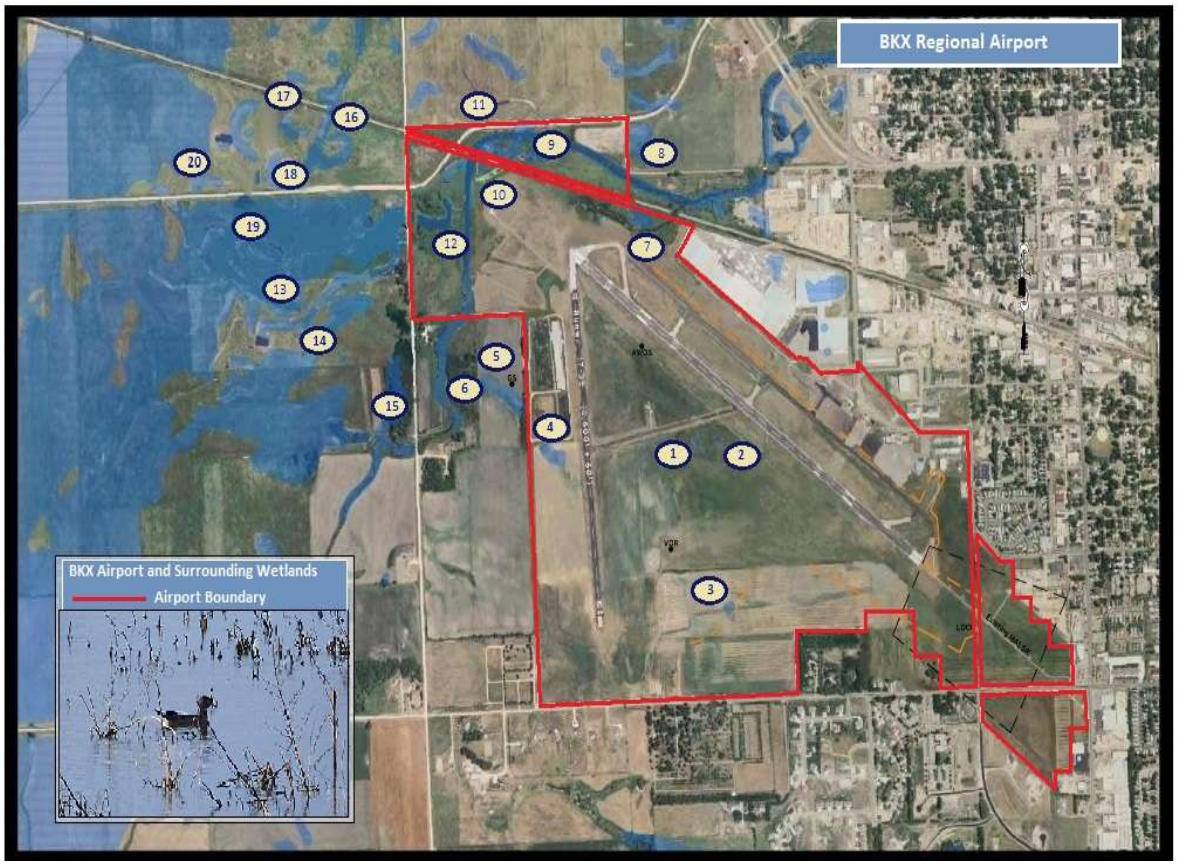
Over the years, attempts were made to further clarify which waters the USCOE and EPA has jurisdiction over. An example is the 1986 Migratory Bird Rule (51 FR 41217) adapted by the USCOE and EPA. The rule extended coverage to intrastate waters, which provide habitat for migratory birds. The vast majority of all wetlands in the United States were protected by the provisions of the CWA for nearly thirty years, until 2001.

On January 9, 2001, the United States Supreme Court decided a case wherein the Solid Waste Agency of Northern Cook County (SWANCC) argued the USCOE had no jurisdiction to deny them a permit to fill wetlands at an abandoned gravel pit. The Supreme Court held in favor of the plaintiff, stating in part the USCOE had no authority because the Migratory Bird Rule does not apply in waters that are not adjacent to navigable waters. The SWANCC ruling was followed in 2006 by *Rapanos v. United States.* A split decision in favor of the plaintiff further weakened the CWA.

Both cases essentially ruled the USCOE has no authority over a wetland unless the wetland is a navigable waterway or has a "significant nexus" to a navigable waterway. The decisions have also left innumerable questions as to what constitutes a "navigable waterway" or "significant nexus." Landowners, developers, state and federal agencies, and the lower courts currently struggle with how to apply the Supreme Court's directives.

Figure 11 (next page) shows wetlands on and immediately adjacent to BKX, as adapted from the Brookings Regional Airport Draft Environmental Assessment (HNTB Corporation 2009). Eight wetlands are shown on BKX property, with a total of 19.6 acres. Of these, four wetlands measuring a total of 17.5 acres are listed as "assumed jurisdictional," meaning the wetlands presumably fall under the jurisdiction of the USCOE.

One of the jurisdictional wetlands is Six Mile Creek, and the other three are immediately adjacent to the creek. Because Six Mile Creek is home to the federally listed endangered Topeka shiner (*Notropis topeka*), the creek and potentially any wetlands near the creek also fall under the protection of the Endangered Species Act. The ramifications of the ESA on any modifications to the creek and other jurisdictional wetlands are discussed in Section 9.




## Brookings Regional Airport
### Wetland Acreages, National Wetlands Inventory (NWI) Classification and Jurisdictional Status

| On-Airport Wetlands | Size (acres) | NWI Classification | Assumed USCOE Jurisdictional status |
|---|---|---|---|
| 1 | 0.1 | PEMA | Non-Jurisdictional |
| 2 | 0.2 | PEMA | Non-Jurisdictional |
| 3 | 0.5 | PEMAd | Non-Jurisdictional |
| 4 | 1.3 | PEMAd | Non-Jurisdictional |
| 7 | 10.3 | PEMC, PEMA | Jurisdictional |
| 9 | 1.3 | PEMA | Jurisdictional |
| 10 | 4.5 | PEMC | Jurisdictional |
| 12 | 1.4 | PEM/ABF | Jurisdictional |

| | |
|---|---|
| ***On-Airport Total*** | 19.6 |
| ***On-Airport Non-Jurisdictional*** | 2.1 |
| ***On-Airport Jurisdictional*** | 17.5 |

Adapted from HNTB Corporation 2009
(City of Brookings Draft Environmental Assessment, 2009. Table 6, page 95)

**Figure 11**

To be clear, this Wildlife Hazard Assessment (WHA) was developed independently of the Environmental Assessment (EA), and both studies were undertaken for different reasons. The EA was completed in anticipation of major changes to be made at the airport, including runway realignment and extensions. The WHA and recommendations deal only with wildlife hazard management under the currently existing conditions at BKX. The wetland mapping from the EA, including wetland numbering and acreages, was used in the WHA simply to avoid duplication of effort and confusion between personnel who must work with both documents.

The recommendation of this WHA is that all wetlands should be removed from airport property to the greatest extent feasible, whether by draining, filling, or both. When wetland removal is not practical, vegetation management and other wildlife control techniques should be employed. In many cases, wetland removal must be mitigated by the creation of wetlands elsewhere, as discussed above and in Section 9 (Threatened and Endangered Species). Any required mitigation should occur outside the separation criteria established by the FAA whenever possible and allowable under the ESA. In addition, wetlands within the separation criteria but not under the control of BKX should be monitored for wildlife hazards and appropriate actions taken. This may require cooperative agreements with neighboring landowners, depredation permits for off-airport property, NOTAMs, or other options deemed necessary and feasible.

#### 8.1.1.1 Six Mile Creek and Associated Wetlands

Six Mile Creek and the associated wetlands are critically important to the watershed in Brookings County. The creek and wetlands provide all the positive benefits of wetlands listed above, with the added benefit of providing habitat for the federally listed endangered Topeka shiner and possibly the state-listed threatened northern river otter (Lontra canadensis). At least 22 species of fish have been documented in the watershed (Figure 12). One of the creek's most important functions noted during the WHA was to help alleviate area flooding.

These benefits of the creek do limit management options, as previously discussed. However, the creek can potentially be altered in the Runway Protection Zones (RPZs) to remove larger areas of open water and reduce heavy vegetation in and adjacent to the stream without substantial adverse effects.

The creek bed was realigned in the late 1980s/early 1990s to allow for runway expansion. Wetland 7 (pictured left) was formerly a portion of the creek channel prior to the creek being rerouted around the north end of the airport property.

For strictly wildlife hazard management purposes, redesigning the creek as a narrow channel with steep, riprapped[1] slopes, fast-flowing water, and no emergent vegetation is a preferred alternative to the status quo. If this is not possible due to flood control, other public safety considerations, or the presence of threatened or endangered species, simply managing the vegetation in and adjacent to the creek will reduce wildlife attractants and allow monitoring of wildlife populations.

Vegetation management can be accomplished without extensive permitting requirements, although great care must be taken when vegetative control is accomplished by chemical means, especially near water. Chemicals must be applied by a certified applicator in accordance with label directions and requirements. Controlling vegetation through chemical applications near the shorelines, in the absence of riprap or other stabilizing material, may also result in erosion of the shorelines and banks.

Control by mechanical or other means—including mowing and burning—is difficult, time consuming and often less effective than the use of chemicals, but is preferable to no action at all. Permitting requirements are generally minimal. However, as with all habitat manipulation where threatened or endangered species may be present, authorization from the appropriate agencies must be obtained before work is started.

**Species of Fish Found in Six Mile Creek and Adjacent Dugouts**

**Listed in Descending Order by Relative Population**

| Common Name | Scientific Name |
|---|---|
| Fathead minnow | *Pimephales promelas* |
| Black bullhead | *Ameiurus melas* |
| Orange-spotted sunfish | *Lepomis humilis* |
| Brook stickleback | *Culaea inconstans* |
| Green sunfish | *Lepomis cyanellus* |
| Iowa darter | *Etheostoma exile* |
| Topeka shiner | *Notropis Topeka* |
| White sucker | *Catostomus commersonii* |
| Common shiner | *Luxilus cornutus* |
| Brassy minnow | *Hybognathus hankinsoni* |
| Creek chub | *Semotilus atromaculatus* |
| Bigmouth shiner | *Notropis dorsalis* |
| Central stoneroller | *Campostoma anomalum* |
| Red shiner | *Notropis lutrensis* |
| Sand shiner | *Notropis stramineus* |
| Johnny darter | *Etheostoma nigrum* |
| Common carp | *Cyprinus carpio* |
| Blacknose dace | *Rhinichthys atratulus* |
| Tadpole madtom | *Noturus gyrinus* |
| Northern pike | *Noturus gyrinus* |
| Bluntnose minnow | *Pimephales notatus* |
| Yellow perch | *Perca flavescens* |

**(Adapted from Thomson and Berry, 2009 Table 2, page 131)**

**Figure 12**

Wetland manipulation can be challenging and expensive, but in the long run it provides a permanent solution to a variety of problems. When the costs are amortized over time and the threat levels from wildlife strikes are reduced, wetland manipulation can be the least expensive option.

[1] Riprap is an embankment of loose stones placed along the shoreline.

### 8.1.1.2 Biosolids Drying Beds and Flow Equalization Basins

The biosolids drying beds and wastewater flow equalization basins (EQ basins) at BKX present special hazardous wildlife management issues. These areas are not listed as wetlands in Appendix 7, but can fulfill the same wildlife needs as natural wetlands, and in some cases may be even more attractive than natural wetlands. Survey work for the WHA showed high levels of wildlife usage at or near the area of the biosolids drying beds and EQ basins, with all of the major bird groups documented at BKX also noted.

Admittedly, other habitat types adjacent to the biosolids drying beds and EQ basins also contributed to the high numbers of observations (see also Section 7 regarding edge effect and synergistic effects).

The major wildlife attractant to the area of the biosolids drying beds and EQ basins could not always be determined. However, the two biosolids drying beds (pictured right) were clearly more attractive to wildlife during the 2010 WHA than were the two EQ basins.

The biosolids drying beds and EQ basins do attract hazardous wildlife, but are integral to the management of the Brookings wastewater treatment plant. An October 2009 letter from Eric Witt, P.E., and Wastewater Plant Operations & Engineering Supervisor, to Jackie Lanning, City Engineer, explains the function, purpose and importance of the biosolids drying beds and EQ basins for wastewater treatment for the City of Brookings (Appendix 12). The letter included a chart showing the annual uses of the EQ basins. Mr. Witt updated the chart for this WHA, as shown in Figure 13.

In general, “detention ponds” are those that hold water for brief periods of time, approximately 48 hours or less, while “retention ponds” hold water indefinitely. Detention ponds are preferable to retention ponds if water storage is necessary on an airport. Prior to 2010, the EQ basins functioned primarily as detention ponds. In some years, the EQ basins were not used at all. However, in 2010 rainfall was nearly double the annual average. Back-to-back rain events caused the EQ basins to hold water for up to 30 days at a time, for a total of at least 107 days.

Even with the additional water, the EQ basins were not highly attractive to wildlife during 2010. Dense upland vegetation[2] was established during the time the basins were dry and was notable in 2009 when survey work first began. The EQ basins were filled the following spring.

Water depth and seasonal fluctuations determine the types and quantity of wetland vegetation available for use by wildlife. Sago pondweed (*Potamogeton pectinatus*), for example, becomes more predominant as the summer progresses and can form dense masses of vegetation at the water's surface. Cattails (*Typha spp*.) grow in standing water and provide habitat for many species of wildlife. Depending on the density of the stand and depth of water, cattails might provide cover for shorebirds, waterfowl, blackbirds and other passerines, pheasants, and mammals ranging in size from rodents to deer. Even during drought conditions, a thick stand of cattails provides wildlife habitat long after the death of the plants themselves.

| Year | Storm/High Flow Event Dates | Approximate Days Water in EQ Basins |
|---|---|---|
| 1999 | May 6-7 | 7 |
| 2000 | Not used | 0 |
| 2001 | April 22-24 (1st event)<br>May 7-8 (2nd event) | 21 (Back to Back Storm Events) |
| 2002 | Not used | 0 |
| 2003 | Not used | 0 |
| 2004 | Sep 23-24 | 7 |
| 2005 | Sep 8-12 | 14 |
| 2005 | Oct 5-8 | 10 |
| 2006 | Apr 1-2 | 7 |
| 2007 | Apr 21-22 | 7 |
| 2007 | May 4-6 | 10 |
| 2008 | May 13-16 | 10 |
| 2009 | Not used | 0 |
| 2010 | March 12-25<br>(14 days flow diversion) | 30 (estimated) |
| 2010 | June 11-21<br>(11 days flow diversion) | 19 (estimated) |
| 2010 | June 26-28<br>(3 days flow diversion) | 16 |
| 2010 | July 17-19<br>(3 days flow diversion) | 6 |
| 2010 | July 23-24<br>(2 days flow diversion) | 5 |
| 2010 | Sept 2-5<br>(4 days flow diversion) | 8 |
| 2010 | Sept 22-30<br>(9 days flow diversion) | 23 |

**Figure 13**

Due to highly variable water levels, the upland vegetation in the EQ basins was destroyed in 2010, and was not replaced by wetland vegetation. If the water had been allowed to remain, wetland vegetation attractive to wildlife would have soon become established, as it did in the biosolids drying beds. Meteorological conditions in 2010 were unusual, and great care must be taken when extrapolating survey results to future years.

Observations during the WHA and supporting information indicate the two biosolids drying beds are incompatible with wildlife hazard management at BKX. The drying beds are rich in nutrients and support

[2] Upland vegetation consists of plants that grow where the ground is typically dry, other than normal precipitation or short-term flooding. Wetland vegetation grows where land is flooded or saturated with water for long periods of time.

submergent, floating, and emergent vegetation. The attractiveness of the area to waterfowl, shorebirds, blackbirds and other hazardous species was obvious and well documented. As a result, the drying beds are scheduled to be removed, which will eliminate the attractants.

The attractant of the EQ basins was less obvious, due in part to the relative lack of vegetation and to nearby waters more attractive to wildlife. In a best case scenario for hazardous wildlife management purposes, the EQ basins should also be moved outside the separation criteria outlined in AC 150/5200-33B. However, circumstances as delineated in Appendix 12 may require the basins to remain on BKX property: a lack of alternative sites and the infrastructure already in place may make relocating the basins as per the AC criteria impractical or unrealistic. If this is the case, other steps must be taken to reduce the attractiveness of the ponds to hazardous wildlife.

Moving the EQ basins further from the AOA and RPZs, redesigning the EQ basins to drain quickly, managing vegetative growth, and using wildlife exclusion methods and/or harassment techniques can reduce the wildlife attractant of the EQ basins to acceptable levels. As is noted under Section 8.2 (Exclusionary Devices at BKX), wires or netting can greatly reduce wildlife usage of the basins, but can also interfere with vegetation control and other management practices. Any exclusionary device must allow mowing, spraying and other management activities to be performed.

Basins lined with cement or an impermeable membrane are more expensive to build, but will require less vegetation maintenance. AC 150/5200-33B recommends detention ponds (such as the EQ basins) be steep-sided and lined with riprap, narrow, linear in shape, and designed to drain within 48 hours. The author believes that occasionally leaving water in an EQ basin for up to 30 days can be useful in controlling upland vegetation, as long as the timing does not attract hazardous wildlife. However, substantially longer time periods will result in wetland vegetation becoming established.

#### 8.1.1.3 Drainages

Drainage on the airport is poor, at least when rainfall is abnormally high, as it was in 2010. The drainage ditches are not considered to be wetlands as per the EA, but they currently fulfill the same wildlife needs as wetlands do, and have the additional wildlife hazard attractant of providing safe wildlife travel lanes over much of the airport. These ditches hold up to four feet of water year-round in some places, are choked with cattails, rushes, willow trees and other vegetation, and are used extensively by a large number and variety of wildlife species.

Limited minnow trapping inside the perimeter fence was conducted to establish the presence or absence of fishes in the drainages and wetlands near the runways and taxiways, as fish can attract many species of hazardous wildlife. Standard minnow traps available at local retail

outlets were used. In all months with open water, fathead minnows (*Pimephales promelas*) and brook sticklebacks (*Cualea inconstans*) were found in the drainage ditch near Stationary Point #8. The same species of fish were also caught elsewhere in shallow drainages north of the wastewater treatment ponds. Wetland 7 was connected to Six Mile Creek during the survey period, but only one fathead minnow was found in multiple trapping attempts. No fish were noted in the EQ basins.

*The drainage ditches at BKX provide habitat and safe travel lanes year-round for a large variety of wildlife.*

In addition, gray tiger salamanders (*Ambystoma tigrinium diabolic*) and crayfish (*Orconectes causeyi*) were caught incidental to the minnow trapping. Northern leopard frogs (*Rana pipiens*) were found in many locations around the airport, including the basins.

Ideally, water should be moved and stored underground, but this option is not always feasible due to the expense and/or amount of water to be moved. However, drainages can be sloped and graded to allow rapid and complete removal of water, and to permit control of vegetation by haying or mowing. Until one or a combination of these options can be accomplished, vegetation in the ditches will need to be controlled by other means.

Culverts are used by many species of wildlife as escape cover, den sites, and safe passageways (note skunk pictured below). Placing grids over the entrances of culverts in drainage ditches will reduce or eliminate their use by wildlife. Grids placed on culverts in the perimeter fence line will also reduce ingress onto BKX property. However, grids must be designed to allow easy maintenance or they can become clogged and cause water to back up. Culverts away from aircraft movement areas and the perimeter fence can be left open to intentionally lure mammals for ease of trapping.

## 8.1.2 Upland Management

### 8.1.2.1 Grain Crops

BKX currently has 104 acres of cropland rented to lessees. The four fields range in size from nine to 59 acres (See map, Appendix 6). These fields are second only to wetlands as a wildlife attractant at BKX; grain crops are the primary attractant for several species, including deer, gulls, Canada geese (pictured below in a barley-stubble field at BKX), and a number of other problematic species.

In some cases a mild synergistic effect occurs from two or more highly dissimilar habitat types on the airport; gulls are attracted to runways where they can rest while being able to see predators, and are also attracted to nearby fields on BKX where they have a readily available food source.

Removing the cropland will reduce, but not eliminate, the attraction to the runways. The cropland attractant occurs at all times of year, and is often worse during the majority of the year when crops are not at or near maturity. Simply preparing the ground through plowing, disking or harrowing can attract large numbers of birds looking for insects and rodents. Food in the form of grain or seeds is available year-round, either from the current crop, the previous crop, or weeds such as yellow and green foxtail (commonly known as "pigeon grass" because of its attractiveness to doves and pigeons).

These white-tailed deer were observed crossing Runway 17-35 while en route to cropland on BKX. The fencing installed in 2010 will keep out the vast majority of deer, but occasionally deer will still find a way to enter airport property.

Newly sprouted small grain crops provide excellent browse for deer and geese. In the winter, deer, pheasants and jackrabbits will dig through inches of snow to obtain waste grain from soybean fields.

In addition, some small grain crops provide excellent nesting areas for pheasants, waterfowl and other potentially hazardous birds. Corn and sunflowers attract many of the same species as other crops do, and also draw large numbers of blackbirds just prior to or during harvest.

The inability of airport personnel to routinely patrol unharvested fields without damaging the crop prevents them from adequately locating and/or dispersing hazardous wildlife. Finally, the edge effect created by cropland increases the attractiveness of the area. BKX should eliminate all grain crops from airport property, including the nine acres of cropland outside the perimeter fence on the southeast portion of BKX property. Although no major wildlife hazards were noted in 2010 on this parcel, as the trees on city and private property near the cropland mature, the area will very likely attract large flocks of blackbirds. The position of the cropland places birds in nearly a direct line with any aircraft landing on Runway12-30.

#### 8.1.2.2 Hay Crops and Mowed Areas

BKX currently has approximately 167 acres of land leased out for haying purposes (Appendix 6). Hay is considered a crop under AC 150/5200-33B, but if the separation criteria of the Advisory Circular are met or exceeded, hay is a preferable alternative to grain crops. Replacing grain crops with grasses to be hayed will reduce the number of animals attracted by the crops for food and cover.

An undesirable consequence of switching from agricultural grain crops to grassland for haying is an increase in the number of nesting waterfowl and other grassland birds. Because eastern South Dakota was once predominantly a tall- to mid-grass prairie ecosystem, native species are adapted to living in a grassland ecosystem.

Freshly hayed fields are attractive to birds, including raptors, when the haying process exposes rodents and insects to easy predation. Mammals such as the domestic cat (*Felis catus*) pictured right are also enticed by the prospect of an easy meal. Bales are attractive perch sites for a number of birds, and bale stacks provide homes for rodents and other mammals.

Grass management has a major influence on the species of wildlife that will use the area and is an important factor in hazardous

wildlife management. Some ground nesting birds, for example, are attracted to short grass, while other species are dependent on taller grass stands. Native grassland species at BKX such as bobolinks (*Dolichonyx oryzivorus*) and dickcissels (*Spiza americana*) primarily utilized taller grasses, while Western meadowlarks (*Sturnella neglecta*) utilized both short and tall grass. Bird species adapted to urban environments, such as American robins (*Turdus migratorius*) and starlings, were frequently seen searching for worms and insects on closely mowed areas and did not use taller stands of grass. Blackbirds (including grackles and starlings) use shorter grass when exhibiting flocking behavior, as they prefer to maintain visual contact with other members of the flock.

White-tailed jackrabbits (*Lepus townsendii*) are an example of a mammal species likely to increase in numbers as grasslands are expanded. Jackrabbits are often seen in shorter grass, but they head to taller grass and lowland areas when pursued. Jackrabbits are large enough to do damage to small aircraft when struck, and are highly attractive food sources to many carnivores and avian predators. Population increases can be mitigated by aggressive lethal control methods. Jackrabbits can repopulate rapidly, making continual control necessary.

Considerable research has been and continues to be done to determine the best grasses for use on airports, with little consensus. Wildlife hazard management specialists do agree that reducing biodiversity is important in reducing wildlife attractants. Cropland should be planted as a monoculture of a grass species that is suitable for haying but less attractive to wildlife. To ensure a good stand, it may be necessary to mix in another species of grass, but alfalfa, clover and other forbs should not be part of the mix.

Theoretically, warm-season grasses should be planted as a hay crop because they grow only in the summer, while cool-season grasses exhibit high growth rates in the spring and fall. Grass is usually hayed once during the year (unlike alfalfa, which can be cut two or even three times annually). The fall regrowth exhibited by cool-season grasses provides habitat for wildlife, including nesting cover the following spring. However, warm-season grasses suitable for use in the BKX area are either highly attractive to wildlife, or do not produce a viable stand for haying. In addition, pure stands of warm-season grasses are difficult to establish and are often taken over by smooth bromegrass (*Bromus inermis*) or Kentucky bluegrass (*Poa pratensis*).

Smooth bromegrass, or brome, is an introduced cool-season species. Brome has out-competed stands of native grasses in many areas and is now one of the most common grasses in eastern South Dakota. State and federal wildlife agencies commonly use management techniques designed to reduce smooth brome because of the poor quality habitat it provides for upland game and native birds. However, brome is prized by many livestock producers and is a marketable hay crop.

A monoculture of smooth bromegrass planted for a hay crop is far less attractive to nesting and roosting birds than is the mixture of warm- and cool-season grasses and forbs typically found in such areas. Brome is a reasonable choice for BKX as the principal grass species to be planted.

Timely removal of hay bales is important. Hay bales and bale stacks make excellent homes for many species of wildlife and provide perch sites for raptors and other birds, as pictured below right. In addition, bales pose a hazard if an aircraft accidently leaves the tarmac, as do the ruts made by equipment when removing heavy loads of hay. Finally, the grass is killed if hay bales are left for too long on an area, meaning weeds must be dealt with, and in some cases grass would need to be replanted. In either case, edge effect is created.

Grasses are already well established at BKX in the areas to be mowed. If future seedings are required, a grass specialist and a wildlife biologist should be consulted. Buffalo grass (*Bouteloua dactyloides*), a warm-season grass which grows to a height of about six inches, is gaining favor at some airports as a turf grass because it requires less frequent mowing and is drought- and heat-resistant. A fescue (*Festuca* spp.) infected with the fungal endophyte *Acremonium coenophialum* has proven to reduce rodent populations and is relatively unattractive to wildlife. However, these fescues can adversely affect some livestock and should not be planted in areas that might be used for hay.

The newest research indicates areas to be mowed should be managed to maintain grass at heights of six inches to fourteen inches, depending on the season and location. Grass shorter than six inches attracts small flocking birds (e.g. blackbirds and starlings) and Canada geese. However, taller grass and/or infrequent mowing can encourage nesting activity by some hazardous species, including waterfowl and pheasants. A mowing regimen should be determined by qualified airport personnel familiar with the area and local wildlife populations. At BKX, grass should be kept about six inches high through the summer, but allowed to grow to at least eight inches for the fall and spring migration periods. Use of the grass by wildlife should be monitored to ensure the mowing program is having the desired effect.

BKX could decrease the number of times the grass near the runways and taxiways is mowed, but should increase the use of chemical spray to control weeds and reduce biodiversity. For the purposes of the WHA, a weed is defined as any plant not intentionally grown in a particular location. Three of the seven state-listed noxious weed species were documented during the Wildlife Hazard Assessment on BKX grasslands, including Canada thistle (*Cirsium arvense*), yellow toadflax (*Linaria vulgaris*), and perennial sow thistle (*Sonchus arvensis*). Leafy spurge (*Euphorbia esula*) was noted on private land immediately adjacent to the airport and is likely to spread to BKX property. State law requires noxious weeds be controlled. In addition to the noxious weeds, dozens of other deleterious weeds were noted.

Over 150 species of plants were documented on airport property (Appendix 5). Airport personnel should strive to bring the plant community as close to a monoculture as is reasonably possible. An aggressive program of weed control on airport grounds will reduce vegetative diversity and wildlife habitat, and help maintain good relationships with the neighbors.

Contracts with farming cooperators should require them to be responsible for weed control on their haying units, in part because the airport has no control over how the hay is used. Chemicals necessary to adequately control particularly tenacious weeds may require specific periods of time before the grass can be cut and fed to certain animals (e.g. dairy cattle or livestock ready for slaughter). In addition, BKX has limited resources, and the conversion of grain crops to grassland will add considerably to the number of acres to be sprayed.

To summarize, habitat manipulation will improve the effectiveness of other management techniques, but will not totally solve all problems. Canada geese are a prime example of a wildlife species difficult to manage with simple habitat modifications. They are often noted feeding in agricultural crops, but are also notorious for being attracted to settings such golf courses and city parks.

Canada geese on the Brookings Regional Airport during the WHA survey period used a variety of habitat types, including mowed grass, small grain fields and wetlands.

Giant Canada geese graze on freshly-mown grass beside a man-made pond complete with a nesting island at the Fishback Soccer Field.

### 8.1.2.3 Rodents/Small Mammals

A change in land management practices will result in a change in rodent populations. As was previously discussed, control of rodent populations is an important element in wildlife hazard management. Their burrowing activities can damage underground wiring and leave holes and mounds of earth hazardous to aircraft leaving the tarmac, and to maintenance workers and equipment. However, the primary concern with rodents is their attractiveness as a food source for raptors and carnivorous mammals that pose a direct threat to aircraft.

*Larger rodents on BKX property include woodchucks and beavers. The woodchuck picture above was taken by a trail cam set between a drainage ditch and Runway 12-30.*

Extensive rodent trapping did not show excessively high numbers of mice and voles during the WHA survey period. The highest numbers of deer mice (*Peromyscus spp.*) and voles (*Microtus spp.*) were found in the shrub rows (i.e. the living snow fence) on the south end of the airport between Stationary Points #5 and #6. The vast majority of ground squirrels noted were also seen in this area. In addition, a stack of hay bales left on BKX property over the winter of 2009-2010 at Stationary Point #12 held higher numbers of deer mice than did most other locations on the airport. Uncut grassland, fence lines, and weedy areas adjacent to cropland yielded small numbers of mice and voles. Short grass was generally only attractive to ground squirrels.

Changing farming practices from grain crops to grassland could result in short-term increases in mice and vole populations from late spring until the grass is hayed or mowed. Other rodents are also highly influenced by the types and heights of grasses in an area. The plains pocket gopher (*Geomys bursarius*) is more common in fields containing alfalfa. Richardson's ground squirrels (*Spermophilus richardsonii*), locally known as flickertails (above), and 13-lined ground squirrels (*Spermophilus tridecemlineatus*), commonly called gophers, are partial to mowed or heavily grazed grassy areas.

The Franklin's ground squirrel (*Spermophilus franklinii*), a close relative of the Richardson's ground squirrel, is found primarily in taller grasses adjacent to wooded areas. These three species of ground squirrels can be found on or in the vicinity of BKX, although Franklin's ground squirrels were found in far lower numbers. Franklin's ground squirrels were probably most affected by the heavy rains of 2010 because much of their preferred habitat was flooded.

Shooting and trapping by BKX personnel have proven to be an effective method of ground squirrel control and should be continued. If mouse and vole numbers increase substantially, the use of poison may occasionally be necessary for control, especially in areas such as the living snow fence shrub rows. Any pesticide use must comply with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA is administered by the EPA and requires the user to follow all label directions, including applicator certification when required. At the time of the WHA, no poisoning was deemed necessary.

Beavers (*Castor canadensis*) are also in the order Rodentia, and with a potential body weight of over 60 pounds, could be extremely hazardous to aircraft when crossing a runway. However, no fresh beaver activity or beavers were noted inside the perimeter fence during the WHA. Removing trees inside the perimeter fence, ensuring the integrity of the fence—particularly near Six Mile Creek—and filling/modifying Wetland 7 (see map on Figure 11, p. 36) should keep beavers outside the fence. Still, beavers should be added to the South Dakota Department of Game, Fish and Parks (SD GF&P) depredation permit so they can be removed in the event any are seen inside the fence.

Beaver dams near BKX property back up water and provide areas for ducks, geese and other hazardous wildlife to congregate in or near the RPZs. Many hundreds of beaver stumps on city-owned property northwest of the wastewater treatment pond make travel by vehicle (including all-terrain vehicles and tractors) difficult and dangerous. Many hundreds of live trees and shrubs add to the problem. The airport does not own the property, but BKX and City of Brookings personnel should be aware the limited access can interfere with management of the area and hinder rescue efforts should a plane go down.

The beavers do provide one benefit to wildlife hazard management—the rodents remove a large number of trees (as pictured above) which would otherwise attract raptors and other hazardous wildlife to the area.

### 8.1.2.4 Other Habitat Attractants—Living Snow Fence

The living snow fence consists of multiple shrub rows on the south side of the airport property. The shrubs were planted several years ago to provide protection from excessive snow drifting onto West 8th Street South.

Survey work for the WHA showed the shrub rows were being used by a wide variety of birds and mammals. The rows consist of several shrub species, and provide nesting sites, food sources, safe travel lanes, and resting and roosting areas for a multitude of wildlife species. The shrub rows are especially attractive to mammals, with no other location on the airport showing such a wide variety of species. (Note the skunk and opossum pictured in live traps to the left and below.)

Documented mammalian species include the Franklin's ground squirrel (*Spermophilus franklinii*), 13-lined ground squirrel (*Spermophilus tridecemlineatus*), eastern cottontail (*Sylvilagus floridanus*), white-tailed jackrabbit (*Lepus townsendii*), Virginia opossum (*Didelphis virginiana*), common raccoon (*Procyon lotor*), woodchuck (*Marmota monax*), striped skunk (*Mephitis mephitis*) domestic cat (*Felis catus*), fox squirrel (*Sciurus niger*), deer mouse (*Peromyscus spp.*), vole (*Microtus spp.*), shrew (*Sorex spp.*), and white-tailed deer (*Odocoileus virginianus*).

During spotlight surveys, mammals identified as coyotes (*Canis latrans*) and/or domestic dogs (*Canis familiaris*) were also noted (but proved too elusive to positively discern between the two species).

The ten-foot-high perimeter fence was not completed until after the survey period. The living snow fence was bounded by a four-foot chain-link fence to the east, south, and west, but not to the north towards the runways. Also, several mature cottonwoods (*Populus deltoides*) west of the living snow fence were removed during the WHA. The cottonwoods were preferred perching sites for raptors hunting the shrub rows and adjacent fields.

Wildlife in the shrub rows generally presented very little direct danger to aircraft. However, flocking birds (mostly blackbirds and starlings), crows, and medium- to large-sized mammals traveling to and from the shrub rows do present a danger, as do the raptors frequently seen hunting the area. Some bird species, especially raptors, were noted less frequently after the cottonwoods were removed.

For the singular purpose of wildlife hazard management, the shrubs should be removed and replaced with temporary snow fence or a permanent solid fence designed to reduce perching locations and to allow vegetation control at the base. However, the attractant of the living snow fence could be reduced to acceptable levels by implementing a management plan.

Work to date has already demonstrated positive results in alleviating wildlife hazards caused by the shrub rows. The installation of the ten-foot perimeter fence likely reduced the number of certain species of mammals using the area, most notably white-tailed deer. Trapping efforts to reduce the number of ground squirrels, along with the removal of preferred raptor perching sites, reduced the number of hawks hunting the shrub rows. Attractants near the shrub rows were identified and can be reduced or eliminated.

A management plan would include periodic pruning of the shrub rows to keep the plants reasonably short and to allow for mowing closer to the base. Additional grass further to the north of the shrub rows could be mowed to reduce the edge effect created by the juxtaposition of short grass, tall grass and shrubs. Attractants near the shrub rows should be removed or excluded and the perimeter fence must be closely monitored for breeches. The shrub rows should continue to be monitored for the presence of hazardous wildlife.

*The shrub rows and the drainage through the middle of the shrubs provide food, water, shelter and space, all in a suitable arrangement, for a variety of wildlife.*

## 8.2 Exclusionary Devices at BKX

Exclusionary devices can be excellent tools to protect certain areas from wildlife incursions. These devices range from a simple grid over a culvert to complex electronic equipment. The most obvious exclusionary device at most airports, including BKX, is a deer-proof perimeter fence. These fences prevent most large mammals, including deer, from accessing the Airport Operations Area.

Because deer–aircraft collisions are notoriously expensive and deadly (Cleary and Dolbeer 2005) and high numbers of deer were known to exist on or adjacent to the airport, a deer-proof fence was designed and contracted prior to the start of the WHA. At the last 2010 onsite inspection by the author, construction of the fence was nearly complete. The fence provides the added value of keeping unauthorized vehicular and pedestrian traffic off airport grounds.

However, exclusionary devices are rarely 100% effective. A ten-foot fence will keep out the vast majority of deer, but hard-packed snow drifts can transform a ten-foot fence into a much shorter one. A gate left open or installed too high off the ground will allow access by deer and other animals, as will breeches caused by falling trees, disrepair, mechanical failure, or other means. An excessively expensive and difficult to maintain fence would be required to keep mammals such as raccoons and coyotes out of a large area such as BKX, as the animals will either dig under or climb over the fence. Fences do not stop birds, and actually provide perching sites and protected travel routes for pheasants and small mammals.

*Deer that do get inside the fence often cannot find their way out, as appeared to be the case with the deer pictured here.*

Proper maintenance of a fence is critical. The entire perimeter of the fence should be inspected frequently for breeches or other damage. This requires a useable trail or path, free of all obstructions. Simply mowing a path on the inside of the perimeter fence would suffice in most areas of BKX. A graded road is not necessary, and could even be counterproductive. In some cases the terrain or weather will dictate the use of an all-terrain vehicle or snowmobile. Ideally, the trail should allow travel with a pickup or tractor to transport equipment necessary for repairs and maintenance when needed.

All vegetation within a foot of the fence, including grass, should be eliminated by chemical means. The vegetation hides breeches, damages the fence, and provides safe travel lanes for wildlife. Unattended gates must be closed immediately after use.

*Exclusionary fences need periodic maintenance to maintain their effectiveness.*
*Trees and shrubs overhanging or near the fence should be removed, and all vegetation within a foot of the fence should be killed.*

Wires or netting over ponds are effective in excluding some wildlife species in some places, but certainly not all wildlife species in all places. Careful consideration should be given before wires or nets are installed. These exclusion devices can interfere with the implementation of other management techniques on a pond, including vegetation and insect control. Overhead wires do not prevent pheasants or large birds such as great blue herons (*Ardea herodias*) and Canada geese from using a wetland. The birds simply land outside the wires and walk to the edge of the wetland. Raccoons, skunks and other small mammals are not deterred by overhead wires.

An electric fence in addition to overhead wires or netting will reduce many of these problems, but upkeep of a fence could be problematic if, for example, the fence is placed around the perimeter of a wetland where the water depth and shoreline location are constantly changing. The fence can also further hinder the use of equipment for habitat manipulation and spraying for weed and insect control. Wires and netting can be very effective in reducing wildlife access to an attractant, but if not properly installed, they will be a needless expense and annoyance and can actually interfere with hazardous wildlife management.

Effective exclusionary techniques include the use of taut lines[3] to prevent large birds from landing on towers or light bars, and bird spikes or spike strips to deny all birds use of a perching site. These exclusionary techniques require little maintenance, but only authorized personnel may install these devices on certain airport facilities and equipment. Improper installation could result in interference with critical communication, navigation or lighting operations. In some cases, exclusionary devices cannot be installed and airport personnel must rely on alternate wildlife hazard management techniques, such as scare tactics and hazing.

*An attractant should be removed rather than excluded whenever possible. However, in some cases the attractant is necessary to the operation of the airport.*

[3] Taut lines are tightly stretched wires placed a few inches above a perching site. The wires are too small in diameter for larger birds to grasp. However, they must also be tight and strong so they do not stretch to allow the bird's feet to push the wire to the surface below. Taut lines of any diameter may also be placed to interfere with bird flight patterns near the perching site.

## 8.3 Scare Tactics and Hazing at BKX

Scaring and hazing include a large variety of management techniques, from simply honking a vehicle's horn to shooting pyrotechnics near undesirable wildlife. Scaring and hazing will always play a role in wildlife hazard management. Wildlife hazards will present themselves at inopportune times, and must be dealt with quickly. Occasionally, individual animals can be permanently removed from an area by hazing. Some animals are merely passing through and need an impetus to move on.

Species such as ring-billed gulls, on the other hand, will often simply move from one spot on the airport grounds to another when hazed. The birds may be chased multiple times until they choose to move on for reasons of their own. The use of pyrotechnics by qualified personnel helps considerably in these situations, and is an invaluable aide in wildlife hazard management. BKX personnel use pyrotechnics frequently and wisely, and should continue to do so. New personnel must be trained in the proper use of the equipment.

It is, however, important to note that pyrotechnics are not a suitable management technique for use near buildings or airplanes, in adverse weather conditions, or if an accidental fire is possible. In addition, pyrotechnics can attract unwanted attention and concern from neighbors and others in the vicinity, and can be dangerous to the user and bystanders.

Some animals cannot be permanently removed by hazing or scaring techniques. Rodents, jackrabbits and multitudes of other animals will hide nearby and return after the perceived danger has passed. Scare tactics and hazing require constant vigilance, and are not always effective for long periods of time due in part to habituation.

Habituation has long been a recognized problem in wildlife damage management. According to the manual *Ornithology in Laboratory and Field* (Pettingill 1970):

> Habituation, the declining in a response to repeated stimulation without reinforcement ('reward or punishment'), is one form of learning … Habituation is becoming used to, and no longer reacting to, anything new that proves to be harmless or non-rewarding.

Because of habituation, most hazing or scaring techniques are more effective when used in combination with lethal means, i.e. reinforcement by punishment. Gulls that are not easily removed by being subjected to hazing and scaring techniques will rapidly leave the airport vicinity if one or two in the flock are killed. Thus, although it is certainly not necessary to kill every bird, it may be essential to kill some individuals in each flock in order to reinforce the hazing and scaring techniques.

A wide variety of commercial products to scare birds or other wildlife are available. Mylar balloons, propane cannons, imitation owls, mounted coyotes, flashing lights and distress calls are but a very few of the hundreds of products available. The author believes these items can occasionally be useful to deter wildlife from using an area, especially when moved from place to place or exchanged for another device every day or two to avoid habituation. However, the time and money may be better spent on other management techniques. Chemical repellants are another commonly considered but expensive option for a wildlife deterrent. At this point in time, the author is unaware of empirical evidence showing chemical treatments work effectively, consistently, and/or for long periods of time in field conditions.

One visual deterrent that has met with some success is placing dead birds in a "death pose" in problem areas. According to Cleary and Dolbeer (2005):

> Several experiments and field demonstrations have shown that a dead turkey vulture (freeze-dried taxidermy mount with wings spread), hung by its feet in a vulture roosting or perching area, will cause vultures to abandon the site. Initial trials using dead gulls and ravens suspended from poles have also shown promising results in dispersing these species from feeding and resting sites. The dead bird must be hung in a "death pose" to be effective. Dead birds lying supine on the ground or in the roost are generally ignored or might even attract other birds. Permits must be in place before federally protected migratory birds can be obtained and used as "dead-bird deterrents." Research is under way to determine if artificial "dead-bird effigies" can be developed that will be just as effective as the taxidermy mounts.

Hand-held laser devices that project a one-inch or larger diameter beam have been used to successfully disperse Canada geese, double-crested cormorants (*Phalacrocorax auritus*), and American crows (*Corvus brachyrhynchos*) from roosting areas. The devices are effective at long ranges, but only at night and for a limited number of species. A handheld spotlight has been used by the author to successfully disperse ducks and geese on multiple occasions. However, neither a small laser nor the handheld spotlight had any visible effect when used by the author in an attempt to disperse vultures from a roosting site near BKX.

## 8.4 Lethal Control at BKX

Lethal control is an essential component of an effective hazardous wildlife control program at BKX. In some cases, lethal control is the only effective means of controlling a particular species. Ground squirrels, raccoons, skunks, rabbits and other animals that cannot reasonably be removed or excluded by other methods need to be controlled by lethal means.

Lethal control is used as a last resort for most species. Unfortunately, lethal control is a never-ending solution because it does not fix the underlying problem of having wildlife attractants in the wrong location. Additionally, lethal methods can be dangerous to non-target species, airport personnel, and the surrounding community. Personnel using firearms must receive quality training on a continuing basis and be provided with the equipment necessary to effectively and safely remove hazardous animals.

Killing problematic wildlife is often perceived by the general public as brutal or unnecessary. In addition, the events of September 11, 2001, when four U.S. commercial airplanes were hijacked by terrorists and crashed into high-profile American targets, changed security practices at airports around the world.

The general public now has a heightened awareness of and response to potential threats. The presence of an armed person on the airport grounds or the sound made when discharging a firearm or pyrotechnic device creates the possibility that people will misinterpret actions related to wildlife hazard management as illegal or terroristic activities. Therefore, the use of firearms and pyrotechnics requires communication with local law enforcement agencies to avoid the potential for an emergency response triggered by such a misunderstanding.

The safest and most effective firearms to use in dispersing birds are usually shotguns. Compared to .22 caliber rifles, shotguns have a limited range and the louder noise is more effective at frightening wildlife. However, the louder noise is also more apt to alarm members of the public.

BKX personnel should have access to the variety of equipment necessary for the variety of circumstances they will encounter. Equipment needs include but are not limited to traps, firearms, subsonic (low velocity) and/or fragmenting bullets, shotgun shells with non-toxic shot, pyrotechnic devices, binoculars, bird identification books, and internet access for wildlife identification and wildlife hazard management information. BKX personnel must also have the appropriate training, licenses and permits to engage in wildlife control activities.

*Depredation permits must be used judiciously, especially when otherwise–protected wildlife species are concerned. If harassment techniques must be reinforced by lethal means, one or two birds near the front of the flock should be killed in full view of the others, rather than shooting into the center of the flock and killing many.*

### 8.4.1 Lethal Control and Legal Status of Wildlife Species

Almost all wildlife is protected by federal or state laws. Birds not protected by law include European starlings, English/house sparrows (*Passer domesticus*), rock doves/pigeons (*Columba livia*) and Eurasian collared-doves (*Streptopelia decaocto*). These species may be killed at any time and their nests destroyed.

Yellow-headed (*Xanthocephalus Xanthocephalus*), red-winged, rusty (*Euphagus carolinus*) and Brewer's blackbirds (*Euphagus cyanocephalus*), grackles (*Quiscalus spp.*), cowbirds (*Molothrus ater*), crows and magpies (*Pica hudsonia*) may be controlled without a federal or state permit when concentrated in numbers and in a manner that constitutes a health hazard or other nuisance (e.g. on airports).

While many of the species listed above are present at BKX, most lethal control measures require depredation permits from the appropriate state or federal agencies. The permits allow certain wildlife species to be controlled by killing, nest destruction, or other methods not generally allowed. BKX personnel annually review and update the mandated permits, and due to immediate dangers, two species (turkey vultures and cliff swallows) were added during the WHA. Other species may be added as a result of the WHA and corresponding review of the existing permits.

The Wildlife Services Division of the USDA is the federal agency responsible for animal damage control. Wildlife Services (WS) works with the U.S. Fish and Wildlife Service, its sister agency, to obtain the necessary federal permits issued to airports. The USFWS has issued all depredation permits requested by the Brookings Regional Airport. In the very recent past, the SD GF&P has begun to accept the USFWS permits without requiring its own review or additional paperwork, which has streamlined the process. However, permits issued by the USFWS are only valid for migratory wildlife. The SD GF&P is the agency responsible for issuing depredation permits for non-migratory wildlife.

Some species may not generally be a problem, but may require quick action by airport personnel if the species does become a hazard. Also, the possibility exists for misidentification and accidental taking of a non-permitted species even by reasonably well-trained personnel. To alleviate these problems, additional species may need to be added to the depredation permits by BKX after consultation with an airport wildlife biologist and if allowed by regulatory agencies.

Gulls take up to five years to achieve adult plumage and can be exceedingly difficult to identify even with training and experience (Cleary and Dolbeer 2005). Ducks present a similar problem. Ducks in summer plumage or juvenile plumage can be very hard to identify, even by experienced hunters with the bird in hand. Although anyone shooting a firearm should know his/her target, airport personnel cannot always be expected to differentiate one duck species from another. In a situation requiring rapid removal of hazardous wildlife, a duck is a duck, and the exact species should not need to be a major concern. Adding a small number of common and similar wildlife species to a depredation permit avoids potential legal problems and allows airport personnel the flexibility required to do their jobs.

Attempts to remove permitted animals such as raccoons, skunks and ground squirrels will at times result in the incidental take of non-target species. Traps set over ground squirrel burrows can kill other wildlife such as weasels (*Mustela spp*.), which use the rodent holes for cover or in search of food. In past years, the author has recommended some species of wildlife should be listed on the depredation permits to avoid potential legal problems if they are killed incidental to other trapping.

However, conversations in February of 2011 by the author with SD GF&P Wildlife Damage Management personnel show the state agency has become highly cognizant of the need for effective wildlife hazard management at airports. The permitting process will continue to become easier, and fewer species will need to be listed. In essence, airport personnel performing wildlife hazard management will be granted the same exemptions to state law as landowners are granted. Landowners may trap and kill certain nuisance species (e.g. skunks,

raccoons, ground squirrels, badgers, woodchucks, rabbits, fox, coyotes and other common "varmints") without regard to seasons, limits or licenses.

All wildlife taken under the terms of a depredation permit must be reported annually to the appropriate agencies. Incidental wildlife taken should be reported and–unless the animal is threatened or endangered or the depredation permit is grossly misused–the report will be handled as an "incidental take" rather than a violation of the depredation permit.

The author recommends all wildlife taken, regardless of the need for a permit, be documented. Documentation confirms airport personnel are actively involved in wildlife hazard management, and the numbers of animals taken may show dangerous population trends. Early recognition of developing trends allows timely management modifications.

BKX personnel should continue to use non-lethal methods to remove wildlife from the airport when practical. Depredation permits should be used primarily to allow the lethal control of a small number of animals and to enhance scare and harassment techniques.

Exclusionary devices, scare tactics, hazing, and lethal control are all necessary components of a wildlife hazard management program, but all have shortcomings and problems. The need to use these methods can be greatly reduced through the use of habitat manipulation. Nonetheless, habitat manipulation works best when combined with other control techniques.

## 9. Threatened and Endangered Species

According to the Endangered Species Act (ESA) of 1973, as amended (Title 16 UCS Chapter 35-Endangered Species), an endangered species is any species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The ESA makes it unlawful for a person to take a listed animal without a permit. Take is defined in 50 CFR 17.3 as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Harm is further defined as "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." Listed plants are not protected under the take provisions except on areas under federal jurisdiction.

The USFWS has management authority for federally listed threatened and endangered species. The South Dakota Department of Game, Fish and Parks (SD GF&P) is responsible

for state-listed threatened and endangered species under state law (SDCL 34A-8), and has developed a management plan for the Topeka shiner (Shearer 2003).

Concerted efforts were made to document the presence (or absence) of threatened or endangered species during the WHA. In addition to field studies, surveys, and literature review, this author communicated directly with USFWS, SD GF&P and SDSU personnel regarding the potential for the occurrence of threatened and endangered species at BKX.

## 9.1 Federally Listed Threatened and Endangered Species at BKX

The threatened western prairie fringed orchid (*Platanthera praeclara*) and the endangered Topeka shiner (*Notropis topeka*) are listed as shown in the chart below (Figure 14) provided by the South Dakota Field Office of the USFWS.

| | | | | |
|---|---|---|---|---|
| BROOKINGS COUNTY Federally Listed Species<br>**Figure 14** | FISH | TOPEKA SHINER | Occurrence KNOWN | ENDANGERED |
| | PLANT | WESTERN PRAIRIE FRINGED ORCHID | Occurrence POSSIBLE | THREATENED |

The consensus of experts consulted, along with corroborating evidence from the WHA airport plant inventory, indicates the western prairie fringed orchid is highly unlikely to occur on or in the vicinity of the airport. Although the orchid has been found on disturbed sites, the plant is primarily a product of tall-grass prairies. According to the species profile information on the USFWS Environmental Conservation Online System (last accessed February 17, 2011) and related information in the Federal Register (54 FR 39857-39863), there are multiple probable contributing factors leading to the decline in western prairie fringed orchid numbers.

The contributing factors may include the conversion of grassland to cropland, drainage, the loss of pollen-spreading hawkmoths to insecticides, the spread of highly competitive species (e.g. leafy spurge, Kentucky bluegrass and Canada thistle), fire suppression efforts, and the encroachment of trees into otherwise suitable orchid habitat. It is also probable that habitat fragmentation has reduced or eliminated the prospects for the genetic exchange necessary for a healthy population. The WHA recommendations proposed for wildlife hazard management purposes are not expected to impact western prairie fringed orchid populations.

Federally endangered Topeka shiners are well documented in the Brookings area, including Six Mile Creek, and fall under the purview of the Endangered Species Act. (See Figure 15 on page 64, a map showing known Topeka shiner occurrences near the Brookings Regional Airport). This does not mean work to remove hazardous wildlife attractants must be halted.

However, any changes to wetlands (including Six Mile Creek) will require consultation with and monitoring by the USFWS.

Minnow trapping in wetlands and drainages inside the perimeter fence was done during the WHA to determine the presence or absence of fishes. Fish attract a variety of hazardous wildlife species, including large birds such herons, pelicans and cormorants. Only fathead minnows (*Pimephales promelas*) and brook sticklebacks (*Culaea inconstans*) were found. Topeka shiners were not found. However, trapping was limited and Topeka shiners were not specifically targeted.

Although Topeka shiners are not state-listed in South Dakota, populations of the fish have been significantly reduced within its range by factors such as degradation of stream quality, destruction of shiner habitat, siltation of spawning areas, channelization of streams, construction of dams, and introduced predaceous fishes (Knight and Gido 2005).

Topeka shiners are known to exist only in fragmented portions of six states (South Dakota, Minnesota, Kansas, Iowa, Nebraska and Missouri). Within South Dakota, Topeka shiners occupy the majority of their historic known range in the state, and are known to occur in the watersheds of the James, Vermillion, and Big Sioux Rivers.

According to Nathan Baker, wildlife biologist with SD GF&P (personal communication January 6, 2011),

> Whooping cranes (*Grus americana*) are a Federally Endangered species that migrates through South Dakota every spring and fall and may occur in this area temporarily. Topeka shiners (*Notropis topeka*) are a Federally Endangered fish species that occurs in small prairie streams in eastern South Dakota. Within 10 miles of the Brookings Regional Airport Topeka shiners have been documented throughout the Upper Big Sioux watershed in the Big Sioux River, Medary Creek, North Deer Creek (South Fork), and Six Mile Creek. Specifically, Topeka shiners have been documented approximately two miles upstream on Six Mile Creek, four miles southwest on the Big Sioux River, 5 miles north on the south fork of North Deer Creek, and 6 miles to the Southeast of the Brookings Regional Airport on Medary Creek (see attached map). It is highly likely that Topeka shiners occur in portions of Six Mile Creek in the immediate vicinity of the Brookings Regional Airport. Several other documented records of Topeka shiners have been found in Moody and Minnehaha Counties to the South.

While it was once thought Topeka shiners required small prairie streams with a substrate of clean gravel or sand, recent studies have found substantial populations in ponds and dugouts

with heavily-silted bottoms (Thompson and Berry 2009). The 2009 study was completed on dugouts in or adjacent to the Six Mile Creek basin. Green sunfish (*Lepomis cyanellus*) and orange-spotted sunfish (*lepomis humilis*) are important to recruitment of Topeka shiners, as the shiner usually spawns over the nests of these sunfish (USFWS 1998, Shearer 2003). Thompson and Berry noted the presence of both species in their 2009 study.

An excellent reference manual regarding management of the Topeka shiner, *Dugouts and Stream Fishes, Especially the Endangered Topeka Shiner*, was published in December of 2010 (U.S. Department of Agriculture et al.). The booklet was a result of the Six Mile Creek study and other research in Iowa and Minnesota, and can be found online at http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=29141.wba (last accessed March 6, 2011).

*Dugouts and Stream Fishes, Especially the Endangered Topeka Shiner* indicates Topeka shiner and other fish populations in creeks can be protected and/or stabilized by dugouts (stock dams) designed to the standards given. The stated conclusion is:

> Populations of Topeka shiners and other stream fishes may not be harmed and could be conserved when dugouts are constructed in very frequently flooded or frequently flooded zones anywhere in the longitudinal dimension of a stream such as Six Mile Creek. Dugouts can be a refuge during stream intermittence and a source of fish when the dugout is reconnected to the stream during flooding. The dugout should intersect with the ground water to promote fish survival. Topeka shiner use of off-channel habitat along Six Mile Creek agrees with observations made by other researchers studying streams in Iowa and Minnesota (Clark 2000; Dahle 2001; Hatch 2001).

If wetland removal or changes to Six Mile Creek are made to remove hazardous wildlife attractants, the results of these studies might be useful in helping alleviate negative effects to Topeka shiner populations. In some cases, these dugouts might be allowable to mitigate loss of jurisdictional wetlands as required by the U.S. Corps of Engineers.

A project is underway by multiple agencies and individuals in Iowa to increase Topeka shiner populations by restoring oxbows[4] in river systems where the minnows were once known to exist. Preliminary indications are that the experimental restorations are working (Johnson 2009). The oxbows are similar in size and nature to many of the dugouts in the Thompson and Berry study, although they were dredged to remove silt.

[4] Oxbows are portions of rivers and creeks that have been cut off from the main channel and have formed a lake or pond near the river or creek.

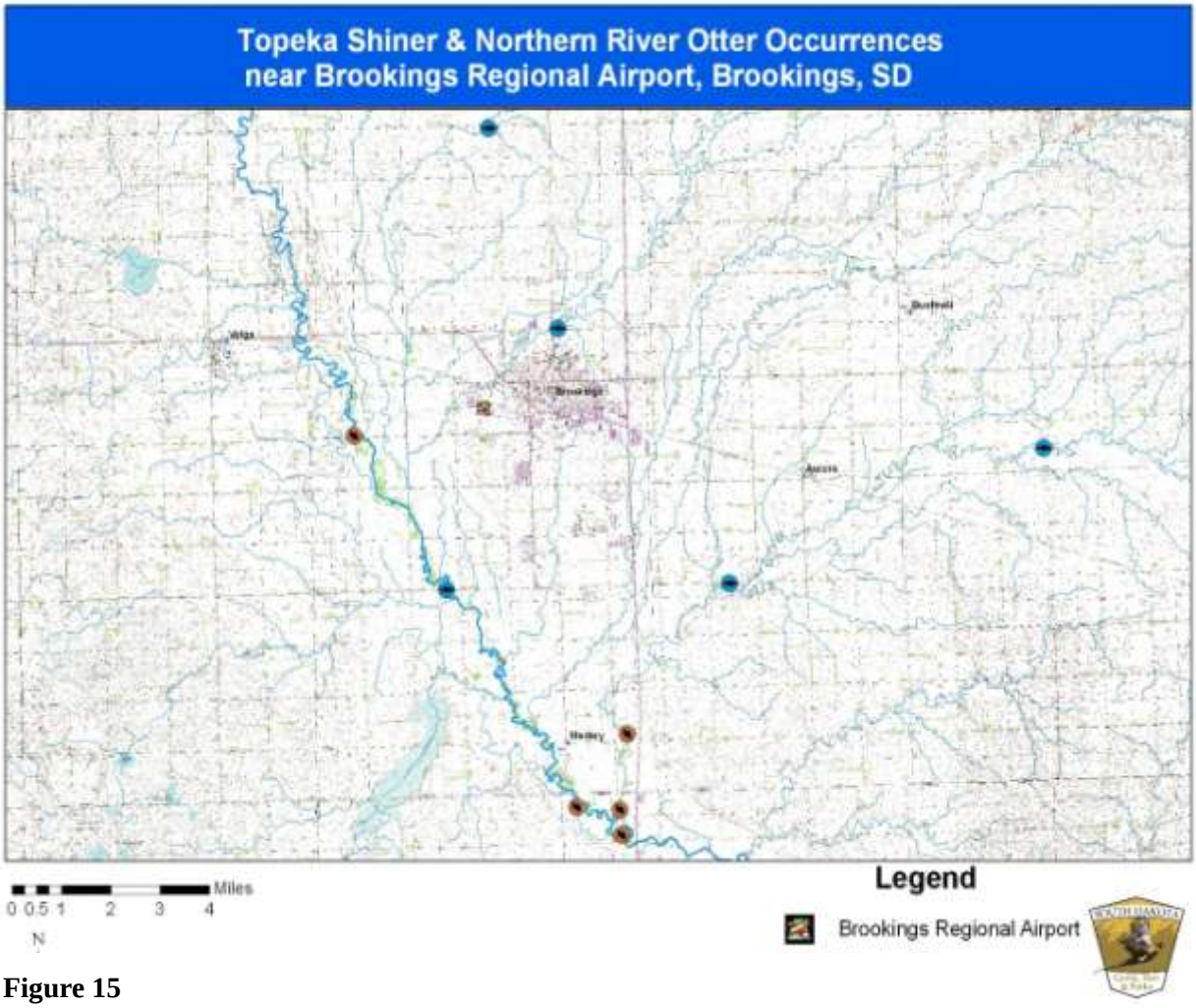



**Figure 15**

Mitigation wetlands[5] should occur outside the separation criteria outlined in AC 150/5200-33B. For BKX, the distance should be a minimum of 2000 feet from the Airport Operations Area. However, the FAA may allow mitigation activities inside the separation zone if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species which cannot be replicated when moved to a different location (Cleary and Dolbeer 2005). Wetland mitigation inside the separation criteria must not create a significant attractant to hazardous wildlife.

Placing mitigation wetlands and/or dugouts in the upper reaches of the Six Mile Creek basin out of the BKX five-mile general zone might be more effective in stabilizing or increasing Topeka shiner populations in the area than if the mitigation wetlands were placed closer to the project area. This possibility exists because Topeka shiners are a pioneering species,

[5] Mitigation wetlands are creations, restorations and enhancements designed to compensate for wetland impacts occurring as a result of drainage or filling of wetlands for construction or other purposes (e.g. to remove hazardous wildlife attractants).

found in the tributaries to major rivers (e.g. the Big Sioux River and the James River), but only occasionally in the rivers themselves.

In addition, placing mitigation wetlands outside the general zone will help ensure they do not create wildlife hazards to aircraft at BKX. However, the USFWS and USCOE will make the final determination on where mitigation wetlands will be placed and how they will be designed.

Because the airport receives federal funding, an ESA Section 7 consultation with the USFWS must be completed before project construction is initiated to ensure compliance with the Endangered Species Act. ESA Section 7 requires federal agencies (including the FAA) to ensure the agencies' activities are not likely to jeopardize listed species or their habitat.

## 9.2 State-Listed Threatened and Endangered Species at BKX

Regardless of federal status, species may be listed as threatened or endangered under state laws. The state of South Dakota has identified only one threatened or endangered species of concern in the Brookings area (other species may occasionally be found, but are not dependent on the area for survival). Nathan Baker, wildlife biologist with SD GF&P (personal communication January 6, 2011), stated:

> The northern river otter (*Lontra canadensis*) is a state threatened species that inhabits rivers, pond and lakes and has also been documented along the Big Sioux River and Medary Creek within 10 miles of the Brookings Regional Airport. Northern river otters may occur in Six Mile Creek in the vicinity of the Brookings Regional Airport.

Mr. Baker provided a map of documented otter sightings (Figure 15, previous page). SD GF&P personnel should be consulted regarding any proposed changes to Six Mile Creek and adjacent wetlands.

Bald eagles (*Haliaeetus leucocephalus*) are listed as a state threatened species, and ospreys (*Pandion haliaetus*) are listed as endangered. These species are given protection by state laws in addition to the protection provided by federal laws, including the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA).

**Ospreys were seen on multiple occasions during the WHA near gravel quarries east of Brookings.**

Both species were documented either at BKX or in the general zone during the WHA. The birds are currently seen in the Brookings area only during migratory periods; however, the bald eagle population is expanding its nesting range in eastern South Dakota.

## 9.3 Possible Threatened and Endangered Species at BKX

BKX personnel should be aware that while the USFWS only reports two federally listed threatened or endangered species in Brookings County, others may be present for short periods of time. Bald eagles were delisted in October 2007, but are still protected under the Bald and Golden Eagle Protection Act (16 U.S.C. §§ 668a – d), the Migratory Bird Act (16 U.S.C. §§7, Subchapter II), and SD state laws listing bald eagles as threatened. These birds are subject to the "take" provisions of the laws, as described earlier in this section. However, airports may obtain a permit to harass eagles should it become necessary for the safety of the public. One bald eagle was noted over BKX property during the WHA. More than twenty were seen a short distance away at Lake Campbell (one of which is pictured below), and two more were observed just west of the airport near North Deer Creek.

Whooping cranes (*Grus americana*) are unlikely— but not impossible—to be seen at BKX, especially during the spring and fall migratory periods. The birds are protected under the ESA and the MBTA, in addition to SD state laws. If whooping cranes are noted on the airport, all activities which might disturb the birds must be discontinued until the cranes move on.

USFWS Ecological Services Office and/or Law Enforcement in Pierre as well as SD GF&P officials should be notified of the presence of whooping cranes and other endangered species. Contact information, current as of March 2011, is below:

## Federal Offices USFWS

USFWS Ecological Offices
420 S. Garfield Avenue
Suite 400
Pierre, SD 57501-5408
Office: 605-224-8693
Fax: 605-224-9974
Email: southdakotafieldoffice@fws.gov

USFWS Special Agent
28563 Powerhouse Road
Pierre, SD 57501
Office: 605-224-9045 or
605-280-1712

U.S. Fish & Wildlife Service
Office of Law Enforcement
Mountain-Prairie Region
P.O. Box 25486 - DFC
Denver, Colorado, USA 80225
Phone: 303-236-7540
Fax: 303-236-7901

## State Offices SD GF&P

Jeff Grendler
Conservation Officer
Northern Plains Biostress Laboratory
P.O. Box 214B
Brookings, SD 57007
Office: 605-688-6120
State Radio Dispatch: 605-353-7132
Brookings Police Dispatch: 605-697-8300
Email: jeff.grendler@state.sd.us

Ron Schauer
Regional Program Manager
SD Dept. of Game, Fish and Parks
4500 South Oxbow Avenue
Sioux Falls, SD 57106
Office: 605-363-2725
Fax: 605-362-2704
Email: ron.schauer@state.sd.us

Nathan Baker
Wildlife Biologist
SD Dept. of Game, Fish and Parks
523 East Capitol Avenue
Pierre, SD 57501
Office: 605-773-3387/4345
Fax: 605-773-6245
Email: nathan.baker@state.sd.us

## 10. Cooperation between Federal Agencies

Federal agencies often have conflicting missions. For example, The USFWS has a mandate to protect and preserve migratory wildlife and associated habitats, while the U.S. Air Force is charged with protecting our national security. The missions are incompatible at times, such as when the Air Force wishes to test aircraft or weapons over critical wildlife habitat.

However, the safety of the flying public is of utmost importance, and an Interagency Memorandum of Agreement between five federal agencies requires the agencies to work together to reduce wildlife hazards to aircraft. According to Cleary and Dolbeer (2005):

> 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) (finalized 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.

The MOA is critical to the success of wildlife hazard management programs at BKX and elsewhere. The SD GF&P is not a signatory to the MOA and has no obligation to follow the terms of the agreement. However, SD GF&P officials are aware of hazardous wildlife management problems facing airports and have been cooperative in alleviating these problems.

## 11. On-Site Surveys and Results

Approximately 88 species of birds, 25 species of mammals, and two species of fish were documented on or immediately adjacent to the airport during the WHA. Most were noted during standardized survey work. In addition, 23 fish species are known to occur in the Six Mile Creek drainage (Thompson and Berry 2009).

Crustaceans, reptiles, and amphibians were not surveyed per se, but occasionally these animals were noted in the course of other work (see photo below right). A listing of wildlife identified by the author or otherwise documented during the WHA is included in Appendix 5. The listing is not meant to be a comprehensive record of all wildlife species that might be on, over or under airport property; it simply shows the species identified during the WHA, and includes the vast majority of hazardous wildlife species potentially in the area.

This snapping turtle near Stationary Point #21 could be a serious hazard to aircraft if crossing a runway.

There is undoubtedly a myriad of warblers, sparrows and other small birds on adjacent residential areas and cemeteries that were not specifically identified. These birds may occasionally pass over airport property, but do not pose a significant threat to aircraft. A comprehensive list of birds documented in the Brookings area was provided by the South Dakota Ornithologist's Union and is included in Appendix 5.

Larger birds such as crows, raptors, vultures, waterfowl and herons on property near BKX may pose a threat, and thus were identified when seen. No acceptable management technique exists to remove birds from residential areas and cemeteries, and these areas will continue to be a source of hazardous birds—primarily blackbirds, crows and an occasional raptor. In agricultural settings, some control work may be accomplished with landowner permission and the proper permits. Still, the best option is to eliminate attractants on airport property whenever possible.

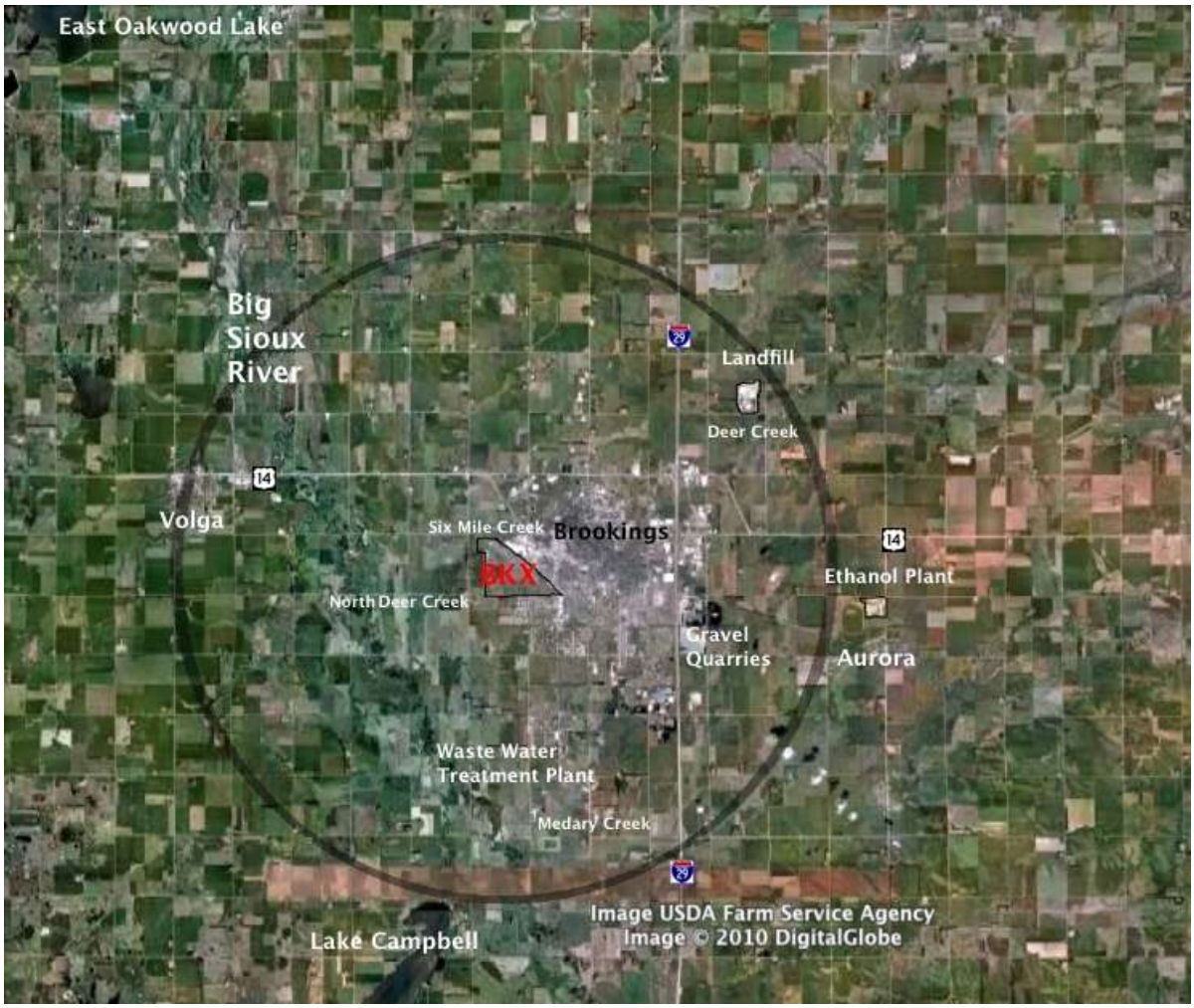
Plants noted on BKX property included 153 species other than the agricultural grain crops grown on the airport. Twenty-five species of trees, shrubs and woody vines, 91 species of

forbs[6], and 37 species of grass or grass-like plants[7] were documented. Plant identification was accomplished primarily by Dr. Gary E. Larson, plant taxonomist and herbarium curator at SDSU, on two separate site visits in 2009 and 2010. The diversity of plant life contributes heavily to the diversity of wildlife species, including the wildlife most hazardous to aircraft.

[6] Forbs are broad-leafed plants other than grasses, sedges, rushes, shrubs and trees. Common forbs in the area include alfalfa, sweet clover, and many herbaceous (non-woody) weeds.

[7] Grass-like plant species include sedges, cattails and rushes.

## 12. Off-Site Surveys and Results—The General Zone




*Pictured above is the "general zone" for the Brookings Regional Airport. The general zone is a five-mile perimeter around an airport's Airport Operations Area. The vast majority of bird strikes occur within the perimeter.*

**Figure 16**

Statistics from the national FAA Bird Strike database show 94% of strikes occur on or near airports while the aircraft is landing, taking off or circling (Dolbeer et al. 2009). Work to reduce wildlife collisions with aircraft must begin at airports, but clearly cannot stop at the airport boundaries. Attractants near the airport must also be identified and mitigated whenever possible.

Advisory Circular 150/5200-33B, "Hazardous Wildlife On or Near Airports," is a comprehensive document which covers subjects including general separation criteria for

hazardous wildlife attractants, land-use practices on or near airports which could potentially attract hazardous wildlife, and procedures for wildlife hazard management by operators of public-use airports. The latest version of the AC is readily available on the FAA website (http://www.faa.gov/airports/resources/advisory_circulars/ ). See also the "Advisory Circulars and CertAlerts" on page 103 for a current listing of ACs pertaining to wildlife hazard management at airports.

As previously stated in Section 2.2 (Off-Site Surveys), the AC specifically addresses safety zones around an airport. For airports serving turbine-powered aircraft, including BKX, wildlife attractants must be 10,000 feet from the AOA. The FAA also recommends a minimum separation criterion of five statute miles between the AOA and the hazardous wildlife attractant if the attractant could cause wildlife movement into, on, or across the approach or departure airspace. The five-mile perimeter is often referred to in FAA documents as the "general zone" (Figure 16, previous page).

Off-site surveys were designed to locate and evaluate potential wildlife attractants within or near the separation distances identified by AC 150/5200-33B.

## 12.1 Brookings Area Attractants

The area surrounding the Brookings Regional Airport has the habitat to supply all the needs for a vast array of wildlife. Outside the city, wetlands (including lakes, creeks and rivers), grasslands, tree plantings and agricultural fields provide a diverse environment. Brookings County is part of the Prairie Pothole Region, where drainage is often poor, periodic flooding is common, and wildlife habitat abounds.

Agricultural interests dominate much of the landscape. Normal farming and livestock husbandry practices sometimes provide significant wildlife attractants. The attractants can be greatly strengthened by other environmental features of the area.

Agriculture is vitally important to the region's economy and the airport has very limited authority or ability to manage or alleviate hazards caused by agricultural practices. Reclassifying zoning from agricultural to residential or commercial, if even possible, might eliminate some wildlife attractants but could also bring an entirely new set of problems and safety issues for the airport. In addition, many of the agricultural areas are in the flood plain, limiting potential land uses. Agricultural activities will continue to be an attractant to wildlife in the area.

No major livestock feeding operations, which often attract large numbers of birds such as starlings, are located near BKX. However, vultures were attracted to pastures near BKX, especially during calving season, where they were noted eating afterbirth (pictured previous page). In addition, heavily grazed pastures and their associated wetlands and stock dams near BKX were attractive to Canada geese (pictured left), puddle ducks, herons, egrets and shore birds. The attraction was enhanced by heavy rainfalls in 2010, which formed temporary wetlands in the short grass.

Hazardous wildlife may even be attracted to the city itself. A major turkey vulture roost site is located near the center of Brookings at the 4th Street water tower. Parks and recreation areas, particularly those with natural wetlands or retention ponds, provide homes to giant Canada geese and other waterfowl. Countless trees in the city attract crows and an occasional raptor. Large parking lots provide resting and/or feeding areas for gulls.

The wildlife in Brookings County and the outdoor recreational opportunities it provides (hunting, fishing, bird watching, nature photography, etc.) draw many visitors to the area and provide an impetus for residents to stay. The wildlife is also a source of considerable revenue. Many individuals and clubs work hard to protect, preserve and improve the habitat in the area, including the Brookings Wildlife Federation, Pheasants Forever, The South Dakota Waterfowl Association, Ducks Unlimited, Whitetails Unlimited, Big Sioux Bowman, and the National Wild Turkey Federation. Other than airport safety, there is little impetus to remove wildlife attractants, and many reasons to keep them. Public education is necessary to help achieve a balance between wildlife values and wildlife hazard management.

Birds not attracted to the airport property but nonetheless moving through the area are perhaps a greater hazard to aerial navigation than are birds documented on airport property. Large numbers of migratory waterfowl move through the area in the spring and fall; most birds are seen west of I-29, but they can be found anywhere. Waterfowl migrations start earlier in the spring and end later in the fall than do the migrations of most of the other bird species using the airport.

Major waterfowl attractants in the BKX region include the Big Sioux River, Lake Campbell, the Oakwood Lakes, and an untold number of flooded fields, potholes and larger wetlands. Even though some of the major attractants are over 30 miles from the airport, waterfowl may pass through the general zone in search of food, water and resting areas during migratory

periods. Migratory birds, especially waterfowl, will always be a problem. Management techniques for these migrating waterfowl are currently limited to the airport issuing Notice to Airmen (NOTAMs), modifying flight schedules when possible, and reducing the amount of habitat on BKX property used for feeding, roosting or resting activities.

Bird-detecting radar deserves mention as a potential tool to monitor the presence of birds. The technology cannot yet be economically installed at smaller airports, but several models are currently being developed and tested around the world. Most research is aimed at designing low-cost radar systems capable of detecting birds at or near airports. The radar could be used to develop a bird-strike advisory system and display information either at the airport operations center or in an aircraft cockpit.

Of course, airports always have some birds in the area, and by necessity, business must go on as usual. Radar would also not detect birds on the ground. With the notable exception of migrating geese and large flocks of other birds, most avian hazards at the Brookings Regional Airport would likely not be seen on radar or recognized as a significant hazard to be avoided. Most strikes at BKX have occurred when only a very few birds were on or near a runway. The best use of radar is currently at large airports with air-traffic control towers; pilots there can be warned to delay a takeoff or landing while flocks of birds are passing through.

## 12.2 Specific Attractants and Hazardous Wildlife

Specific attractants within or near the general zone included:

- Brookings Sanitary Landfill—gulls.
- Gravel quarries east of Brookings—gulls and geese.
- Valero Ethanol Plant in Aurora—gulls.
- Roosting and resting areas (multiple locations)—gulls, waterfowl, herons, egrets.
- 4th Street water tower in Brookings—vultures.
- Nesting areas under bridges on and adjacent to Highway 14—cliff swallows.

The South Dakota Soybean Processors plant in Volga, SD, and the Brookings Wastewater Treatment Plant were both considered potential attractants, but were eliminated as significant attractants over the course of multiple visits by the author and after speaking with personnel at each location.

Golf courses, recycling centers, composting sites and other common wildlife attractants were not found to pose significant hazards. Retention ponds in the area, particularly those with islands or peninsulas suitable for nesting, do attract giant Canada geese. BKX has little direct control over the design or placement of these ponds, but can provide input to city and county engineers and zoning personnel. Some retention ponds are designed to also provide landscaping and are accessible to the public. For safety reasons, these ponds cannot be steep-

sided. On the other hand, ponds built for the sole purpose of holding storm water should be fenced and designed similar to those on airport property.

### 12.2.1 Gulls

The daily and seasonal movements of gulls were closely monitored during the WHA. Seven of the 17 recorded strikes at BKX involved gulls (Figure 4, Page 16). Gulls are unquestionably a hazard to aircraft at BKX, and aggressive action to eliminate or reduce the problem should be taken. Removing grain crops (and the associated tillage practices) will reduce the number of gulls attracted to the airport. Gulls attracted by safe resting areas (e.g. runways, taxiways and short grasses) must immediately be hazed away from airport property, including using lethal means when necessary, as is the current policy.

However, the primary concern noted was large numbers of gulls, primarily Franklin's gulls (*Leucophaeus pipixcan*) and ring-billed gulls (*Larus delawarensis*), flying through BKX airspace while traveling between the landfill and resting or roosting areas. Ring-billed gulls have a wingspan of four feet and weigh from one pound to over two pounds. Franklin's gulls are considerably smaller, with a wingspan under three feet and a weight of slightly over half a pound. However, Franklin's gulls have a tendency to fly in tighter flocks, making multiple hits in a strike situation more probable.

Neither the landfill nor the numerous roosting areas can reasonably be eliminated. To adequately determine the attractants and their synergistic effects, it was necessary to survey outside the general zone. Lesser attractants were also identified and surveyed.

Survey work was hampered due to several unusual flooding events in 2010 (note photo, left). Of greater importance is the probability that daily movements of wildlife were influenced by such events.

Gull movements were noticeably different in 2009 than in 2010, presumably in part due to the flooding events. In the fall of 2009, the primary gull roosting area was Lake Campbell. In 2010, gulls were noted in far lesser numbers on Lake Campbell, but used East Oakwood Lake and multiple locations in the Big Sioux River drainage as roosting areas.

Flooded pastureland was used extensively by gulls, primarily for resting and feeding areas (pictured right), but larger bodies of floodwaters were occasionally used for roosting sites as well.

The heaviest gull movements occurred shortly after sunrise and again just before sunset, but significant numbers were also often seen at other times of day. Gulls were noted feeding in agricultural fields when farming activities disturbed the soil, and also in flooded fields and pastures as the water receded. In both cases, food sources were readily available. This type of feeding activity was typical and widespread.

Two primary man-made food sources were noted: the Valero Ethanol Plant in Aurora and the Brookings Sanitary Landfill. The ethanol plant was mentioned by landfill personnel and others as a potential attractant for gulls. Survey work, including a tour of the plant, showed the problem was limited to days when distiller's grains were being loaded in waiting trucks. Gulls and other birds would forage for distiller's grains that had been inadvertently dumped on the ground. On most days, no gulls were seen at the plant, even when gull use was heavy at the nearby landfill. The maximum number seen at any one time was approximately 200 birds, except on one occasion discussed below. Ethanol plant personnel would like to get rid of the gulls because their flocking behavior occasionally interferes with truck drivers' vision. The author gave suggestions to the plant personnel to help alleviate the problem.

Hazards to aircraft from gulls using the ethanol plant were relatively minor in comparison to hazards from gulls using the landfill. Although gulls traveling directly between the plant and Lake Campbell were in the general zone, their height above ground level (AGL) was far lower than aircraft would be under normal conditions. Gulls traveling to the gravel quarries east of Brookings when en route to or from the plant appeared to take the same primary route to roosting areas as gulls using the landfill did. This path took them closer to BKX, where their altitude AGL was considerably closer to the altitude of aircraft landing or taking off.

However, gulls using the ethanol plant seemed to also use the landfill. In any case, the author did not consider the attractant of the ethanol plant to be a crucial source of hazardous gull movements through BKX airspace. If the ethanol plant did not exist, the gulls would simply use the landfill. In some cases, the attractant of the ethanol plant may have been beneficial by drawing gulls further from the flight paths of aircraft using BKX airspace.

The author followed or attempted to follow gulls on multiple occasions, and soon learned the birds did not always follow a straight line to their destination. On August 24, 2010, the author estimated at least 2500 gulls were at the landfill in the late afternoon, another 1000 were at the ethanol plant, and more than 500 were on a newly opened gravel pit just east of Brookings.

The author was later at Stationary Point #23 (the snow-drop location) on the north side of the airport just before sunset. Over the course of several minutes, several thousand gulls in loosely-knit flocks flew over BKX property at heights of roughly 10 to 100 feet. The gulls came from the east and most passed directly over Runway 12-30 before veering to the north. The author followed as they took a winding path to the northwest. The birds often changed direction for no apparent reason, and followed no obvious landmarks—such as the Big Sioux River—until they finally ended up at East Oakwood Lake.

The next afternoon, August 25, 2010, no gulls were noted at the ethanol plant and only 50 were at the landfill, but approximately 2000 were at two gravel quarries. Lake Campbell and areas along the Big Sioux River southeast of the airport were later used for roosting sites. Other than those two days, no major gull use of the gravel quarries was documented. Gulls were seldom seen on the quarries at all, and the highest number recorded either prior to or after August 24 and 25, 2010 was 150 gulls on September 14, 2009. Gulls were often noted flying over the water-filled gravel quarries without stopping. It is unknown if they preferred to fly over water, or were looking for food, or if the quarries were simply on the way to their destination.

The attraction of gulls to the Brookings Sanitary Landfill is indisputable (pictured right). According to survey work and interviews with landfill personnel, measurable numbers of gulls begin using the landfill in late March or early April of each year, but leave in May, presumably heading to nesting areas. Gulls return in late June and remain in the area—or they move on and other gulls move in—until the end of November. In 2009, gull numbers peaked in late October and early November,

with up to an estimated 4000 using the landfill. In 2010, gull numbers seemed to peak in September and October with up to 2500 noted before the WHA survey period ended. Numbers of several hundred or more were the norm, rather than a rarity. Again, flooding and alternate food sources may have served to spread the birds over a larger area, or alternatively, nesting success might have been lower in 2010.

The only option to reduce the gull hazards to aircraft is a robust and effective program to prevent gulls from using the landfill as a food source. Normal hazing methods without lethal control will not work at a location where food is easy to obtain. Gulls pay little attention to the bulldozers moving the garbage (pictured below) or to humans unloading pickups and trailers. Although gulls may spend a major portion of the day at the landfill, they can obtain all the food they need in a very few minutes. Exclusionary devices would interfere with the operation of the landfill; machinery must remain unobstructed by wires or netting. Habitat manipulation, including limiting water sources and growing tall grasses in potential resting areas, will help reduce resting and loafing sites. However, these changes will not totally solve the problem, as other resting and loafing sites are available nearby, and the primary attractant at the landfill is food. In some cases habitat manipulation would also interfere with the management of the landfill.

An effective deterrent program may require a person from sunrise to sunset to haze and use lethal means as needed to remove all gulls, whether feeding or resting. This would not necessarily require landfill personnel dedicated solely to gull control the entire season. Presumably the gulls would learn after one or two visits not to return. However, constant vigilance would be required, and when gulls returned or new gulls found the landfill, the hazing would need to resume immediately. This will not be easy or inexpensive to accomplish, but if gulls are allowed to use the landfill, a high degree of danger to aircraft will continue to exist. More drastic measures—such as moving the landfill or baling the garbage inside a building—may need to be considered.

### 12.2.2 Giant Canada Geese

The giant Canada goose (*Branta canadensis maxima*), a native to the Great Plains, was nearly extinct in the late 1940's. These geese do not migrate to northern tundra regions for the nesting season as do other goose species, but instead travel only as far north as the Great Plains region.

Remnant populations located in captive flocks were used to start restoration efforts in the Dakotas and elsewhere in the early 1960s. The restoration efforts were hugely successful. By 1998, the South Dakota Department of Game, Fish and Parks was no longer involved in the massive effort to expand breeding flocks of giant Canada geese, and now expends considerable time and money on the prevention of damage to agricultural crops. According to SD GF&P waterfowl biologist Paul Mammenga (personal communication March 2011) the 2010 spring population index for giant Canada geese in South Dakota was 163,326, with the most recent 3-year index showing an average of 143,208 giant Canada geese.

Hunting regulations have changed from closed seasons to special early seasons with liberal limits. In 2010, an additional August season was added in an attempt to kill even more geese, primarily to reduce crop depredation on private land. Giant Canada geese also cause conflicts with humans by posing health and safety hazards at parks, beaches, golf courses and airports.

Giant Canada geese are sometimes referred to as “elephants of the sky” by personnel involved in bird-strike prevention programs. The geese reach weights of 12 to 15 pounds, while snow geese are one-third to one-half the size, with a weight of 4 to 6 pounds.

Off-site surveys showed Canada geese used the gravel quarries east of Brookings from early spring through freeze-up in December. The quarries and surrounding landscape provide all their needs, including nesting and brood-rearing areas. Shallow waters with emergent vegetation, nesting islands, and peninsulas are adjacent to large areas of open, deep water. Food sources are abundant. (Note cover photo and photos on previous page and below.)

The most serious problem noted was heavy usage of at least one gravel quarry (the Bowes gravel quarry) by Canada geese after other area waters froze up, as pictured right and next page. Well over 1000 geese were documented on the quarry in December 2009. Daily movements of the geese to feed and later return to the water put birds into BKX airspace when the geese flew to the west and northwest.

Geese heading other directions were generally flying lower than aircraft would be at that distance from the airport. The staff of the Bowes gravel quarry may be willing to harass geese off the quarry when the water begins to freeze and the number of birds begins to build up. This possibility should be considered if the number of geese using any of the gravel pits reaches unacceptably high limits.

Other than times when Canada geese and other waterfowl used the quarries as staging areas during migration, as pictured above, geese using the gravel quarries were no more or no less numerous or dangerous to aircraft than geese from hundreds of other locations around the county.

Because giant Canada geese have adapted to so many habitats and are so numerous in eastern South Dakota, most wildlife hazard management must be accomplished at the airport. Removal of cropland, along with grass and wetland management, will greatly reduce the number of geese attracted to BKX.

However, the birds are attracted to highly variable habitat types, not all of which can be changed. Pictured above and right, respectively, are geese using the snow-dump area adjacent to Six Mile Creek and a different flock grazing on short, green grass beside Runway 17-35.

BKX has developed a zero-tolerance policy for giant Canada geese due to their proven danger to aircraft. The birds are immediately hazed from the area when seen, and lethal control should be used when necessary to effectively remove the geese.

*The importance of the zero tolerance policy for giant Canada geese on BKX property cannot be over-emphasized. Birds on adjacent private property should also be hazed, if allowed by the landowner.*

### 12.2.3 Vultures

Turkey vultures (*Cathartes aura*), with a weight of three to five pounds and a wingspan of approximately six feet, pose a major hazard to aircraft at BKX. Their low wing-loading ratio (ratio of body weight to wing area) enables them to soar effortlessly for hours on end. The vultures' flocking behavior and apparent lack of fear of aircraft all increase the hazard level. Vultures eat carrion—dead animals—which they find by sight or by smell.

BKX personnel do not allow food sources for vultures to remain on airport property. However, vultures are attracted to locations that provide updrafts— including large areas of cement and tarmac— making airport environments ideal for vultures.

Other raptors seem to be aware vultures are experts at finding thermal updrafts. The author observed a bald eagle (*Haliaeetus leucocephalus*) join a small flock (or kettle) of vultures circling the BKX airfield. The birds gradually gained altitude and moved west until they were out of sight. Vultures may soar to heights of several thousand feet.

Vultures were also noted sitting on short grass (pictured above near Runway 12-30) and hay bales on airport property. As many as sixty vultures were noted on one occasion.

The vultures also perched on fence posts just north of airport property, as pictured right. BKX has a zero-tolerance policy for turkey vultures, and a depredation permit to reinforce the harassment techniques.

The primary known turkey vulture roost in the Brookings area is the 4th Street water tower. The highest counts occurred on April 26, 2010, when 65 vultures were counted on the tower, and on July 8, 2010, when 59 vultures were noted. Vulture numbers during the WHA were high in April, dipped in May and June, and gradually increased in numbers until late September and early October, after which time the birds were gone for the winter.

At times, vultures used large weeping willow trees near Hillcrest Elementary School as well as other trees in the general vicinity of the water tower. The author observed vultures leave the water tower during late-night storm events, apparently moving to nearby trees, and begin to return before dawn. Vultures using other roosting sites would come to the tower in the morning and spend from several minutes to more than an hour before leaving for the day. After staging on the water tower, the vultures often left in a loosely grouped kettle.

The author believes if the vultures were not able to use the 4th Street water tower as a roosting and staging area (shown previous page and below), large flocks of vultures would be less likely to be attracted to the airport or occupy BKX airspace. The airport should encourage the Brookings Municipal Utilities Department to eliminate use of the tower by vultures; exclusionary techniques are relatively simple and inexpensive.

The Brookings Municipal Utilities Department placed a 10-foot section of narrow rebar approximately six inches above a railing on the water tower to test if vultures would continue to use the spot as a perching site. The rebar was rarely used. In the photo below, a vulture near the center on the top rail is perched on the rebar and is struggling to keep its balance. The vulture moved to better footing shortly after the photo was taken.

Taut lines (tight wires or cable stretched between beams or other anchoring points) or other devices placed to prevent vultures from sitting on ledges and/or spreading their wings properly would prevent most of them from using the tower.

Because vultures require a relatively wide platform to balance on, a strong fiberglass, metal or wooden dowel less than an inch in diameter and projecting about a foot above the larger-diameter pipes or posts would prevent their use as perching sites. The foremost unknown factor is where the vultures will go if their primary roosting and staging location is eliminated. If no

other site becomes as attractive as the 4th Street water tower, the birds will probably disperse in smaller groups when leaving the new roosts (whatever they may be), and may even move out of town. Still, while unlikely, the vulture problem could conceivably increase at BKX if the birds are forced to roost elsewhere. For this reason, changes to the tower should be reversible.

### 12.2.4 Cliff Swallows

Cliff swallows (*Petrochelidon pyrrhonota*) are small birds that would ordinarily not be cause for concern. However, a strike with multiple birds of any size is potentially a problem. Cliff swallows nest in large colonies under bridges near BKX, and are attracted to the airport where they fly in tight flocks over the runways in search of insects in adjacent hayfields. The swallows also use the runways and taxiways as resting areas as pictured below left. Many of the birds are young-of-the-year, and have not yet learned to avoid aircraft. Based on the number of dead swallows found on the highways near the bridges, juvenile birds are not adept at avoiding vehicular traffic, either.

Several bridges on Highway 14 and at least one on an adjacent county road are located and designed in a manner to provide ideal homes to cliff swallows in close proximately to the airport. Their nests (pictured next page) are built primarily of mud, which is readily available at the building sites.

BKX should encourage the appropriate Department of Transportation (DOT) agency to install nesting barriers under the bridges. In addition to being an airport safety issue, the nests are also a bridge safety issue. Many seams cannot currently be inspected for cracks or damages due to the nests, and nesting activities may weaken certain structures.

A piece of plexiglass or other slick material placed at an angle where the nests are located will reduce or eliminate nesting (Hygnstrom et. al. 1994: see the Section on cliff swallows at http://icwdm.org/handbook/birds/bir_e121.pdf ). Netting would also work, but would require considerably more maintenance. Exclusionary devices must allow inspection of the bridges by DOT personnel, and work cannot be done while nesting is in progress without special permits.

Cliff swallow attractants can be reduced at BKX with the use of insecticides applied by a certified pesticide applicator to reduce bird attractants. Label directions must be followed; haying may need to be delayed after insecticide application, depending on the insecticide used and the intended use for the hay. Dairy cattle, for example, cannot be fed hay recently treated with some pesticides.

Cliff swallows have been involved in at least two reported strikes at BKX (Figure 4, Page 16), and perhaps as many as five. A depredation permit was obtained for cliff swallows in 2010, as hazing and scare techniques alone were not effective.

### 12.2.5 Common Crows

Common crows (*Corvus brachyrhynchos*) are a moderate- to- occasionally-high hazard at BKX. They are one of the larger of the passerines (perching birds), with a three-foot wingspan and weight of about one pound. Crows were noted in all months during the WHA, and at all but three of the 24 stationary survey points. The maximum number seen was approximately 60 on September 24, 2010 (pictured above). The crows were passing directly through the flight path of aircraft using Runway 12-30. Most flocks of crows were

seen on the south end of the airport, closer to private property with trees used for roosting and nesting.

Crows were attracted to mowed grass, the living snow fence shrub rows, grain fields and water sources on BKX.

However, many crows simply pass through BKX airspace. These birds use a wide variety of food sources, ranging from crops to road-killed animals. Crows were often noted foraging in open dumpsters adjacent to the airport (pictured above and below), as were starlings and other wildlife.

*BKX should encourage neighbors to ensure that dumpsters and junk piles do not attract hazardous wildlife such as crows, starlings and other scavengers. Most people and businesses will cooperate fully to reduce wildlife attractants if they are made aware of the problem.*

On BKX property, crows should be harassed whenever seen and shot if possible. Lethal means will be required as crows are among the most intelligent of birds and will habituate rapidly to simple scare tactics. A combination of hazing and lethal control will ensure the birds learn the airport is an inhospitable environment.

Constant vigilance on the part of BKX personnel is required, as additional birds will enter the population after hazing or lethal control, and not all attractants can be eliminated.

## 13. Conclusion

The Brookings Regional Airport is an important asset to the community and critical to the success of the South Dakota State University Aviation Program. The airport does not currently have commercial service, but has maintained its Part 139 Class 4 Airport Certification Status. This Wildlife Hazard Assessment is a requirement for maintaining that certification status.

The WHA identified several areas of concern, but none that are insurmountable or particularly unusual. Recommendations to reduce or eliminate wildlife hazards to aircraft are given throughout the report and summarized immediately following this conclusion. Several of the more important recommendations have largely been completed, or the changes are in the planning process. To date, the installation of a 10-foot fence around the entire perimeter of the AOA has been completed; plans are being made to remove the biosolids drying beds and move the flow equalization basins; and BKX personnel are doing an excellent job of using wildlife hazard management techniques and keeping good strike records.

In addition, an Environmental Assessment is nearly complete. The EA, while developed independently of the WHA for the purposes of runway realignment, will facilitate wetland manipulation to simplify and improve wildlife hazard management.

While many recommendations are made in this WHA, no procedure or combination of procedures will remove all wildlife hazards from an airport. Wildlife management is a complex science, and it is not always possible to predict the entire array of consequences of any particular management action. Too many variables and too many interactions between species exist to precisely predict the final outcome of any strategy. In addition, by definition wildlife is free to move about at will.

Some of the recommendations from this WHA will almost certainly result in an increase in the number of some species of wildlife. For example, removing the cropland and increasing the amount of hay ground will significantly improve habitat for nesting ducks and pheasants. However, a few nesting hens with their chicks are far preferable to flocks of giant Canada geese, mallards, and pheasants crossing the runways multiple times on their way to and from the cropland. If all the recommendations are implemented, native grassland species of birds such as bobolinks and meadowlarks will increase, but large flocks of hundreds or even thousands of blackbirds attracted to crops and wetlands will decrease. Again, a few scattered birds are preferable to huge flocks.

Removing raccoons, fox, skunks and badgers from airport property will surely reduce the probability of an aircraft hitting one of these mammals on landing or takeoff. However, in the absence of other control actions, rodent numbers may increase in response to reduced

predation. This could increase the probability of an airplane strike with raptors attracted to a flourishing rodent population.

Airport personnel should be willing to experiment with new techniques to reduce the quantity of animals that continue to pose a problem. The solution to reducing the hazard level from insect-eating birds could be as simple as occasionally using an insecticide to spray a wide strip of grass along each side and at the end of the runways and taxiways. Reducing insect numbers will certainly reduce the number and species of insectivorous birds using the areas, and may in time influence the types of vegetation growing in the sprayed areas. A change in vegetation will mean a change in wildlife species using the area, possibly reducing wildlife hazards, but also potentially increasing problems. Monitoring must be done to definitively assess the effects of any management action, and to become aware of unintended consequences. For every action, there may be an unknown and unpredictable reaction.

Finally, many wildlife species readily adapt to a variety of environmental conditions, and some individuals of a species do not always react the same as other individuals. We too must be adaptable and amenable to new management techniques if we are to be successful in our endeavors to control wildlife hazards at the Brookings Regional Airport.

# 2010 Brookings Regional Airport Wildlife Hazard Assessment
# Synopsis of Wildlife Hazard Management Recommendations

**Please note additional information and justification for each of these recommendations are given elsewhere in this report.**

**1) Perimeter Fencing**

Work has been completed on the FAA recommendation to increase the perimeter fence to a height of ten feet (primarily to exclude deer). However, maintenance of the fence is as critical as is the installation. Older sections of the fence are currently in need of repairs, and the entire perimeter of the fence should be inspected frequently for breeches or damage. This requires a useable trail or path, free of obstructions. Simply mowing a path on the inside of the perimeter fence would suffice in most areas of BKX. In some cases the terrain or weather may dictate the use of an all-terrain vehicle or snowmobile. Ideally, the trail should allow travel when needed with a pickup or tractor to transport equipment necessary for repairs and maintenance.

All vegetation within a foot of the fence, including grass, should be eliminated by chemical means as needed. The vegetation hides breeches, damages the fence, and provides safe travel lanes for wildlife.

Unattended gates need to be closed immediately after use.

**2) Interior Fencing**

One section of interior barbed-wire fence exists on the west side of the airport. This fence provides a safe travel lane for wildlife, perching sites for a variety of birds, and habitat for mice, shrews and voles. In addition, the fence line produces an edge effect, which attracts many species of wildlife. The fence is dilapidated, serves no useful function, and interferes with airport maintenance and farming operations. The fence is scheduled to be removed.

**3) Living Snow Fence**

The living snow fence consists of a number of shrub rows on the south side of the airport property. The shrubs were planted to provide protection from excessive snow drifting onto West 8$^{th}$ Street South.

Survey work showed the shrub rows are being used by a wide variety of birds and mammals. The shrubs provide nesting sites, food sources, safe travel lanes, and resting and roosting areas. Wildlife in the shrub rows generally presented very little direct danger to aircraft. Flocking birds (primarily blackbirds and starlings), crows, and larger mammals traveling to

and from the shrub rows do present a danger, as do the raptors that were frequently seen hunting the area.

For the singular purpose of wildlife hazard management, the shrubs should be removed and the area returned to grassland. Temporary snow fence or even a permanent solid fence—if designed to reduce perching sites and maintained to control vegetation at the base—is a preferred alternative to the shrub rows.

However, the attractant of the living snow fence could be reduced to acceptable levels by implementing a management plan. Work already completed has demonstrated positive effects. The installation of the ten-foot perimeter fence should reduce the number of certain species of mammals using the shrub rows. Trapping efforts to reduce the number of ground squirrels, along with the removal of preferred raptor perching sites (large cottonwoods) to the west, reduced the number of hawks hunting the shrub rows. Attractants immediately adjacent to the shrub rows were identified and can be reduced or eliminated.

The management plan would require periodic pruning of the shrub rows to keep the plants reasonably short and to allow mowing closer to the base. The grass could also be mowed further to the north of the shrubs to reduce the edge effect created by the combination of short grass, tall grass and shrubs immediately adjacent to each other. Attractants near the shrub rows should be removed or excluded, and the perimeter fence near the shrub rows must be closely monitored for breeches. In addition, the shrub rows should continue to be monitored for the presence of hazardous wildlife.

**4) Wetland Management**

Wetlands and the associated vegetation at BKX provide all or some of the needs of nearly every hazardous wildlife species on the airport, either directly or indirectly. All wetlands should be removed from airport property to the greatest extent feasible, whether by draining, filling or both. When wetland removal is not practical, vegetation control and wildlife control techniques must be employed. In many cases, wetland removal must be mitigated by the creation of wetlands elsewhere. Mitigation should occur outside the separation criteria established by the FAA. Wetlands off airport property but within the separation criteria should be monitored for the presence of hazardous wildlife, and appropriate actions taken.

<u>Wetlands: Biosolids Drying Beds and Flow Equalization Basins</u>

The two biosolids drying beds are incompatible with wildlife hazard management at BKX and should be removed. The flow equalization basins (EQ basins) should also be removed, but circumstances may require the basins to remain on BKX property. If a lack of suitable sites to relocate the EQ basins and the infrastructure already in place makes moving them impractical or unrealistic, steps must be taken to reduce the attractiveness of the basins to hazardous wildlife.

Moving the EQ basins further from the runways, redesigning them to drain quickly and to reduce vegetative growth, and using wildlife exclusion methods and harassment techniques can reduce the wildlife attractant to acceptable levels. AC 150/5200-33B recommends that detention ponds, such as the EQ basins, be steep-sided, narrow, linear in shape, riprap lined, and designed to drain within 48 hours.

Wetlands: Drainages

Drainage on the airport is poor in general, at least when rainfall is abnormally high, as it was in 2010. The drainage ditches in particular hold up to four feet of water year-round in some places, are choked with cattails, rushes, and other vegetation, and are used extensively by a large number and variety of wildlife species.

Ideally, water should be moved underground. Where that option is not feasible, drainages should be sloped and graded to allow for rapid and complete removal of water and for control of vegetation by haying or mowing. Until this can be accomplished, vegetation in the ditches needs to be controlled by other means.

Placing grids over the entrances of culverts in drainage ditches will reduce or eliminate their use by wildlife as escape cover, den sites, and safe passageways. Grids placed on culverts in the perimeter fence line will also reduce ingress onto BKX property. However, grids must be designed to allow easy maintenance, or they can become clogged and cause water to back up. Culverts away from aircraft movement areas and the perimeter fence can be left open to intentionally lure mammals for ease of trapping.

Wetlands: Six Mile Creek

Six Mile Creek is an important waterway. The creek helps alleviate flooding in the area, and is home to the federally listed endangered Topeka shiner and possibly the state-listed threatened northern river otter. Options are limited, but the creek can be altered to remove large areas of open water and reduce heavy vegetation both in and adjacent to the stream. A narrow channel with steep, riprapped slopes, no vegetation, and fast-flowing water is one preferred alternative for the creek. However, simply managing the vegetation to remove wildlife attractants and to allow for easier monitoring of wildlife populations would be a significant improvement.

### 5) Grain Crops and Hay Land

All grain crops should be removed from airport property. The crops are second only to water sources in attracting hazardous wildlife. Hay is also considered a crop under AC 150/5200-33B, but if the AOA separation criteria are met, hay is a preferable alternative to grain crops.

Because reducing diversity is a key to reducing wildlife, any new plantings should be limited to one or two species of grass, with no forbs (e.g. alfalfa). All hay crops, including existing stands, should be managed to reduce forbs and weedy growth.

Timely removal of hay bales is important. Hay bales and bale stacks make excellent homes for many species of wildlife and provide perching sites for raptors, vultures and other hazardous birds. In addition, the bales pose a hazard if an aircraft accidently leaves the tarmac. Finally, the grass is killed if hay bales are left on an area for too long. Weeds then become a problem, and in some cases grass must be replanted. In either situation, edge effect is created.

**6) Mowed Areas**

Mowed areas should be managed to maintain grass at heights of 6" to 14", depending on the season and location. Grass shorter than 6" attracts small flocking birds (e.g. blackbirds and starlings) and Canada geese. However, taller grass and/or infrequent mowing can encourage nesting activity by some hazardous species, including waterfowl and pheasants. A mowing regimen should be determined by airport personnel familiar with the area and local wildlife populations and movements.

**7) Weed Control and Biodiversity**

BKX should increase the use of chemical spray to control weeds and reduce biodiversity. For the purposes of the WHA, a weed is defined as any plant not intentionally grown in a particular location. Three of the seven state-listed noxious weed species were documented during the WHA on BKX property, including Canada thistle (*Cirsium arvense*), yellow toadflax (*Linaria vulgaris*), and perennial sow thistle (*Sonchus arvensis*). Leafy spurge (*Euphorbia esula*) was noted on private land immediately adjacent to the airport and is likely to spread to BKX property. State law requires noxious weeds to be controlled. In addition to the noxious weeds, numerous other deleterious plant species were noted.

Over 150 species of plants were documented on airport property. Airport personnel should strive to bring the plant community as close to a monoculture as is reasonably possible. An aggressive program of weed control on airport grounds will reduce vegetative diversity and wildlife habitat, and help maintain good relationships with the neighbors.

Contracts with farming cooperators should require them to be responsible for weed control on their haying units, in part because the airport has no control over how the hay is used. Chemicals necessary to adequately control particularly tenacious weeds may require specific periods of time before the grass can be cut and fed to certain animals (e.g. dairy cattle or livestock ready for slaughter).

## 8) Wildlife Hazards and Attractants Currently Requiring Special Attention

Deer

White-tailed deer were a serious concern during the WHA. However, the installation of deer-proof perimeter fencing was nearly completed in 2010 (with only a small amount of work to be finished on gates remaining). Deer should no longer be a major concern if the fence is monitored for breeches or damage, gates are kept closed, and airport personnel are continually alert for the presence of deer—fences are rarely totally deer-proof. Recommended habitat changes at BKX would also help airport personnel notice and remove any deer that do make it past the fence.

Small- to Medium- Sized Mammals

BKX personnel should continue their work to remove ground squirrels, rabbits and other mammals from airport property. While small mammals are rarely a direct threat to aircraft, their burrowing activities can damage underground wiring essential to airport operations and leave holes and mounds of dirt, which could damage any aircraft that might leave the tarmac. In addition, small mammals attract hazardous wildlife to the airport (e.g. owls, raptors and mammalian carnivores).

Gulls

A great deal of time was spent on gull hazards during the WHA. Gulls are unquestionably a hazard to aircraft at BKX, and aggressive action to eliminate or reduce the problem should be taken. Removing grain crops (and the associated tillage practices) will reduce the number of gulls attracted to the airport. Gulls attracted by safe resting areas (e.g. runways, taxiways and short grasses) must immediately be hazed away from airport property, as is the current policy. For hazing to be effective, it is often necessary to kill a few gulls.

However, the primary concern noted was large numbers of gulls flying through BKX airspace while traveling between the Brookings Sanitary Landfill and resting or roosting areas. Neither the landfill nor the multiple roosting areas can reasonably be eliminated. The only option to reduce the gull hazards to aircraft is a robust and effective program by the landfill staff to prevent gulls from using the landfill as a food source. BKX should encourage the Brookings Sanitary Landfill management to help reduce hazards to aircraft by preventing gulls from using the landfill.

Vultures

Turkey vultures are a major hazard at BKX. Their size, flocking behavior, and apparent lack of fear of aircraft all increase the hazard level. BKX personnel do not allow food sources for vultures (i.e. dead animals) to remain on airport property. However, vultures are attracted to areas that provide updrafts, including large areas of tarmac. They also occasionally sit on short grass and hay bales on airport property. BKX has a zero-tolerance policy for the birds, and a depredation permit to reinforce the harassment techniques.

The author believes if the vultures were not able to use the 4th Street water tower as a roosting and staging area, large flocks of vultures would be less likely to be attracted to the airport or to occupy BKX airspace. The airport should encourage the Brookings Municipal Utilities Department to eliminate use of the tower by vultures. Exclusion techniques are relatively simple and inexpensive. The foremost unknown factor is where the vultures will go if their primary roosting location is eliminated. While unlikely, the vulture problem could conceivably increase at BKX if the birds are forced to roost elsewhere. For this reason, changes to the tower should be reversible.

Giant Canada Geese

The numbers of giant Canada geese have increased greatly in the past few decades; the SD Department of Game, Fish and Parks has added two special hunting seasons specifically to reduce goose numbers to prevent damage to farmers' crops. Giant Canada geese can weight over 15 pounds, so a very high percentage of goose—aircraft collisions cause damage, injury and sometimes death.

Removal of crops from BKX, and grassland and wetland management will greatly reduce the number of geese attracted to the area. Any geese on BKX should be harassed or killed. Geese must not be allowed to nest in any area under the control of BKX.

Canada goose nests were located in dozens of locations in the general zone. Several gravel quarries east of Brookings provide nesting, brood rearing, loafing and staging habitat for Canada geese and a small number of other waterfowl from spring until winter. However, no major hazards were noted until freeze-up. The Bowes gravel quarry was one of the last bodies of water in the area to freeze in 2009, and over a thousand geese congregated on the quarry during the first part of December. Geese feeding to the north and west flew through BKX air space and occasionally over the airport itself. BKX should encourage the Bowes' staff to harass the geese from the quarries if and when concentrations reach high levels.

Cliff Swallows

Cliff swallows are small birds that would ordinarily not be cause for concern. However, a strike with multiple birds of any size is potentially a problem. Cliff swallows nest in large colonies under bridges near BKX, and are attracted to the airport, where they fly in tight flocks over the runways in search of insects in adjacent hayfields. The swallows also use the runways and taxiways as resting areas. Many of the birds are young-of-the-year, and have not yet learned to avoid aircraft. Based on the number of dead swallows found on the highways near the bridges, juvenile birds are not adept at avoiding vehicular traffic, either.

BKX should encourage the appropriate Department of Transportation (DOT) agency to install nesting barriers under the bridges. A simple piece of plexiglass placed at an angle where the nests are located will reduce or eliminate nesting. Netting would also work, but is expensive and would require considerably more maintenance.

Insecticides can be applied at BKX by a certified pesticide applicator to reduce bird attractants. Label directions must be followed; haying may need to be delayed after pesticide application, depending on the insecticide used and the intended use for the hay.

Crows

BKX should encourage neighbors to ensure that dumpsters and junk piles do not attract hazardous wildlife such as crows and other scavengers. Most people and businesses will cooperate fully to reduce wildlife attractants if they are aware of the problem.

### 9) Planning and Zoning Decisions

BKX should be proactive in planning and zoning decisions that affect the airport, including the locations of landfills, recycling centers, mitigation wetlands, water treatment facilities, livestock feeding operations, and other land uses which could attract hazardous wildlife into BKX flight zones.

BKX management must maintain close contact with city and county officials concerning planning and zoning decisions that might affect the airport, whether wildlife-related or not. These officials may be invited to participate in Wildlife Hazards Working Group meetings.

### 10) Interaction with other Governmental Agencies

BKX should work with other departments of the City of Brookings and with county, state, and federal agencies as needed to reduce wildlife attractants in the area. For example, the trees and shrubs planted by the Brookings Parks, Recreation and Forestry Department on airport property south of West 8$^{th}$ Street South are not currently a significant wildlife attractant. In time, many of the taller-growing trees may grow higher than allowable in the Runway Protection Zone, and trees and shrubs could become prime roosting and perching locations for hazardous birds. The trees and shrubs must be monitored, and some may need to be removed.

An example of where BKX might cooperate with other agencies to their mutual benefit is the former tree nursery site on the north side of the airport, adjacent to the West 10$^{th}$ Street snow-drop location. Although the site is highly attractive to a large number of wildlife species, the perimeter fence prevents most wildlife species other than birds from becoming a hazard to aircraft. The area could conceivably be used as a dog park or other recreational opportunity to benefit the public, while making the site less attractive to hazardous wildlife.

### 11) Documenting Wildlife Strikes

BKX must continue documenting wildlife strikes by using the proper reporting techniques, including using FAA Form 5200-7, *Bird/Other Wildlife Strike Report*, and by positively identifying the species involved in the strikes. Fixed-base operators and SDSU personnel should be reminded periodically of the need and means for reporting strikes. Complete and accurate data are vitally important when making management decisions.

**12) The Wildlife Hazard Management Plan and Wildlife Hazards Working Group**

The FAA Administrator may determine a Wildlife Hazard Management Plan is needed after considering a variety of factors, including the findings of the WHA, aircraft usage at the airport, and views of the airport operator and airport users.

If determined to be necessary, BKX should develop and implement a Wildlife Hazard Management Plan (WHMP) as prescribed by 14 CFR 139.337. The manual *Wildlife Hazard Management at Airports* outlines the requirements of a WHMP and gives suggestions on how best to implement the plan (Cleary and Dolbeer 2005).

The plan should be reviewed at least annually by a Wildlife Hazards Working Group (WHWG). The WHWG is a committee consisting of personnel integral to the mitigation of wildlife hazards at the airport. The group is responsible for reviewing the WHMP, making recommendations for changes to the plan, and tracking the progress made on completing the recommendations of the WHA.

**13) Equipment, Personnel and Training**

BKX must provide the necessary personnel, training, permits and equipment to effectively monitor and reduce wildlife hazards to aircraft. BKX personnel should have access to the variety of equipment needed for the variety of circumstances they will encounter. This should include equipment and chemicals for vegetation management. BKX personnel must also have the appropriate training, licenses and permits to engage in wildlife control activities.

Wildlife hazard training could also be provided to the South Dakota State University aviation program.

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## Internet Resources

*Wildlife Hazard Management at Airports, A Manual for Airport Personnel*:
http://wildlife.pr.erau.edu/EnglishManual/2005_FAA_Manual_complete.pdf

FAA Wildlife Hazard Mitigation Homepage:
http://wildlife.pr.erau.edu/index.html

Birdstrike Committee USA:
http://www.birdstrike.org

FAA's Wildlife Strikes to Civil Aircraft in the United States, 1990-2008 Report:
http://wildlife-mitigation.tc.faa.gov/wildlife/downloads/BASH90-08.pdf

Internet Center for Wildlife Damage Management (Prevention and Control of Wildlife Damage):
http://icwdm.org/ In re: cliff swallows http://icwdm.org/handbook/birds/bir_e121.pdf

*Wildlife Hazard Management at Airports, A Manual for Airport Personnel*:
http://wildlife.pr.erau.edu/EnglishManual/2005_FAA_Manual_complete.pdf

Wildlife Hazard Mitigation Requirements and Programs:
http://www.faa.gov/airports_airtraffic/airports/regional_guidance/central/airport_safety/part139/best_practice/wildlife/

FAA, Siting Criteria for Ground Based Augmentation System (GBAS), Order 6884.1:
http://www.faa.gov/documentLibrary/media/Order/6884_1.pdf

Memorandum of Agreement between Federal Agencies:
http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/birdstrikes.pdf

South Dakota Game, Fish and Parks Administrative Rules:
http://legis.state.sd.us/rules/DisplayRule.aspx?Rule=41

South Dakota Codified Laws:
http://legis.state.sd.us/statutes/TitleList.aspx

South Dakota Game, Fish and Parks Home Page:
http://www.sdgfp.info/

U.S. Fish & Wildlife Service Services, South Dakota Field Office:
(Includes data on threatened and endangered species.)
http://www.fws.gov/southdakotafieldoffice/

*Dugouts and Stream Fishes, Especially the Endangered Topeka Shiner*:
http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=29141.wba

*The Topeka Shiner and Six Mile Creek*, Farm and Home Research Publication, SDSU:
ftp://ftp-fc.sc.egov.usda.gov/WHMI/WEB/pdf/Products/TopekaShiner.pdf

*Wake-up Call from the Topeka Shiner*, Farm and Home Research Publication, SDSU:
ftp://ftp-fc.sc.egov.usda.gov/WHMI/WEB/pdf/Products/TopekaShiner.pdf

NOAH 1998 Aerial Photo of BKX:
http://www.ngs.noaa.gov/AERO/ASPphoto/1S0R9347.JPG

Aerial Photos of Major United States Airports:
http://www.ngs.noaa.gov/AERO/ASPphoto/aspphoto.html

Natural Resource Conservation Service's Web Soil Survey Page:
(Provides the ability to navigate to a location of interest and generate a survey.)
http://websoilsurvey.nrcs.usda.gov/app/

Qualified Airport Biologists Listing:
http://wildlife.pr.erau.edu/workshop/qualified_biologists.html

## Advisory Circulars and CertAlerts:

Search for any Advisory Circular by Number or Key words:
http://www.faa.gov/airports/resources/advisory_circulars/

AC 150/5200-32A, Reporting Wildlife Aircraft Strikes:
http://www.faa.gov/documentLibrary/media/advisory_circular/150-5200-32A/150_5200_32A.pdf

AC 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports:
http://www.faa.gov/documentLibrary/media/advisory_circular/150-5200-33B/150_5200_33b.pdf

AC 150/5200-34A, Construction or Establishment of Landfills Near Public Airports:
http://www.faa.gov/documentLibrary/media/advisory_circular/150-5200-34A/150_5200_34a.pdf

AC 150/5300 Airport Design:
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AC 150/5200-36, Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports:
http://www.faa.gov/documentLibrary/media/advisory_circular/150-5200-36/150_5200_36.pdf

Certalert No. 98-05: Grasses Attractive to Hazardous Wildlife:
http://www.faa.gov/airports/airport_safety/certalerts/media/cert9805.pdf

CertAlert 06-07, Deer Hazard to Aircraft and Deer Fencing:
http://www.faa.gov/airports/airport_safety/certalerts/media/cert0416.rtf

CertAlert 09-10, Wildlife Hazard Assessments in Accordance with Part 139 Requirements:
http://wildlife.pr.erau.edu/general/cert0910.pdf

CertAlert 10-01, Interpretation of the term "consecutive calendar months" as used in part 139, Certification of Airports. For Airport Operators & FAA Airport Certification Safety Inspectors:
http://www.faa.gov/airports/airport_safety/certalerts/media/cert1001.pdf

Please note the online locations of these sites may change from time the time. The author has no control over the changes.

# Appendices

# Appendices


| | |
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# Appendix 1:

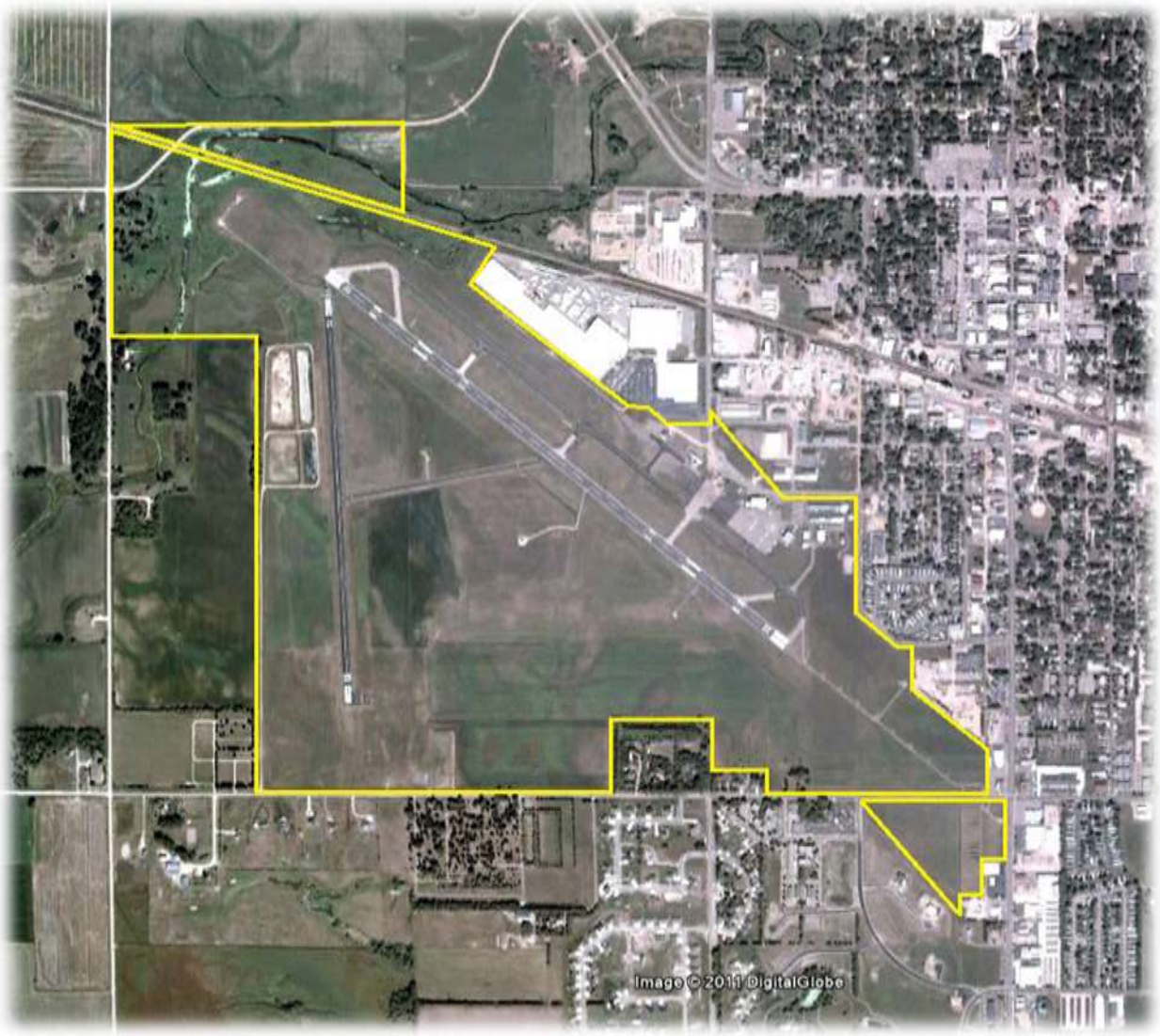
## Acronyms

| *Acronyms Used* | |
|---|---|
| AC | Advisory Circular |
| AGL | Above Ground Level |
| AOA | Airport Operations Area |
| BGEPA | Bald and Golden Eagle Protection Act |
| BKX | Brookings Regional Airport |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| DOD | U.S. Department of Defense |
| DOT | Department of Transportation |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| ESA | Endangered Species Act |
| EPA | Environmental Protection Agency |
| FAA | Federal Aviation Administration |
| FBO(s) | Fixed-Base Operator(s) |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| FOD | Foreign Object Debris |
| MBTA | Migratory Bird Treaty Act |
| MOU | Memorandum of Understanding |
| NASDAC | National Aviation Safety Data Analysis Center |
| NWI | National Wetlands Inventory |
| NOTAM | Notice to Airmen |
| RPZ(s) | Runway Protection Zone(s) |
| SD GF&P | South Dakota Department of Game, Fish, and Parks |
| SDSU | South Dakota State University |
| SWANCC | Solid Waste Agency of Northern Cook County |
| USCOE | U.S. Corps of Engineers |
| USDA | U.S. Department of Agriculture |
| USFWS | U.S. Fish and Wildlife Service |
| WHA | Wildlife Hazard Assessment |
| WHMP | Wildlife Hazard Management Plan |
| WHWG | Wildlife Hazard Working Group |
| WS | Wildlife Services (USDA) |

# Appendix 2:

## Brookings Regional Airport Boundary Lines

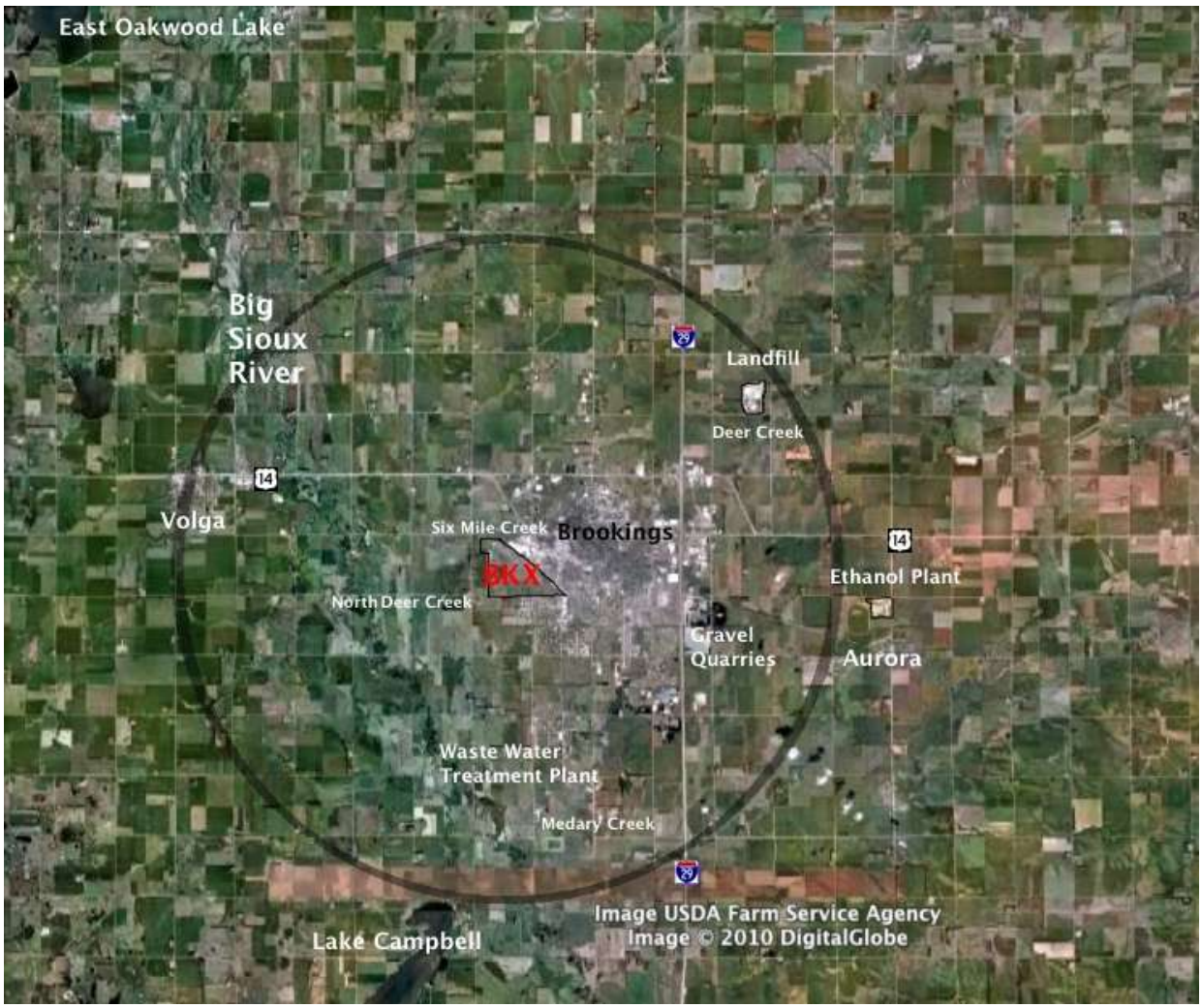
# Brookings Regional Airport Boundary Lines



# Appendix 3:

## General Zone, Brookings Regional Airport

## General Zone, Brookings Regional Airport



# Appendix 4:

## Map and Description of BKX On-Site Survey Area

# Stationary Observation Points

2010 BKX Wildlife Hazard Assessment

Brookings, SD

Brookings Regional Airport

# Brookings Regional Airport 2010 Wildlife Hazard Assessment
# On-Site Observation Points

| Area Covered | Location | Altitude (ft) | Habitat |
|---|---|---|---|
| Stationary Point #1:<br>SSW of office on access road adjacent to TW (taxiway) A. | N: 44° 18.303'<br>W: 96° 48.654' | 1634 ' | Overview of airport. Tarmac, mowed areas. |
| Stationary Point #2:<br>East hangers and buildings | N: 44° 18.214'<br>W: 96° 48.249' | 1624' | Buildings, short grass, tarmac. |
| Stationary Point #3:<br>At hold-short line for RW 30-12 | N: 44° 18.086'<br>W: 96° 48.339' | 1646' | End of 30-12. Edge of tarmac, hay field (heavy in clover/forbs), Mowed areas. |
| Stationary Point #4:<br>100 feet east of 3-bar lights on access road to white shed. | N: 44° 17.962'<br>W: 96° 48.164' | 1632' | Access road, hay both sides, forbs east, more grasses west. Drainage heavy in wet times. |
| Stationary Point #5:<br>SE corner near Pheasant Lounge check 30-12 RPZ | N: 44° 17.845'<br>W: 96° 47.987' | 1661' | Juxtaposition of commercial zone, mowed grass, shrub rows. Parks setting and cropland south. |
| Stationary Point #6:<br>Corner by nursery trees- check 30-12 RPZ | N: 44° 17.844'<br>W: 96° 48.324' | 1651' | Shrub rows, tall trees west, mowed grass and hay land. Cropland northwest. Tree nursery, small trees and mowed grass. |
| Stationary Point #7:<br>Near ILS antennae | N: 44° 18.096'<br>W: 96° 48.595' | 1632' | Mowed grass, tarmac, hay land, drainage ditch. |
| Stationary Point #8:<br>VOR road at drainage facing NE | N: 44° 18.235'<br>W: 96° 48.792' | 1623' | Mowed grass, tarmac, hay land, drainage ditch. |
| Stationary Point # 9:<br>AWOS Tower area & TW-B | N: 44° 18.281'<br>W: 96° 49.097' | 1619' | Mowed grass, tarmac, hay land, drainage ditch. |
| Stationary Point #10<br>17-35 at hold short line on Taxiway B | N: 44° 18.260'<br>W: 96° 49.246' | 1649' | Tarmac, croplands south and west, hay land north. Ponds to north west. |
| Stationary Point #11:<br>35 at hold short line/turn around on south end.<br>Check 35-17 RPZ | N: 44° 17.966'<br>W: 96° 49.221' | 1644' | Tarmac, hay land, heavy alfalfa. |
| Stationary Point #12<br>Property line corner at hay stacking site (NW of Greenwood Catholic Cemetery) | N: 44° 17.83'<br>W: 96° 49.121' | 1664' | Cropland, hay land, heavy alfalfa. Influence of trees in cemetery. |
| Stationary Point #13:<br>BKX gate by Lutheran Cemetery | N: 44° 17.959'<br>W: 96° 49.432' | 1643' | Cropland, hay land, heavy alfalfa. Influence of mowed grass and tall trees in cemetery. |
| Stationary Point #14:<br>Center of ponds facing runway | N: 44° 18.354'<br>W: 96° 49.360' | 1613' | Ponds-biosolids drying beds east, equalization basins west. Tall trees and cropland land outside fence. Gravel roads (grit). Heavy cover north/northwest. Runway 17-35 east. Large variety of habitat types. |

# Brookings Regional Airport 2010 Wildlife Hazard Assessment
# On-Site Observation Points (Continued)

| | | | |
|---|---|---|---|
| Stationary Point #15:<br>Localizer Road near building | N: 44° 18.650'<br>W: 96° 49.509' | 1600' | Heavy cover west and north, also Six Mile Creek. Mowed grass southeast. |
| Stationary Point #16:<br>Taxiway A @ A4/30-12 sign, near north end of runways. Face and include wetland. | N: 44° 18.568'<br>W: 96° 49.158' | 1612' | Tarmac, short grass, hay land, Wetland 7. |
| Stationary Point #17:<br>Crystal Ridge Circle at east end Check 30-12 RPZ | N: 44° 17.639'<br>W: 96° 48.087' | 1655' | Residential area. Still quite open. |
| Stationary Point #18:<br>North of Pitts' house by fence on west side of West 16th Ave. | N: 44° 18.559'<br>W: 96° 48.743' | 1600' | Tall trees west in pasture, jungle to east: wet area with shrubs, immature trees, tall grasses. Gravel road. Susceptible to flooding. |
| Stationary Point #19:<br>West on west 6th Street to end of airport property, face east at midpoint to intersection. | N: 44° 18.704'<br>W: 96° 49.904' | 1597' | Tall grass north, pasture south, gravel road. All low areas susceptible to flooding. |
| Stationary Point #20:<br>South side of railroad on 16th Avenue West. | N: 44° 18.786'<br>W: 96° 49.745' | 0p1598' | RR track, gravel road, tall grass south, pasture and cropland north. Lots of willows in ditch. All low areas susceptible to flooding. |
| Stationary point #21:<br>West side of railroad track on West 10th Street, 12-30 RPZ | N: 44° 18.764'<br>W: 96° 49.614' | 1596' | RR track, gravel road, Six Mile Creek to south, wetland vegetation. Tall grass south, pasture north. All low areas susceptible to flooding. |
| Stationary Point #22:<br>West 10th Street, 17-35 RPZ | N: 44° 18.797'<br>W: 96° 49.324' | 1595' | RR track, gravel road, Six Mile Creek to south, wetland vegetation. Tall grass south, pasture north. All low areas susceptible to flooding. |
| Stationary Point #23:<br>West 10th Street at snow drop area. | N: 44° 18.769'<br>W: 96° 49.159' | 1599' | RR track, gravel road, Six Mile Creek to south, wetland vegetation. Tall grass south, pasture north. All low areas susceptible to flooding. Snow drop area weedy, mowed, lots of grit. |
| Stationary Point #24:<br>Fishing pond on Hwy 14 near West 10th Street. | N: 44° 19.082'<br>W: 96° 48.913' | 1593' | Pond surround by mature trees. Highway east, pasture north and south. |

# <u>Appendix 5</u>:

## Listing of Wildlife and Plants on the Airport

**I**. Listing of Wildlife and Plants Noted on or Immediately Adjacent to the Brookings Regional Airport

**II**. South Dakota Birding Checklist, South Dakota Birds

**III**. Vascular Plants Checklist for Brookings Regional Airport

# Listing of Wildlife and Plants Noted on or Immediately Adjacent to the

## Brookings Regional Airport
## August 2009-November 2010

The agricultural crops grown on the airport during the WHA are not included in the list below. In 2009 and 2010, the crops included corn, soybeans, wheat and barley.

**No state- or federal-endangered or threatened wildlife or plant species were noted on the Brookings Municipal Airport during the Wildlife Hazard Assessment. However, Topeka shiners (*Notropis topeka*) are known to inhabit Six Mile Creek, and Northern river otters (*Lontra* Canadensis) have been documented near the airport in connecting drainages.**

## Birds Noted, Separated by Taxonomic Orders:

### Waterfowl--Order Anseriformes
American Widgeon *Anas americana*
Blue-winged Teal *Anas discors*
Bufflehead *Bucephala albeola*
Canada Goose *Branta canadensis sp.*
Common Goldeneye *Bucephala clangula*
Hooded Merganser *Lophodytes cucullatus*
Gadwall *Anas strepera*
Giant Canada Goose *Branta canadensis maxima*
Lesser Scaup *Aythya affinis*
Mallard *Anas platyrhynchos*
Northern Shoveler *Anas clypeata*
Northern Pintail *Anas acuta*
Redhead *Aythya americana*
Ring-necked Duck *Aythya collaris*
Snow Goose *Chen caerulescens*
Wood Duck *Aix sponsa*

### Shorebirds & Gulls--Order Charadriiformes
Franklin's Gull *Larus pipixcan*
Herring Gull *Larus argentatus*
Killdeer *Charadrius vociferus*
Sandpipers *Calidris spp.*
Lesser Yellowlegs *Tringa flavipes*
Ring-billed Gull *Larus delawarensis*
Dowitcher *Limnodromus ssp.*
Willet *Tringa semipalmata*

### Herons & Allies--Order Ciconiiformes
American Bittern *Botaurus lentiginosus*
Black-crowned Night-heron *Nycticorax nycticorax*
Cattle Egret *Bubulcus ibis*
Great Blue Heron *Ardea herodias*
Great Egret *Ardea alba*
Green Heron *Butorides striatus*

### Pelicans & Cormorants--Order Pelecaniformes
Double-crested Cormorant *Phalacrocorax auritus*

### Cranes & Allies--Order Gruiformes
American Coot *Fulica americana*

### Grebes--Order Podicipediformes
Pied-billed Grebe *Podilymbus podiceps*

### Owls--Order Strigiformes
Great-horned Owl *Bubo virginianus*
Short-eared Owl *Asio flammeus*

### Hawks, Falcons--Order Falconiformes
American Kestrel *Falco sparverius*
Bald Eagle *Haliaeetus leucocephalus*
Cooper's Hawk *Accipiter cooperii*
Northern Harrier (Marsh Hawk) *Circus cyaneus*
Red-tailed Hawk *Buteo jamaicensis*
Rough-legged Hawk *Buteo lagopus*
Swainson's Hawk *Buteo swainsoni*

### Perching Birds--Order Passeriformes
American Crow *Corvus brachyrhynchos*
American Goldfinch *Carduelis tristis*
American Robin *Turdus migratorius*
American Tree Sparrow *Spizella arborea*
Barn Swallow *Hirundo rustica*
Black-capped Chickadee *Parus atricapillus*
Blue Jay *Cyanocitta cristata*
Bobolink *Dolichonyx oryzivorus*
Brown-headed Cowbird *Molothrus ater*
Chipping Sparrow *Spizella passerina*
Clay-colored Sparrow *Spizella pallida*
Cliff Swallow *Petrochelidon pyrrhonota*

Common Grackle *Quiscalus quiscula*
Common Yellowthroat *Geothlypis trichas*
Dark-eyed Junco *Junco hyemalis*
Dickcissel *Spiza americana*
Eastern Kingbird *Tyrannus tyrannus*
European Starling *Sturnus vulgaris*
Field Sparrow *Spizella pusilla*
Grasshopper Sparrow *Ammodramus savannarum*
Horned Lark *Eremophila alpestris*
House Sparrow *Passer domesticus*
House Finch *Carpodacus mexicanus*
House Wren *Troglodytes aedon*
Marsh Wren *Cistothorus palustris*
Northern Cardinal *Cardinalis virginianus*
Northern Shrike *Lanius excubitor*
Red-winged Blackbird *Agelaius phoeniceus*
Savannah Sparrow *Passerculus sandwichensis*
Sparrow Ammodramus spp.
Song Sparrow *Melospiza melodia*
Western Meadowlark *Sturnella neglecta*
Yellow-headed Blackbird *Xanthocephalus xanthocephalus*
Warbler R*uficapilla spp.*
Warbler *Dendroica spp.*

Near-Passerine Birds--Order Coraciiformes.
Belted Kingfisher Ceryle alcyon

Gallinaceous Birds--Order Galliformes
Gray Partridge *Perdix perdix*
Ring-necked Pheasant *Phasianus colchicus*

Goatsuckers--Order Caprimulgiformes
Common Nighthawk *Chordeiles minor*

Woodpeckers--Order Piciformes
Northern Flicker (yellow-shafted) *Colaptes auratus*
Downy Woodpecker *Picoides pubescens*
Hairy Woodpecker *Picoides villosus*
Red-headed Woodpecker *Melanerpes erythrocephalus*

Pigeons & Doves--Order Columbiformes
Eurasian Collared-Dove *Streptopelia decaocto*
Mourning Dove *Zenaida macroura*
Rock Dove (pigeon) *Columba livia*

New World Vultures--Order Ciconiiformes
Turkey Vulture *Cathartes aura*

## Mammals Noted, Separated by Taxonomic Orders:

Deer--Order Artiodactyla
White-tailed Deer *Odocoileus virginianus*

Carnivores--Order Carnivora
American Badger *Taxidea taxus*
Common Raccoon *Procyon lotor*
Coyote *Canis latrans*
Domestic Cat *Felis catus**
Domestic Dog *Canis familiaris**
Long-tailed Weasel *Mustela frenata*
Mink *Mustela vison*
Red Fox *Vulpes vulpes*
Striped Skunk *Mephitis mephitis*

Gophers, Mice & Rodents--Order Rodentia
Beaver *Castor Canadensis*
Fox Squirrel *Sciurus niger*
Franklin's Ground Squirrel *Spermophilus franklinii*
House Mouse *Mus musculus*
Richardson's Ground Squirrel *Spermophilus richardsonii*
Thirteen-lined Ground Squirrel *Spermophilus tridecemlineatus*
Vole *Microtus spp.*
Deer Mouse *Peromyscus spp.*
Plains Pocket Gopher *Geomys bursarius*

Muskrat *Ondatra zibethicus*
Woodchuck *Marmota monax*

Rabbits--Order Lagomorpha
Eastern Cottontail *Sylvilagus floridanus*
White-tailed Jackrabbit *Lepus townsendii*

Opossums--Order Marsupialia
Virginia Opossum *Didelphis virginiana*

Shrews & moles--Order Insectivora
Shrew *Sorex spp.*

*For the purposes of a Wildlife Hazard Assessment, domestic house pets not under the immediate control of their owners are considered to be wildlife.

# Fish, Reptiles, Crustaceans and Amphibians Noted Separated by Taxonomic Families:

Frogs: Family Ranidae
Northern Leopard Frog *Rana pipiens*

Salamanders: Family Ambystomatid
Gray Tiger Salamander *Ambystoma tigrinium diaboli*

Crayfish: Family Astacidae
Crayfish *Orconectes causeyi*

Garter Snakes: Family Colubridae
Garter Snake *Thamnophis spp.*

Box Turtles: Family Emydidae
Painted Turtle *Chrysemys picta*

Snapping Turtles: Family Chelydridae.
Snapping Turtle *Chelydra serpentine*

Minnows: Family Cyprinidae
Fathead Minnow *Pimephales promelas*

Sticklebacks: Family Gasterosteidae
Brook Stickleback *Culaea inconstans*

Fishes Known in Six Mile Creek:

**Species of Fish Found in Six Mile Creek and Adjacent Dugouts**

**Listed in Descending Order by Relative Population**

| Common Name | Scientific Name |
|---|---|
| Fathead minnow | *Pimephales promelas* |
| Black bullhead | *Ameiurus melas* |
| Orange-spotted sunfish | *Lepomis humilis* |
| Brook stickleback | *Culaea inconstans* |
| Green sunfish | *Lepomis cyanellus* |
| Iowa darter | *Etheostoma exile* |
| Topeka shiner | *Notropis Topeka* |
| White sucker | *Catostomus commersonii* |
| Common shiner | *Luxilus cornutus* |
| Brassy minnow | *Hybognathus hankinsoni* |
| Creek chub | *Semotilus atromaculatus* |
| Bigmouth shiner | *Notropis dorsalis* |
| Central stoneroller | *Campostoma anomalum* |
| Red shiner | *Notropis lutrensis* |
| Sand shiner | *Notropis stramineus* |
| Johnny darter | *Etheostoma nigrum* |
| Common carp | *Cyprinus carpio* |
| Blacknose dace | *Rhinichthys atratulus* |
| Tadpole madtom | *Noturus gyrinus* |
| Northern pike | *Noturus gyrinus* |
| Bluntnose minnow | *Pimephales notatus* |
| Yellow perch | *Perca flavescens* |

**(Adapted from Thomson and Berry, 2009 Table 2, page 131)**

# South Dakota Birding Checklist

# Brookings Area Birds

## Courtesy of the South Dakota Ornithologists Union

http://www.homepages.dsu.edu/palmerj/SDOU/

**The birds on this list are known to occur in the Brookings area. They may or may not have been documented on the Brookings Regional Airport during the 2010 Wildlife Hazard Assessment. Occasionally birds not on this list may also pass through the area.**

Species status is categorized as Regular (occurred in 8-10 of the last 10 years), Casual (occurred in 4-6 of the last 10 years) or Accidental (occurred In 0-2 of the last ten years). Species observed during 3 of the last ten years are Casual If reported 2 or more of the last 5 years and Accidental otherwise. Species observed during 7 of the last 10 years are Regular If reported during 4 or more of the last 5 years and Casual otherwise. Status listed is based on the period of December 1, 1999 through November 30, 2009.

| Common Name | Status | Genus species | Brookings |
|---|---|---|---|
| Snow Goose | R | *Chen caerulescens* | migrant |
| Ross's Goose | R | *Chen rossii* | migrant |
| Canada Goose | R | *Branta canadensis* | resident |
| Tundra Swan | R | *Cygnus columbianus* | migrant |
| Wood Duck | R | *Aix sponsa* | resident |
| Gadwall | R | *Anas strepera* | summer |
| American Widgeon | R | *Anas americana* | summer |
| American Black Duck | R | *Anas rubripes* | summer |
| Mallard | R | *Anas platyrhynchos* | resident |
| Blue-winged Teal | R | *Anas discors* | summer |
| Northern Shoveler | R | *Anas clypeata* | summer |
| Northern Pintail | R | *Anas acuta* | summer |
| Green-winged Teal | R | *Anas crecca* | summer |
| Canvasback | R | *Aythya valisineria* | summer |
| Redhead | R | *Aythya americana* | summer |
| Ring-necked Duck | R | *Aythya collaris* | summer |
| Lesser Scaup | R | *Aythya affinis* | migrant |
| Bufflehead | R | *Bucephala albeola* | migrant |
| Common Goldeneye | R | *Bucephala clangula* | migrant |
| Hooded Merganser | R | *Lophodytes cucullatus* | summer |
| Common Merganser | R | *Mergus merganser* | migrant |
| Red-breasted Merganser | R | *Mergus serrator* | migrant |

| | | | |
|---|---|---|---|
| Ruddy Duck | R | *Oxyura jamaicensis* | summer |
| Gray Partridge | R | *Perdix perdix* | resident |
| Ring-necked Pheasant | R | *Phasianus colchicus* | resident |
| Wild Turkey | R | *Meleagris gallopavo* | resident |
| Common Loon | R | *Gavia immer* | migrant |
| Pied-billed Grebe | R | *Podilymbus podiceps* | summer |
| Horned Grebe | R | *Podiceps auritus* | migrant |
| Red-necked Grebe | R | *Podiceps grisegena* | migrant |
| Eared Grebe | R | *Podiceps nigricollis* | migrant |
| Western Grebe | R | *Aechmophorus occidentalis* | resident |
| Clark's Grebe | R | *Aechmophorus clarkii* | resident |
| American White Pelican | R | *Pelecanus erythrorhynchos* | summer |
| Double-crested Cormorant | R | *Phalacrocorax auritus* | summer |
| American Bittern | R | *Botaurus lentiginosus* | summer |
| Least Bittern | R | *Ixobrychus exilis* | summer |
| Great Blue Heron | R | *Ardea herodias* | summer |
| Great Egret | R | *Ardea alba* | summer |
| Snowy Egret | R | *Egretta thula* | summer |
| Little Blue Heron | R | *Egretta caerulea* | summer |
| Tricolored Heron | A | *Egretta tricolor* | summer |
| Cattle Egret | R | *Bubulcus ibis* | summer |
| Green Heron | R | *Butorides virescens* | summer |
| Black-crowned Night-Heron | R | *Nycticorax nycticorax* | summer |
| White-faced Ibis | R | *Plegadis chihi* | migrant |
| Turkey Vulture | R | *Cathartes aura* | summer |
| Osprey | R | *Pandion haliaetus* | migrant |
| Bald Eagle | R | *Haliaeetus leucocephalus* | summer |
| Northern Harrier | R | *Circus cyaneus* | summer |
| Sharp-shinned Hawk | R | *Accipiter striatus* | migrant |
| Cooper's Hawk | R | *Accipiter cooperii* | summer |
| Broad-winged Hawk | R | *Buteo platypterus* | migrant |
| Swainson's Hawk | R | *Buteo swainsoni* | summer |
| Red-tailed Hawk | R | *Buteo jamaicensis* | summer |
| Rough-legged Hawk | R | *Buteo lagopus* | winter |
| Golden Eagle | R | *Aquila chrysaetos* | rare, yr-around |
| American Kestrel | R | *Falco sparverius* | summer |
| Merlin | R | *Falco columbarius* | migrant |
| Gyrfalcon | R | *Falco rusticolus* | winter |
| Peregrine Falcon | R | *Falco peregrinus* | migrant |

| | | | |
|---|---|---|---|
| King Rail | A | *Rallus elegans* | rare, summer |
| Virginia Rail | R | *Rallus limicola* | summer |
| Sora | R | *Porzana carolina* | summer |
| Common Moorhen | C | *Gallinula chloropus* | migrant |
| American Coot | R | *Fulica americana* | summer |
| Sandhill Crane | R | *Grus canadensis* | migrant |
| Whooping Crane | R | *Grus americana* | migrant |
| Black-bellied Plover | R | *Pluvialis squatarola* | migrant |
| American Golden-Plover | R | *Pluvialis dominica* | migrant |
| Semipalmated Plover | R | *Charadrius semipalmatus* | migrant |
| Piping Plover | R | *Charadrius melodus* | migrant |
| Killdeer | R | *Charadrius vociferus* | summer |
| Black-necked Stilt | R | *Himantopus mexicanus* | migrant |
| American Avocet | R | *Recurvirostra americana* | summer |
| Spotted Sandpiper | R | *Actitis macularius* | summer |
| Solitary Sandpiper | R | *Tringa solitaria* | migrant |
| Greater Yellowlegs | R | *Tringa melanoleuca* | migrant |
| Willet | R | *Tringa semipalmata* | summer |
| Lesser Yellowlegs | R | *Tringa flavipes* | migrant |
| Upland Sandpiper | R | *Bartramia longicauda* | summer |
| Whimbrel | C | *Numenius phaeopus* | migrant |
| Hudsonian Godwit | R | *Limosa haemastica* | migrant |
| Marbled Godwit | R | *Limosa fedoa* | summer |
| Ruddy Turnstone | R | *Arenaria interpres* | migrant |
| Red Knot | C | *Calidris canutus* | migrant |
| Sanderling | R | *Calidris alba* | migrant |
| Semipalmated Sandpiper | R | *Calidris pusilla* | migrant |
| Least Sandpiper | R | *Calidris minutilla* | migrant |
| White-rumped Sandpiper | R | *Calidris fuscicollis* | migrant |
| Baird's Sandpiper | R | *Calidris bairdii* | migrant |
| Pectoral Sandpiper | R | *Calidris melanotos* | migrant |
| Dunlin | R | *Calidris alpina* | migrant |
| Stilt Sandpiper | R | *Calidris himantopus* | migrant |
| Buff-breasted Sandpiper | R | *Tryngites subruficollis* | migrant |
| Ruff | A | *Philomachus pugnax* | migrant |
| Short-billed Dowitcher | R | *Limnodromus griseus* | migrant |
| Long-billed Dowitcher | R | *Limnodromus scolopaceus* | migrant |
| Wilson's Snipe | R | *Gallinago delicata* | summer |
| American Woodcock | R | *Scolopax minor* | summer |

| | | | |
|---|---|---|---|
| Wilson's Phalarope | R | *Phalaropus tricolor* | summer |
| Red-necked Phalarope | R | *Phalaropus lobatus* | migrant |
| Red Phalarope | A | *Phalaropus fulicarius* | migrant |
| Franklin's Gull | R | *Leucophaeus pipixcan* | summer |
| Ring-billed Gull | R | *Larus delawarensis* | yr-around |
| California Gull | R | *Larus californicus* | summer |
| Herring Gull | R | *Larus argentatus* | summer |
| Thayer's Gull | R | *Larus thayeri* | migrant |
| Caspian Tern | R | *Hydroprogne caspia* | summer |
| Black Tern | R | *Chlidonias niger* | summer |
| Common Tern | R | *Sterna hirundo* | summer |
| Forster's Tern | R | *Sterna forsteri* | summer |
| Rock Pigeon | R | *Columba livia* | resident |
| Eurasian Collared-Dove | R | *Streptopelia decaocto* | resident |
| Mourning Dove | R | *Zenaida macroura* | summer |
| Yellow-billed Cuckoo | R | *Coccyzus americanus* | summer |
| Black-billed Cuckoo | R | *Coccyzus erythropthalmus* | summer |
| Barn Owl | R | *Tyto alba* | rare |
| Eastern Screech-Owl | R | *Megascops asio* | resident |
| Great Horned Owl | R | *Bubo virginianus* | resident |
| Snowy Owl | R | *Bubo scandiacus* | winter |
| Northern Hawk Owl | A | *Surnia ulula* | winter |
| Burrowing Owl | R | *Athene cunicularia* | rare |
| Barred Owl | R | *Strix varia* | rare |
| Great Gray Owl | A | *Strix nebulosa* | winter |
| Long-eared Owl | R | *Asio otus* | winter/migrant |
| Short-eared Owl | R | *Asio flammeus* | rare |
| Northern Saw-whet Owl | R | *Aegolius acadicus* | winter/migrant |
| Common Nighthawk | R | *Chordeiles minor* | summer |
| Whip-poor-will | R | *Caprimulgus vociferus* | summer |
| Chimney Swift | R | *Chaetura pelagica* | summer |
| Ruby-throated Hummingbird | R | *Archilochus colubris* | summer |
| Belted Kingfisher | R | *Megaceryle alcyon* | summer |
| Red-headed Woodpecker | R | *Melanerpes erythrocephalus* | summer |
| Red-bellied Woodpecker | R | *Melanerpes carolinus* | summer |
| Yellow-bellied Sapsucker | R | *Sphyrapicus varius* | migrant |
| Downy Woodpecker | R | *Picoides pubescens* | resident |
| Hairy Woodpecker | R | *Picoides villosus* | resident |
| Northern Flicker | R | *Colaptes auratus* | resident |

| | | | |
|---|---|---|---|
| Pileated Woodpecker | R | *Dryocopus pileatus* | rare |
| Olive-sided Flycatcher | R | *Contopus cooperi* | migrant |
| Western Wood-Pewee | R | *Contopus sordidulus* | rare |
| Eastern Wood-Pewee | R | *Contopus virens* | summer |
| Yellow-bellied Flycatcher | R | *Empidonax flaviventris* | migrant |
| Acadian Flycatcher | A | *Empidonax virescens* | migrant |
| Alder Flycatcher | R | *Empidonax alnorum* | migrant |
| Willow Flycatcher | R | *Empidonax traillii* | summer |
| Least Flycatcher | R | *Empidonax minimus* | summer |
| Eastern Phoebe | R | *Sayornis phoebe* | summer |
| Vermilion Flycatcher | A | *Pyrocephalus rubinus* | migrant |
| Great Crested Flycatcher | R | *Myiarchus crinitus* | summer |
| Western Kingbird | R | *Tyrannus verticalis* | summer |
| Eastern Kingbird | R | *Tyrannus tyrannus* | summer |
| Scissor-tailed Flycatcher | R | *Tyrannus forficatus* | migrant |
| Loggerhead Shrike | R | *Lanius ludovicianus* | summer |
| Northern Shrike | R | *Lanius excubitor* | winter |
| White-eyed Vireo | C | *Vireo griseus* | rare |
| Bell's Vireo | R | *Vireo bellii* | summer |
| Yellow-throated Vireo | R | *Vireo flavifrons* | summer |
| Blue-headed Vireo | R | *Vireo solitarius* | migrant |
| Warbling Vireo | R | *Vireo gilvus* | summer |
| Philadelphia Vireo | R | *Vireo philadelphicus* | migrant |
| Red-eyed Vireo | R | *Vireo olivaceus* | summer |
| Blue Jay | R | *Cyanocitta cristata* | resident |
| American Crow | R | *Corvus brachyrhynchos* | resident |
| Horned Lark | R | *Eremophila alpestris* | yr-around |
| Purple Martin | R | *Progne subis* | summer |
| Tree Swallow | R | *Tachycineta bicolor* | summer |
| Northern Rough-winged Swallow | R | *Stelgidopteryx serripennis* | summer |
| Bank Swallow | R | *Riparia riparia* | summer |
| Cliff Swallow | R | *Petrochelidon pyrrhonota* | summer |
| Barn Swallow | R | *Hirundo rustica* | summer |
| Black-capped Chickadee | R | *Poecile atricapillus* | resident |
| Tufted Titmouse | A | *Baeolophus bicolor* | rare |
| White-breasted Nuthatch | R | *Sitta carolinensis* | resident |
| Brown Creeper | R | *Certhia americana* | winter/migrant |
| Carolina Wren | R | *Thryothorus ludovicianus* | rare |

| | | | |
|---|---|---|---|
| Bewick's Wren | A | *Thryomanes bewickii* | migrant |
| House Wren | R | *Troglodytes aedon* | summer |
| Winter Wren | R | *Troglodytes troglodytes* | migrant |
| Sedge Wren | R | *Cistothorus platensis* | summer |
| Marsh Wren | R | *Cistothorus palustris* | summer |
| Golden-crowned Kinglet | R | *Regulus satrapa* | migrant |
| Ruby-crowned Kinglet | R | *Regulus calendula* | migrant |
| Blue-gray Gnatcatcher | R | *Polioptila caerulea* | summer |
| Eastern Bluebird | R | *Sialia sialis* | summer |
| Veery | R | *Catharus fuscescens* | migrant |
| Gray-cheeked Thrush | R | *Catharus minimus* | migrant |
| Swainson's Thrush | R | *Catharus ustulatus* | migrant |
| Hermit Thrush | R | *Catharus guttatus* | migrant |
| Wood Thrush | R | *Hylocichla mustelina* | summer |
| American Robin | R | *Turdus migratorius* | summer |
| Gray Catbird | R | *Dumetella carolinensis* | summer |
| Northern Mockingbird | R | *Mimus polyglottos* | summer |
| Brown Thrasher | R | *Toxostoma rufum* | summer |
| European Starling | R | *Sturnus vulgaris* | summer |
| American Pipit | R | *Anthus rubescens* | migrant |
| Bohemian Waxwing | R | *Bombycilla garrulus* | winter |
| Cedar Waxwing | R | *Bombycilla cedrorum* | yr-around |
| Blue-winged Warbler | R | *Vermivora pinus* | migrant |
| Golden-winged Warbler | R | *Vermivora chrysoptera* | migrant |
| Tennessee Warbler | R | *Vermivora peregrina* | migrant |
| Orange-crowned Warbler | R | *Vermivora celata* | migrant |
| Nashville Warbler | R | *Vermivora ruficapilla* | migrant |
| Northern Parula | R | *Parula americana* | migrant |
| Yellow Warbler | R | *Dendroica petechia* | summer |
| Chestnut-sided Warbler | R | *Dendroica pensylvanica* | migrant |
| Magnolia Warbler | R | *Dendroica magnolia* | migrant |
| Cape May Warbler | R | *Dendroica tigrina* | migrant |
| Black-throated Blue Warbler | R | *Dendroica caerulescens* | migrant |
| Yellow-rumped Warbler | R | *Dendroica coronata* | migrant |
| Black-throated Gray Warbler | C | *Dendroica nigrescens* | migrant |
| Black-throated Green Warbler | R | *Dendroica virens* | migrant |
| Blackburnian Warbler | R | *Dendroica fusca* | migrant |
| Yellow-throated Warbler | C | *Dendroica dominica* | migrant |
| Pine Warbler | C | *Dendroica pinus* | migrant |

| | | | |
|---|---|---|---|
| Prairie Warbler | A | *Dendroica discolor* | rare, summer |
| Palm Warbler | R | *Dendroica palmarum* | migrant |
| Bay-breasted Warbler | R | *Dendroica castanea* | migrant |
| Blackpoll Warbler | R | *Dendroica striata* | migrant |
| Cerulean Warbler | A | *Dendroica cerulea* | rare, summer |
| Black-and-white Warbler | R | *Mniotilta varia* | migrant |
| American Redstart | R | *Setophaga ruticilla* | summer |
| Prothonotary Warbler | C | *Protonotaria citrea* | rare, summer |
| Worm-eating Warbler | C | *Helmitheros vermivorum* | rare, summer |
| Ovenbird | R | *Seiurus aurocapilla* | summer |
| Northern Waterthrush | R | *Seiurus noveboracensis* | migrant |
| Louisiana Waterthrush | A | *Seiurus motacilla* | migrant |
| Kentucky Warbler | C | *Oporornis formosus* | rare, summer |
| Connecticut Warbler | R | *Oporornis agilis* | migrant |
| Mourning Warbler | R | *Oporornis philadelphia* | migrant |
| MacGillivray's Warbler | R | *Oporornis tolmiei* | migrant |
| Common Yellowthroat | R | *Geothlypis trichas* | summer |
| Hooded Warbler | R | *Wilsonia citrina* | migrant |
| Wilson's Warbler | R | *Wilsonia pusilla* | migrant |
| Canada Warbler | R | *Wilsonia canadensis* | migrant |
| Yellow-breasted Chat | R | *Icteria virens* | migrant |
| Summer Tanager | C | *Piranga rubra* | rare, summer |
| Scarlet Tanager | R | *Piranga olivacea* | summer |
| Spotted Towhee | R | *Pipilo maculatus* | summer |
| Eastern Towhee | R | *Pipilo erythrophthalmus* | summer |
| American Tree Sparrow | R | *Spizella arborea* | winter |
| Chipping Sparrow | R | *Spizella passerina* | summer |
| Clay-colored Sparrow | R | *Spizella pallida* | summer |
| Field Sparrow | R | *Spizella pusilla* | summer |
| Vesper Sparrow | R | *Pooecetes gramineus* | summer |
| Lark Sparrow | R | *Chondestes grammacus* | summer |
| Lark Bunting | R | *Calamospiza melanocorys* | summer |
| Savannah Sparrow | R | *Passerculus sandwichensis* | summer |
| Grasshopper Sparrow | R | *Ammodramus savannarum* | summer |
| Henslow's Sparrow | C | *Ammodramus henslowii* | summer |
| Le Conte's Sparrow | R | *Ammodramus leconteii* | summer |
| Nelson's Sparrow | R | *Ammodramus nelsoni* | summer |
| Fox Sparrow | R | *Passerella iliaca* | migrant |
| Song Sparrow | R | *Melospiza melodia* | summer |

| | | | |
|---|---|---|---|
| Lincoln's Sparrow | R | *Melospiza lincolnii* | migrant |
| Swamp Sparrow | R | *Melospiza georgiana* | summer |
| White-throated Sparrow | R | *Zonotrichia albicollis* | migrant |
| Harris's Sparrow | R | *Zonotrichia querula* | migrant |
| White-crowned Sparrow | R | *Zonotrichia leucophrys* | migrant |
| Dark-eyed Junco | R | *Junco hyemalis* | winter |
| Lapland Longspur | R | *Calcarius lapponicus* | winter |
| Chestnut-collared Longspur | R | *Calcarius ornatus* | rare, summer |
| Snow Bunting | R | *Plectrophenax nivalis* | winter |
| Northern Cardinal | R | *Cardinalis cardinalis* | resident |
| Rose-breasted Grosbeak | R | *Pheucticus ludovicianus* | summer |
| Blue Grosbeak | R | *Passerina caerulea* | summer |
| Indigo Bunting | R | *Passerina cyanea* | summer |
| Dickcissel | R | *Spiza americana* | summer |
| Bobolink | R | *Dolichonyx oryzivorus* | summer |
| Red-winged Blackbird | R | *Agelaius phoeniceus* | summer |
| Western Meadowlark | R | *Sturnella neglecta* | summer |
| Yellow-headed Blackbird | R | *Xanthocephalus xanthocephalus* | summer |
| Rusty Blackbird | R | *Euphagus carolinus* | migrant |
| Brewer's Blackbird | R | *Euphagus cyanocephalus* | summer |
| Common Grackle | R | *Quiscalus quiscula* | summer |
| Great-tailed Grackle | R | *Quiscalus mexicanus* | summer |
| Brown-headed Cowbird | R | *Molothrus ater* | summer |
| Orchard Oriole | R | *Icterus spurius* | summer |
| Baltimore Oriole | R | *Icterus galbula* | summer |
| Purple Finch | R | *Carpodacus purpureus* | winter |
| House Finch | R | *Carpodacus mexicanus* | resident |
| Common Redpoll | R | *Acanthis flammea* | winter |
| Hoary Redpoll | C | *Acanthis hornemanni* | winter |
| Pine Siskin | R | *Spinus pinus* | yr-around |
| American Goldfinch | R | *Spinus tristis* | summer |
| House Sparrow | R | *Passer domesticus* | resident |
| Eurasian Tree Sparrow | A | *Passer montanus* | rare, resident |

# Vascular Plants Checklist
## for the Brookings Regional Airport

Compiled 2009-2010 by Gary E. Larson, SDSU Plant Taxonomist and Herbarium Curator.

Agricultural crops on BKX property 2009-2010—corn, wheat, barley and soybeans—are not listed.

## Trees, Shrubs and Woody Vines

| | | |
|---|---|---|
| Aceraceae | Boxelder | *Acer negundo* |
| | Silver maple | *Acer saccharinum* |
| Caprifoliaceae | Tatarian honeysuckle | *Lonicera tatarica** |
| | Elderberry | *Sambucus canadensis* |
| | Western snowberry | *Symphoricarpos occidentalis* |
| Cornaceae | Redosier dogwood | *Cornus sericea* |
| Cupressaceae | Eastern red cedar | *Juniperus virginiana* |
| | Rocky Mountain juniper | *Juniperus scopulorum** |
| Elaeagnaceae | Russian olive | *Elaeagnus angustifolia** |
| Fabaceae | False indigo | *Amorpha fruticosa* |
| Grossulariaceae | Black currant | *Ribes americanum* |
| Oleaceae | Green ash | *Fraxinus pennsylvanica* |
| Rhamnaceae | Common buckthorn | *Rhamnus cathartica** |
| Rosaceae | Wild plum | *Prunus americana* |
| | Chokecherry | *Prunus virginiana* |
| | Prairie rose | *Rosa arkansana* |
| Salicaceae | Cottonwood | *Populus deltoides* |
| | White willow | *Salix alba** |
| | Peachleaf willow | *Salix amygdaloides* |
| | Sandbar willow | *Salix interior* |
| | Yellow willow | *Salix lutea* |
| Ulmaceae | Hackberry | *Celtis occidentalis* |
| | American elm | *Ulmus americana* |
| | Siberian elm | *Ulmus pumila** |
| Vitaceae | Woodbine | *Parthenocissus vitacea* |

## Forbs

| | | |
|---|---|---|
| Alismataceae | Water plantain | *Alisma plantago-aquatica* |
| Amaranthaceae | Prostrate pigweed | *Amaranthus blitoides** |
| | Redroot pigweed | *Amaranthus retroflexus* |
| | Water hemp | *Amaranthus tuberculatus* |
| Apiaceae | Water hemlock | *Cicuta maculata* |
| | Golden alexanders | *Zizia aurea* |
| Apocynaceae | Dogbane | *Apocynum cannabinum* |
| Asclepiadaceae | Common milkweed | *Asclepias syriaca* |
| Asteraceae | Western yarrow | *Achillea millefolium* |
| | Annual ragweed | *Ambrosia artemisiifolia* |
| | Giant ragweed | *Ambrosia trifida* |
| | Common burdock | *Arctium minus** |
| | Absinth wormwood | *Artemisia absinthium** |
| | Heath aster | *Aster ericoides* |
| | Marsh aster | *Aster lanceolatus* |

| | | |
|---|---|---|
| | Musk thistle | *Carduus nutans** |
| | Canada thistle | *Cirsium arvense** |
| | Flodman thistle | *Cirsium flodmanii* |
| | Bull thistle | *Cirsium vulgare** |
| | Horseweed | *Conyza canadensis* |
| | Philadelphia fleabane | *Erigeron philadelphicus* |
| | Daisy fleabane | *Erigeron strigosus* |
| | Curlycup gumweed | *Grindelia squarrosa* |
| | Annual sunflower | *Helianthus annuus* |
| | Sawtooth sunflower | *Helianthus grosseserratus* |
| | Maximilian sunflower | *Helianthus maximiliani* |
| | Nuttall's sunflower | *Helianthus nuttallii* |
| | Oxeye | *Heliopsis helianthoides* |
| | Prickly lettuce | *Lactuca serriola* |
| | Cup-plant | *Silphium perfoliatum* |
| | Canada goldenrod | *Solidago canadensis* |
| | Late goldenrod | *Solidago gigantea* |
| | Perennial sow thistle | *Sonchus arvensis** |
| | Common dandelion | *Taraxacum officinale** |
| | Goatsbeard or salsify | *Tragopogon dubius** |
| | Ironweed | *Vernonia fasciculata* |
| | Common cocklebur | *Xanthium strumarium* |
| Brassicaceae | Shepherd's purse | *Capsella bursa-pastoris** |
| | Field pennycress | *Thlaspi arvense** |
| | Common pepperweed | *Lepidium densiflorum** |
| | Field mustard | *Sinapis arvensis** |
| | Tall hedge mustard | *Sisymbrium loeselii** |
| Cannabaceae | Wild hemp | *Cannabis sativa** |
| Campanulacea | Palespike lobelia | *Lobelia spicata* |
| Caryophyllaceae | Bouncingbet | *Saponaria officinalis** |
| | White cockle | *Silene latifolia* subsp. *alba** |
| | Common chickweed | *Stellaria media** |
| Chenopodiaceae | Lambsquarters | *Chenopodium album** |
| | Kochia | *Kochia scoparia** |
| Convolvulaceae | Hedge bindweed | *Calystegia sepium* |
| | Field bindweed | *Convolvulus arvensis** |
| Cucurbitaceae | Wild cucumber | *Echinocystis lobata* |
| Fabaceae | Tick trefoil | *Desmodium canadense* |
| | American licorice | *Glycyrrhiza lepidota* |
| | Birdsfoot trefoil | *Lotus corniculatus** |
| | Black medic | *Medicago lupulina** |
| | Alfalfa | *Medicago sativa* |
| | White sweetclover | *Melilotus alba** |
| | Yellow sweetclover | *Melilotus officinalis** |
| | Red clover | *Trifolium pratense** |
| | White clover | *Trifolium repens** |
| Lemnaceae | Duckweed | *Lemna turionifera* |
| Liliaceae | Garden asparagus | *Asparagus officinalis** |
| Nyctaginaceae | Heartleaf four o'clock | *Mirabilis nyctaginea* |

| | | |
|---|---|---|
| Onagraceae | Evening primrose | *Oenothera biennis* |
| Oxalidaceae | Yellow woodsorrel | *Oxalis stricta* |
| Plantaginaceae | Common plantain | *Plantago major** |
| Polygonaceae | Leathery knotweed | *Polygonum achoreum* |
| | Marsh smartweed | *Polygonum amphibium var. emersum* |
| | Oval-leaf knotweed | *Polygonum arenastrum** |
| | Prostrate knotweed | *Polygonum aviculare** |
| | Pale smartweed | *Polygonum lapathifolium* |
| | Pennsylvania smartweed | *Polygonum pensylvanicum* |
| | Lady's thumb | *Polygonum persicaria** |
| | Rhubarb | *Rheum rhabarbum** |
| | Curly dock | *Rumex crispus** |
| | Mexican dock | *Rumex salicifolius* |
| Ranunculaceae | Meadow anemone | *Anemone canadensis* |
| | Late meadowrue | *Thalictrum dasycarpum* |
| | Early meadowrue | *Thalictrum venulosum* |
| Rosaceae | Silverweed | *Potentilla anserina* |
| | Norwegian cinquefoil | *Potentilla norvegica* |
| | Prairie rose | *Rosa arkansana* |
| Scrophulariaceae | Common toadflax | *Linaria vulgaris** |
| Solanaceae | Buffalo bur | *Solanum rostratum* |
| Urticaceae | Pellitory | *Parietaria pensylvanica* |
| | Stinging nettle | *Urtica dioica* |
| Verbenaceae | Bracted vervain | *Verbena bracteata* |
| | Hoary vervain | *Verbena stricta* |
| Violaceae | Dooryard violet | *Viola sororia* |

# Grasses/Grasslikes

| | | |
|---|---|---|
| Poaceae | Redtop | *Agrostis stolonifera** |
| | Garrison creeping foxtail | *Alopecurus arundinaceus** |
| | Big bluestem | *Andropogon gerardii* |
| | Smooth bromegrass | *Bromus inermis** |
| | Sandbur | *Cenchrus longispinus* |
| | Orchardgrass | *Dactylis glomerata"* |
| | Intermediate wheatgrass | *Elymus hispidus** |
| | Quackgrass | *Elymus repens** |
| | Carolina lovegrass | *Eragrostis pectinacea* |
| | Foxtail barley | *Hordeum jubatum* |
| | Meadow fescue | *Lolium pratense** |
| | Witchgrass | *Panicum capillare* |
| | Fall panicum | *Panicum dichotomiflorum* |
| | Switchgrass | *Panicum virgatum* |
| | Reed canarygrass | *Phalaris arundinacea* |
| | Timothy | *Phleum pratense** |
| | Common reed | *Phragmites australis* |
| | Kentucky bluegrass | *Poa pratensis** |
| | Yellow foxtail | *Setaria glauca** |

| | | |
|---|---|---|
| | Green foxtail | *Setaria viridis** |
| | Prairie cordgrass | *Spartina pectinata* |
| | Tall dropseed | *Sporobolus compositus* |
| | Poverty grass | *Sporobolus neglectus* |
| Cyperaceae | Slough sedge | *Carex atherodes* |
| | Limestone meadow sedge | *Carex granularis* |
| | Smoothcone sedge | *Carex laeviconica* |
| | Clustered field sedge | *Carex praegracilis* |
| | Bald spikerush | *Eleocharis erythropoda* |
| | River bulrush | *Scirpus fluviatilis* |
| | Pale bulrush | *Scirpus pallidus* |
| | Threesquare bulrush | *Scirpus pungens* |
| | Softstem bulrush | *Scirpus tabernaemontani* |
| Juncaceae | Baltic rush | *Juncus balticus* |
| | Dudley rush | *Juncus dudleyi* |
| Typhaceae | Narrowleaf cattail | *Typha angustifolia* |
| | Common cattail | *Typha latifolia* |
| | Hybrid cattail | *Typha* X*glauca* |

*Introduced species

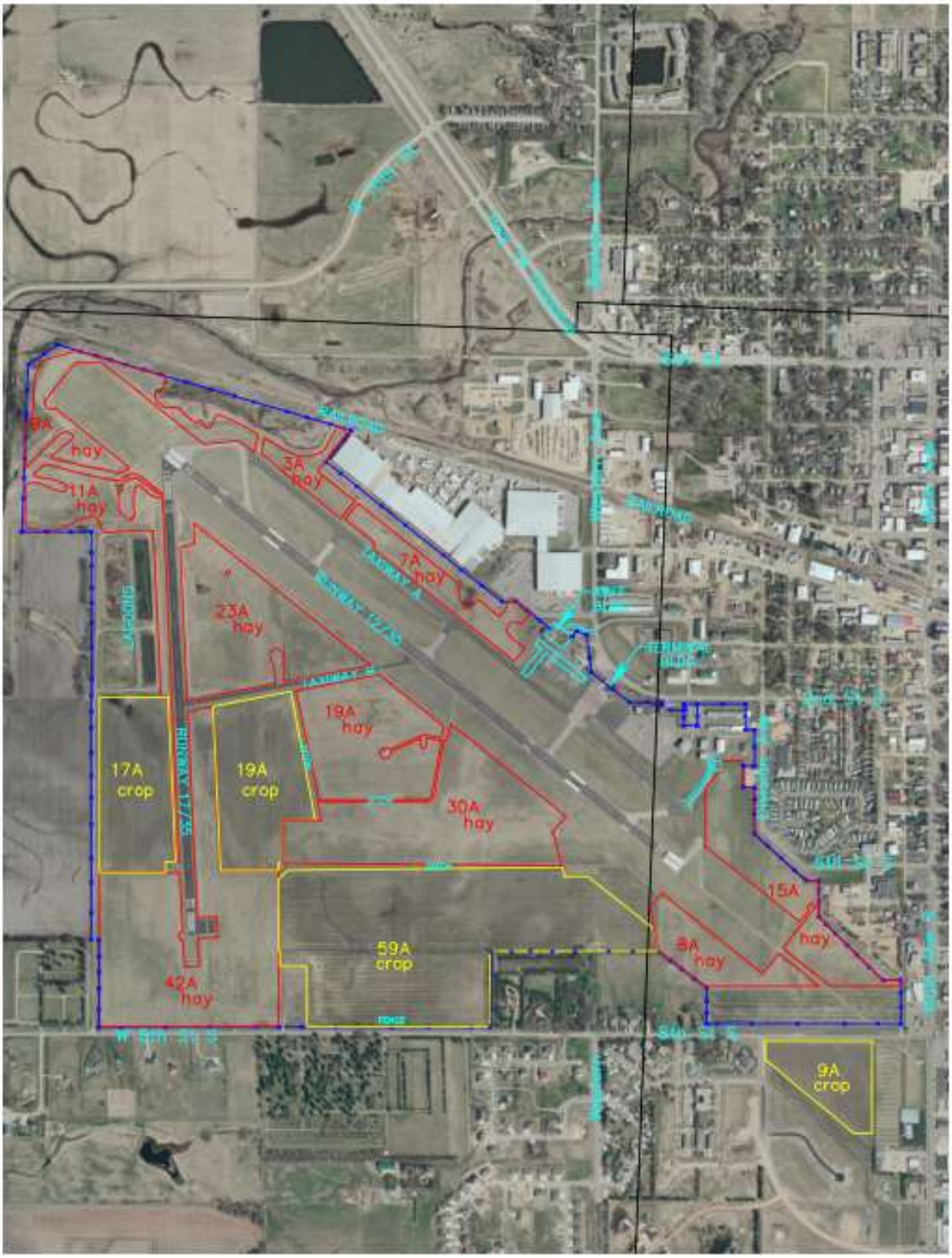
# Appendix 6:

## Brookings Regional Airport Hay and Cropland Map

# Brookings Regional Airport
# Hay & Crop Land

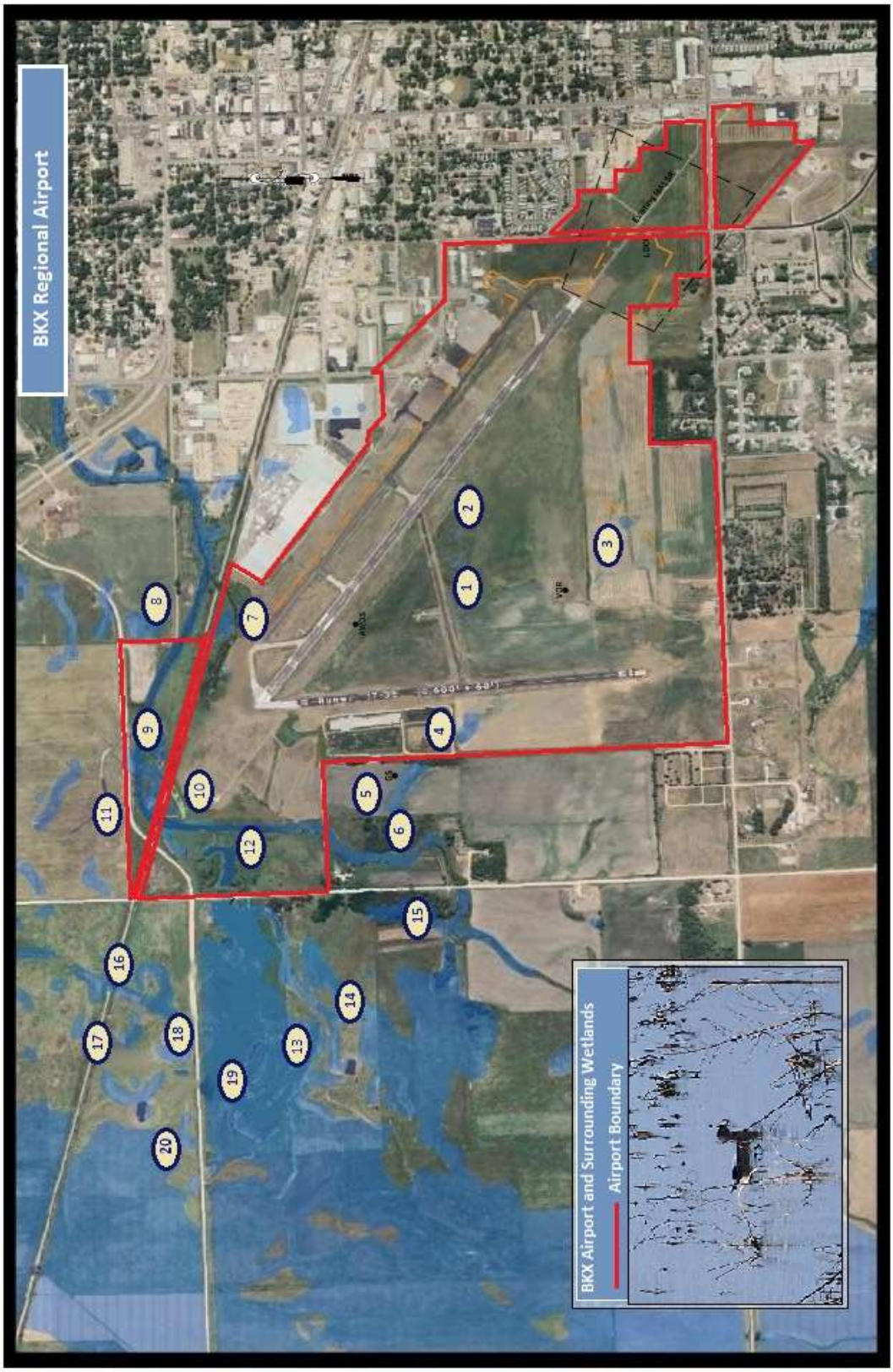
**12-2-2010**

crop
hay
fence



# Appendix 7:

## Brookings Regional Airport Wetlands




Brookings (BKX) Regional Airport on-property and surrounding off-property wetland areas

# Brookings Regional Airport

## On-Airport and Off-Airport

### Wetland Acreages, National Wetlands Inventory Classification & US Army Corps of Engineers Jurisdiction Status.

| On-Airport Wetlands | Size (acres) | NWI Classification | Assumed USCOE Jurisdiction status |
|---|---|---|---|
| 1 | 0.1 | PEMA | Non-Jurisdictional |
| 2 | 0.2 | PEMA | Non-Jurisdictional |
| 3 | 0.5 | PEMAd | Non-Jurisdictional |
| 4 | 1.3 | PEMAd | Non-Jurisdictional |
| 7 | 10.3 | PEMC, PEMA | Jurisdictional |
| 9 | 1.3 | PEMA | Jurisdictional |
| 10 | 4.5 | PEMC | Jurisdictional |
| 12 | 1.4 | PEM/ABF | Jurisdictional |

| Off-Airport Wetlands | Size (acres) | NWI Classification | Assumed USCOE Jurisdiction status |
|---|---|---|---|
| 5 | 2.3 | PEMAd | Non-Jurisdictional |
| 6 | 4.1 | PEMC | Jurisdictional |
| 8 | 0.2 | PEMC | Non-Jurisdictional |
| 11 | 0.2 | PEMA | Jurisdictional |
| 13 | 42.3 | PEMA, PEMC, PEM/ABF | Jurisdictional |
| 14 | 3.7 | PEMA | Jurisdictional |
| 15 | 0.5 | PFOA | Jurisdictional |
| 16 | 1.9 | PEMA, PEMC | Jurisdictional |
| 17 | 0.7 | PEMA | Jurisdictional |
| 18 | 1.1 | PEMA | Jurisdictional |
| 19 | 0.3 | PEMA | Jurisdictional |
| 20 | 0.1 | PEMA | Jurisdictional |

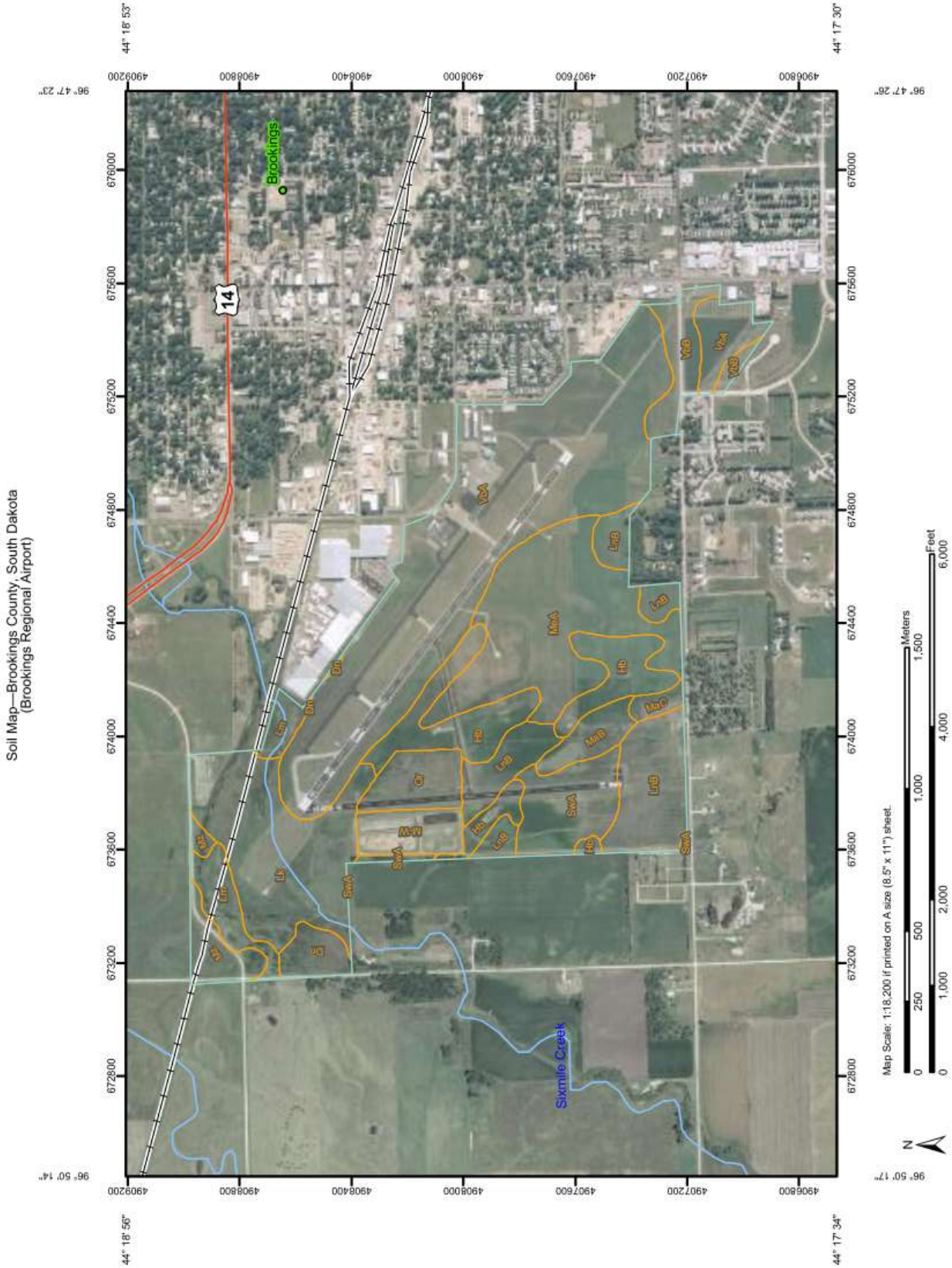
***Acres:***

| | |
|---|---|
| ***Jurisdictional Total*** | 72.4 |
| ***Non-Jurisdictional Total*** | 4.6 |
| ***Off-Airport Total*** | 57.4 |
| ***On-Airport Total*** | 19.6 |
| ***On-Airport Non-Jurisdictional*** | 2.1 |
| ***On-Airport Jurisdictional*** | 17.5 |
| ***Overall Total Wetland Acres*** | **77.0** |

Adapted from HNTB Corporation, 2009, Draft Environmental Assessment, 2009. (Table 6, page 95)

# Appendix 8:

## Soil Mapping and Information


Soil Map—Brookings County, South Dakota
(Brookings Regional Airport)
Brookings
14
Sixmile Creek
Map Scale: 1:18,200 if printed on A size (8.5" x 11") sheet.
Meters
Feet
N

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Units

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

**Special Line Features**
- Gully
- Short Steep Slope
- Other

**Political Features**
- Cities

**Water Features**
- Oceans
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes

## MAP INFORMATION

Map Scale: 1:18,200 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 14N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brookings County, South Dakota
Survey Area Data: Version 16, Feb 11, 2010

Date(s) aerial images were photographed: 7/23/2004; 8/19/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

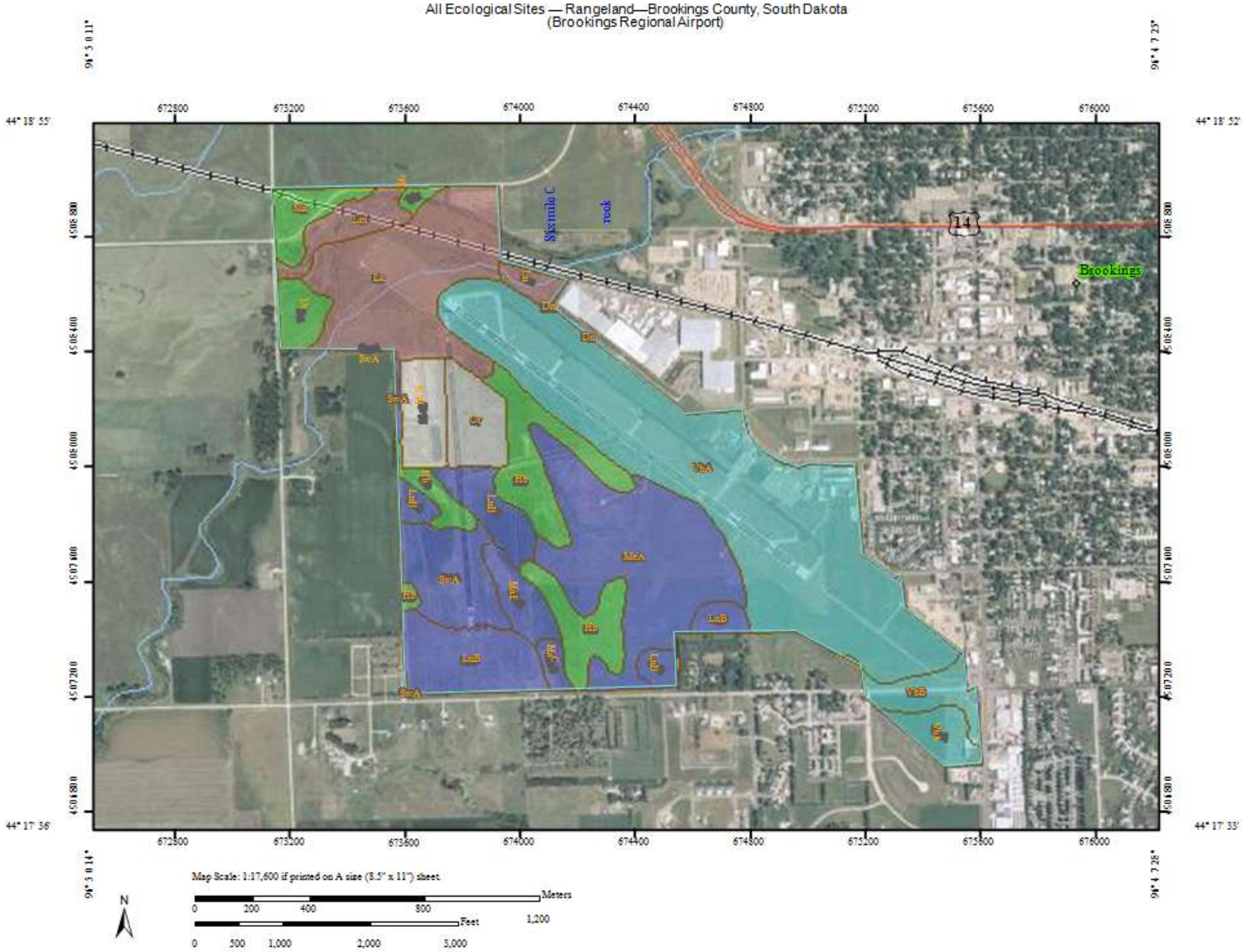
# Map Unit Legend

| Brookings County, South Dakota (SD011) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| Dn | Divide loam, 0 to 2 percent slopes | 10.0 | 1.7% |
| Hb | Hamerly-Badger complex, 0 to 2 percent slopes | 50.1 | 8.7% |
| Lk | Lamoure silty clay loam, 0 to 1 percent slopes | 68.0 | 11.8% |
| Lm | Lamoure-Rauville silty clay loams, channeled | 18.2 | 3.2% |
| LnB | Lanona-Swenoda sandy loams, 2 to 6 percent slopes | 56.7 | 9.8% |
| M-W | Miscellaneous water areas | 14.7 | 2.5% |
| MaB | Maddock-Egeland sandy loams, 2 to 6 percent slopes | 10.8 | 1.9% |
| MaC | Maddock-Egeland sandy loams, 6 to 9 percent slopes | 3.9 | 0.7% |
| MeA | Maddock-Embden complex, 0 to 2 percent slopes | 78.0 | 13.5% |
| Mz | Moritz-Lamoure complex, 0 to 2 percent slopes | 13.5 | 2.3% |
| Or | Orthents, loamy | 16.2 | 2.8% |
| SwA | Swenoda-Lanona sandy loams, 0 to 2 percent slopes | 27.6 | 4.8% |
| VbA | Vienna-Brookings complex, 0 to 2 percent slopes | 191.9 | 33.3% |
| VbB | Vienna-Brookings complex, 1 to 6 percent slopes | 17.5 | 3.0% |
| **Totals for Area of Interest** | | **577.1** | **100.0%** |

# Appendix 9:

## Ecological Site Mapping and Information

All Ecological Sites — Rangeland—Brookings County, South Dakota
(Brookings Regional Airport)




## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

- Soil Map Units

**Soil Ratings**

- R102AY003SD — SUBIRRIGATED
- R102AY006SD — LIMY SUBIRRIGATED
- R102AY009SD — SANDY
- R102AY010SD — LOAMY
- Not rated or not available

**Political Features**

- Cities

**Water Features**

- Oceans
- Streams and Canals

**Transportation**

- Rails
- Interstate Highways
- US Routes

## MAP INFORMATION

Map Scale: 1:17,600 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 14NNAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brookings County, South Dakota
Survey Area Data: Version 16, Feb 11, 2010

Date(s) aerial images were photographed: 7/23/2004; 8/19/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# All Ecological Sites — Rangeland

| Brookings County, South Dakota | | | | |
|---|---|---|---|---|
| Map unit symbol | Component name (percent) | Ecological site | Acres in AOI | Percent of AOI |
| Dn | Divide (85%) | R102AY006SD — LIMY SUBIRRIGATED | 9.0 | 1.6% |
| | Marysland, undrained (9%) | R102AY003SD — SUBIRRIGATED | | |
| | Fordtown (3%) | R102AY010SD — LOAMY | | |
| | Renwash (2%) | R102AY014SD — SHALLOW GRAVEL | | |
| | Castlewood, undrained (1%) | R102AY002SD — WET LAND | | |
| Hb | Hamerly (55%) | R102AY006SD — LIMY SUBIRRIGATED | 49.9 | 9.0% |
| | Badger (30%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Svea (9%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Parnell, undrained (3%) | R102AY001SD — SHALLOW MARSH | | |
| | Tonka, undrained (2%) | R102AY004SD — WET MEADOW | | |
| | Cavour (1%) | R102AY013SD — CLAYPAN | | |
| Lk | Lamoure (75%) | R102AY003SD — SUBIRRIGATED | 66.9 | 12.1% |
| | Lowe (15%) | R102AY003SD — SUBIRRIGATED | | |
| | Rauville (5%) | R102AY002SD — WET LAND | | |
| | Ludden, undrained (3%) | R102AY002SD — WET LAND | | |
| | LaDelle (2%) | R102AY020SD — LOAMY OVERFLOW | | |
| Lm | Lamoure, channeled (65%) | R102AY003SD — SUBIRRIGATED | 17.6 | 3.2% |
| | Rauville (25%) | R102AY002SD — WET LAND | | |
| | Ludden, undrained (5%) | R102AY002SD — WET LAND | | |
| | Marysland, undrained (4%) | R102AY003SD — SUBIRRIGATED | | |
| | Divide (1%) | R102AY006SD — LIMY SUBIRRIGATED | | |
| LnB | Lanona (60%) | R102AY009SD — SANDY | 53.5 | 9.7% |
| | Swenoda (25%) | R102AY009SD — SANDY | | |
| | Maddock (5%) | R102AY009SD — SANDY | | |
| | Strayhoss (5%) | R102AY010SD — LOAMY | | |
| | Doland (4%) | R102AY010SD — LOAMY | | |
| | Marysland, undrained (1%) | R102AY003SD — SUBIRRIGATED | | |
| M-W | Miscellaneous water (100%) | | 14.7 | 2.7% |

| Brookings County, South Dakota | | | | |
|---|---|---|---|---|
| Map unit symbol | Component name (percent) | Ecological site | Acres in AOI | Percent of AOI |
| MaB | Maddock (55%) | R102AY009SD — SANDY | 10.8 | 2.0% |
| | Egeland (35%) | R102AY009SD — SANDY | | |
| | Embden (9%) | R102AY009SD — SANDY | | |
| | Marysland, undrained (1%) | R102AY003SD — SUBIRRIGATED | | |
| MaC | Maddock (65%) | R102AY009SD — SANDY | 3.6 | 0.7% |
| | Egeland (25%) | R102AY009SD — SANDY | | |
| | Embden (7%) | R102AY009SD — SANDY | | |
| | Doland (1%) | R102AY010SD — LOAMY | | |
| | Marysland, undrained (1%) | R102AY003SD — SUBIRRIGATED | | |
| | Strayhoss (1%) | R102AY010SD — LOAMY | | |
| MeA | Maddock (50%) | R102AY009SD — SANDY | 77.2 | 14.0% |
| | Embden (40%) | R102AY009SD — SANDY | | |
| | Egeland (4%) | R102AY009SD — SANDY | | |
| | Allivar (3%) | R102AY014SD — SHALLOW GRAVEL | | |
| | Divide (2%) | R102AY006SD — LIMY SUBIRRIGATED | | |
| | Marysland, undrained (1%) | R102AY003SD — SUBIRRIGATED | | |
| Mz | Moritz (50%) | R102AY006SD — LIMY SUBIRRIGATED | 13.2 | 2.4% |
| | Lamoure (35%) | R102AY003SD — SUBIRRIGATED | | |
| | Lowe (10%) | R102AY003SD — SUBIRRIGATED | | |
| | Rauville (2%) | R102AY002SD — WET LAND | | |
| | Divide (1%) | R102AY006SD — LIMY SUBIRRIGATED | | |
| | La Prairie (1%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Ludden, undrained (1%) | R102AY002SD — WET LAND | | |
| Or | Orthents, loamy (95%) | | 16.2 | 2.9% |
| | Badger (1%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Barnes (1%) | R102AY010SD — LOAMY | | |
| | Buse (1%) | R102AY012SD — THIN LOAMY | | |
| | McIntosh (1%) | R102AY006SD — LIMY SUBIRRIGATED | | |
| | Vienna (1%) | R102AY010SD — LOAMY | | |
| SwA | Swenoda (55%) | R102AY009SD — SANDY | 26.9 | 4.9% |
| | Lanona (35%) | R102AY009SD — SANDY | | |
| | Maddock (5%) | R102AY009SD — SANDY | | |
| | Strayhoss (4%) | R102AY010SD — LOAMY | | |
| | Marysland, undrained (1%) | R102AY003SD — SUBIRRIGATED | | |

| Brookings County, South Dakota | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Component name (percent)** | **Ecological site** | **Acres in AOI** | **Percent of AOI** |
| VbA | Vienna (60%) | R102AY010SD — LOAMY | 180.6 | 32.7% |
| | Brookings (30%) | R102AY020SD — LOAMY OVERFLOW | | |
| | McIntosh (5%) | R102AY006SD — LIMY SUBIRRIGATED | | |
| | Badger (3%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Parnell, undrained (1%) | R102AY001SD — SHALLOW MARSH | | |
| | Tonka, undrained (1%) | R102AY004SD — WET MEADOW | | |
| VbB | Vienna (65%) | R102AY010SD — LOAMY | 12.7 | 2.3% |
| | Brookings (20%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Buse (5%) | R102AY012SD — THIN LOAMY | | |
| | McIntosh (5%) | R102AY006SD — LIMY SUBIRRIGATED | | |
| | Badger (3%) | R102AY020SD — LOAMY OVERFLOW | | |
| | Parnell, undrained (1%) | R102AY001SD — SHALLOW MARSH | | |
| | Tonka, undrained (1%) | R102AY004SD — WET MEADOW | | |
| **Totals for Area of Interest** | | | **552.6** | **100.0%** |

# Appendix 10:

## FAA 5200-7 Bird/Other Wildlife Strike Report Form

U S. Department of Transportation
**Federal Aviation Administration**

Form Approved OMB NO. 2120-0045
3/31/2010

# BIRD / OTHER WILDLIFE STRIKE REPORT

| | | |
|---|---|---|
| **1. Name of Operator** | **2. Aircraft Make/Model** | **3. Engine Make/Model** |
| **4. Aircraft Registration** | **5. Date of Incident**<br>_____ _____ _____<br>Month / Day / Year | **6. Local Time of Incident**<br>☐ Dawn ☐ Dusk ____HR ____MIN<br>☐ Day ☐ Night ☐ AM ☐ PM |
| **7. Airport Name** | **8. Runway Used** | **9. Location if En Route** (Nearest Town/Reference & State) |
| **10. Height** (AGL) | **11. Speed** (IAS) | |

**12. Phase of Flight**

- ☐ A. Parked
- ☐ B. Taxi
- ☐ C. Take-off Run
- ☐ D. Climb
- ☐ E. En Route
- ☐ F. Descent
- ☐ G. Approach
- ☐ H. Landing Roll

**13. Part(s) of Aircraft Struck or Damaged**

| | Struck | Damaged | | Struck | Damaged |
|---|---|---|---|---|---|
| A. Radome | ☐ | ☐ | H. Propeller | ☐ | ☐ |
| B. Windshield | ☐ | ☐ | I. Wing/Rotor | ☐ | ☐ |
| C. Nose | ☐ | ☐ | J. Fuselage | ☐ | ☐ |
| D. Engine No. 1 | ☐ | ☐ | K. Landing Gear | ☐ | ☐ |
| E. Engine No. 2 | ☐ | ☐ | L. Tail | ☐ | ☐ |
| F. Engine No. 3 | ☐ | ☐ | M. Lights | ☐ | ☐ |
| G. Engine No. 4 | ☐ | ☐ | N. Other: (Specify) | ☐ | ☐ |

**14. Effect on Flight**

- ☐ None
- ☐ Aborted Take-Off
- ☐ Precautionary Landing
- ☐ Engines Shut Down
- ☐ Other: (Specify)

**15. Sky Condition**

- ☐ No Cloud
- ☐ Some Cloud
- ☐ Overcast

**16. Precipitation**

- ☐ Fog
- ☐ Rain
- ☐ Snow
- ☐ None

**17. Bird/Other Wildlife Species**

**18. Number of birds seen and/or struck**

| Number of Birds | Seen | Struck |
|---|---|---|
| 1 | ☐ | ☐ |
| 2-10 | ☐ | ☐ |
| 11-100 | ☐ | ☐ |
| more than 100 | ☐ | ☐ |

**19. Size of Bird(s)**

- ☐ Small
- ☐ Medium
- ☐ Large

**20. Pilot Warned of Birds** ☐ Yes ☐ No

**21. Remarks** *(Describe damage, injuries and other pertinent information)*

**DAMAGE / COST INFORMATION**

| | | |
|---|---|---|
| **22. Aircraft time out of service:**<br>_____ hours | **23. Estimated cost of repairs or replacement** (U.S. $):<br>$ | **24. Estimated other Cost** *(U.S. $) (e.g. loss of revenue, fuel, hotels):*<br>$ |
| **Reported by** *(Optional)* | **Title** | **Date** |

Paperwork Reduction Act Statement: The information collected on this form is necessary to allow the Federal Aviation Administration to assess the magnitude and severity of the wildlife-aircraft strike problem in the U.S. The information is used in determining the best management practices for reducing the hazard to aviation safety caused by wildlife-aircraft strikes. We estimate that it will take approximately 6 minutes to complete the form. The information collected is voluntary. Please note that an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control number associated with this collection is 2120-0045. Comments concerning the accuracy of this burden and suggestions for reducing the burden should be directed to the FAA at: 800 Independence Ave SW, Washington, DC 20591, Attn: Information Collection Clearance Officer, ABA-20

U.S. Department
of Transportation

**Federal Aviation Administration**

800 Independence Ave. S.W.
Washington, D.C. 20561

Official Business
Penalty for Private Use, $300

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IF MAILED
IN THE
UNITED STATES

# BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 12438 WASHINGTON D.C.

POSTAGE WILL BE PAID BY FEDERAL AVIATION ADMINISTRATION

Federal Aviation Administration
Office of Airport Safety and Standards, AAS-310
800 Independence Avenue, SW
WASHINGTON, DC 20591

FOLD AND TAPE HERE

**Directions for FAA Form 5200-7**
**Bird/Other Wildlife Strike Report**

1. Name of Operator - This can be an airline (abbreviations okay - UAL, AAL, etc.), business (Coca Cola), government agency (Police Dept., FAA) or if a private pilot, his/her name.
2. Aircraft Make/Model - Abbreviations are okay, but to include the model (e.g. B737-200).
3. Engine Make/Model - Abbreviations are allowed (e.g., PW 4060, GECT7, LYC 580).
4. Aircraft Registration - This means the N# (for USA registered aircraft).
5. Date of Incident - Give the local date, not the ZULU or GMT date.
6. Local Time of Incident - Check the appropriate light conditions and fill in the hour and minute local time and check AM or PM or use the 24 clock and skip AM/PM.
7. Airport Name - Use the airport name or 3 letter code if a US airport. If a foreign airport, use the full name or 3 letter code and location (city/country).
8. Runway used - Self-explanatory.
9. Location if En Route - Put the name of the nearest city and state.
10. Height AGL - Put the feet above ground level at the time of the strike (if you don't know, use MSL and indicate this). For take-off run and landing roll, it must be 0.
11. Speed (IAS) - Speed at which the aircraft was traveling when the strike occurred.
12. Phase of Flight - Phase of flight during which the strike occurred. Take-off run and landing roll should both be 0 AGL.
13. Part(s) of Aircraft Struck or Damaged - Check which parts were struck and damaged. If a part was damaged but not struck indicate this with a check on the damaged column only and indicate in comments (#21) why this happened (e.g., the landing gear might be damaged by deer strike, causing the aircraft to flip over and damage parts not struck by deer).
14. Effect on Flight - You can check more than one and if you check (Other", please explain in Comments (#21).
15. Sky condition - Check the one that applies.
16. Precipitation - You may check more than one.
17. Bird/Other Wildlife Species - Try to be accurate. If you don't know, put unknown and some description. Collect feathers or remains for identification for damaging strikes.
18. Number of birds seen and/or struck - check the box in the Seen column with the correct number if you saw the birds/other wildlife before the strike and check the box in the Struck column to show how many were hit. The exact number, can be written next to the box.
19. Size of Bird(s) - Check what you think is the correct size (e.g. sparrow = small, gull = medium and geese = large).
20. Pilot Warned of Birds - Check the correct box (even if it was an ATIS warning or NOTAM).
21. Remarks - Be as specific as you can. Include information about the extent of the damage, injuries, anything you think would be helpful to know. (e.g., number of birds ingested).
22. Aircraft time out of service - Record how many hours the aircraft was out of service.
23. Estimated cost of repairs or replacement - This may not be known immediately, but the data can be sent at a later date or put down a contact name and number for this data.
24. Estimated other cost - Include loss of revenue, fuel, hotels, etc. (see directions for #23).
25. Reported by - Although this is optional, it is helpful if questions arise about the information on the form (a phone number could also be included).
26. Title - This can be Pilot, Tower, Airport Operations, Airline Operations, Flight Safety, etc.
27. Date - Date the form was filled out.

# Appendix 11:

## Information for Collecting Bird Strike Evidence

# General Information for Collecting Birdstrike Material

Feather Identification Lab, Smithsonian Institution

## COLLECTING REMAINS

**Feathers:**

*Whole Bird*: Pluck a variety of feathers (breast, back, wing, tail)
*Partial Bird*: Collect a variety of feathers with color or pattern
*Feathers only*: Send all materials
Do not cut feathers from the bird (we need the down at the base)
Do not use any sticky substance (no tape or glue)
Place remains in a re-closeable bag
Allow remains to dry before sealing bag.

**Blood / Tissue ("Snarge"):**

Place dry snarge in a re-closeable bag
If need, wipe off with alcohol wipe or paper towel sprayed with 70% alcohol
Please do not use water or bleach – it is not compatible with our DNA analysis

- Include copy of FAA 5200-7 report
- Include contact information

## SHIPPING

**Routine / Non-Damaging Cases: *US Postal Service***

Feather Identification Lab
Smithsonian Institution
NHB E600, MRC 116
P.O. Box 37012
Washington, DC 20013-7012

**Priority / Damaging Cases: *Overnight Shipping***

Feather Identification Lab
Smithsonian Institution
NHB, E600, MRC 116
10th & Constitution Ave., NW
Washington, DC 20560-0116

## WEBSITES

Civil Aviation: http://wildlife-mitigation.tc.faa.gov
Birdstrike Committee: www.birdstrike.org

## Feather Lab Contact Information

202-633-0801
dovec@si.edu
heackerm@si.edu

* Basic safety measures and good hygiene when collecting material is encouraged. Use latex gloves, face mask and eye protection; always thoroughly wash hands after handling remains.

# HOW TO COLLECT BIRDSTRIKE EVIDENCE

**BIRDSTRIKE SAMPLE**

**If both whole feathers & "snarge" are available, collect both types of evidence.**
***"The more the merrier"***

**Whole Feathers**

**Tissue / Blood "Snarge"**

**Whole Carcass**

**Feather Fragments**

**Pull (don't cut) variety of feathers: breast, back, wing, tail.**

**Collect as much material as possible.**

**Wipe/scrape off all material. If needed, spray area with alcohol to loosen material then wipe off. Do not use water or bleach.**

- **Allow samples to dry**
- **Include FAA form 5200-7**

REGULAR SHIPMENT:

Smithsonian Institution
Feather Identification Lab
E600, MRC 116
P.O. Box 37012
Washington, DC 20013-7012

OVERNIGHT SHIPMENT:

Smithsonian Institution
Feather Identification Lab
E600, MRC 116
10th & Constitution Ave, NW
Washington, DC 20560

# Appendix 12:

## Letter Regarding Equalization Basins and Biosolids Drying Beds

BROOKINGS
municipal utilities

525 Western Ave., P.O. Box 588
Brookings, SD 57006-0588
(605) 692-6325 voice
(605) 697-8485 fax

# MEMORANDUM

**To:** Jackie Lanning, City Engineer
**From:** Eric Witt
**cc:** Michael Wilson, Jeff Weldon, Steve Meyer, Paul Melby, Gary Englund, Larry Mutchler
**Date:** Updated 10/19/09
**Subject:** Airport Environmental Assessment Issues
**Re:** Equalization Basins and Biosolids Drying Beds

As requested at a September 30, 2008 meeting, a memo dated October 14, 2008 was distributed as a follow up to the discussion of the BMU facilities currently located at the Airport. This memo serves as an update to the October 14, 2008 memo:

## Background

The September 30, 2008 meeting and discussion was prompted by the pending completion of the Environmental Assessment (EA) for the Airport and the eventual decision whether to relocate the Airport or modify the existing Airport runway alignment. At our meeting, Michael Wilson, Airport Manager, presented excerpts from the draft EA, supporting FAA information, and the currently proposed runway re-alignment (if the airport remains at its current location). The proposed runway re-alignment will intersect the BMU facilities at the Airport.

## Existing BMU Facilities Located at the Airport Property

The existing BMU facilities consist of two biosolids drying beds and two flow equalization (EQ) basins; the facilities each have significantly different purposes:

### Biosolids Drying Beds

The biosolid drying beds are clay-lined containment basins used to store and further dry liquid biosolids from the municipal wastewater treatment plant (WWTP); biosolids are the end product of the anaerobic digestion process common at mechanical WWTPs. Once the digestion process is complete, the liquid biosolids (approximately 2% solids) is hauled via semi tanker to the drying beds to air-dry to a dry solid (approximately 35 – 45% solids – a cake or soil like consistency). Once dried, the material is excavated from the drying beds, hauled and applied to agricultural fields as a beneficial re-use for nutrient application. The nutrient application is very similar to applying manure to agricultural fields that will benefit from the nitrogen application. The drying beds are used in rotation so that liquid biosolids are being added to only one basin
each year while the other basin is allowed to dry and the material disposed of in the fall of the year.

Both the US EPA and SD DENR regulate the handling and ultimate disposal of municipal biosolids (40 CFR Part 503 Regulations) via permit. Testing of biosolids for both the nutrient content and heavy metals is required. Field application of biosolids must be done in accordance with the permit and BMU's Biosolid Management Plan. BMU's biosolids and their disposal have historically been well within the criteria set forth in the 40 CFR Part 503 regulations.

The biosolids drying beds are storage and drying facilities that are currently required for biosolids management. Assuming the airport runway is re-aligned, options for removal of the drying beds include either replacement at another location or replacement with mechanical dewatering equipment at the WWTP. After consideration of both operational issues and airport facility considerations, BMU is currently pursuing mechanical dewatering equipment which will eliminate the need to replace the drying beds. Equipment evaluation and demonstrations are underway and dewatering equipment is expected to be acquired and operational within the next year.

If dewatering equipment procurement and installation proceed as anticipated, the biosolids drying beds will be loaded with liquid biosolids during the winter/spring of 2010 and cleaned out for the final time in either the fall of 2010 or 2011. Abandonment of the biosolids drying beds was addressed in the October 14, 2008 memo.

**Flow Equalization Basins**

The EQ basins are clay-lined containment basins (with vegetated bottoms and side slopes) used for short-term storage of sanitary sewer flow during periods of high flow due to inflow and infiltration (I&I). The Brookings WWTP has a peak treatment capacity of 6 million gallons per day (MGD). During periods of high flows due to I&I, the collection system can deliver significantly more flow to the WWTP than can be processed. The EQ basins provide an approximate combined storage capacity of 22 million gallons (MG). Without short-term flow equalization storage, the WWTP would either need to bypass untreated wastewater to the Big Sioux River (which would result in violation of our DENR permit), or expand the WWTP to handle significantly higher peak flows during storm events.

High peak flows due to I&I during storm events is a common problem in communities with heavy soils and an aging collection system; managing the I&I events with flow equalization is a common and economical method of addressing this issue and reduces the capital cost and WWTP operational issues that are associated with significantly over-sizing a treatment plant to manage relatively infrequent flow conditions.

During periods of high flows associated with storm events, wastewater is diverted from the west side collector sewer that drains some of the older areas of Brookings. The wastewater is pumped from the collection system via pumps located at the former WWTP west of Western Avenue to the EQ basins. Once the flow has subsided, the wastewater from the EQ basins is allowed to feed slowly back into the collection system via gravity flow to the WWTP for treatment. The length of time wastewater is stored in the EQ basins varies depending on flow and environmental conditions; generally, during periods of high groundwater and saturated soils (more typical during spring conditions) it takes longer to drain the EQ basins as some amount of infiltration into the collection system continues to take place after the actual storm event. Typically, the EQ basins are utilized for flow equalization once or twice per year. A review of EQ basin utilization for the last ten years follows:

**High Flow Events**

| Year | Storm Event | Approximate Days Water in EQ Basins |
|---|---|---|
| 1999 | May 6-7 | 7 |
| 2000 | Not used | 0 |
| 2001 | April 22-24 (1st event), May 7-8 (2nd event) | 21 (Back to Back Storm Events) |
| 2002 | Not used | 0 |
| 2003 | Not used | 0 |
| 2004 | Sep 23-24 | 7 |
| 2005 | Sep 8-12 | 14 |
| 2005 | Oct 5-8 | 10 |
| 2006 | Apr 1-2 | 7 |
| 2007 | Apr 21-22 | 7 |
| 2007 | May 4-6 | 10 |
| 2008 | May 13-16 | 10 |
| 2009 | Not used to date | 0 to date |

The EQ basins are critical to the WWTP operations, even though they are utilized relatively infrequently. If they are required to be abandoned due to the runway realignment, they will need to be replaced at another location. However, the replacement location siting will be difficult; property acquisition would be required for a suitable replacement property that is:

1) out of the floodplain (to avoid extensive fill and a possibly a liner system above the floodplain elevation),
2) preferably a reasonable distance from current and future residential areas,
3) within close proximity to the oldest portion of the wastewater collection system to avoid significant pump station and pumping costs to and from the basins. (The current location of the existing facilities takes advantage of existing pumping facilities to the EQ basins and gravity-flow out of the basins back to the collection system).

As such, if the Airport runway is realigned, BMU would strongly prefer to work with City, Airport, and FAA requirements to relocate the EQ basins south of the existing location but still within the Airport property. Measures to minimize the wildlife attractiveness of these facilities can be implemented during construction and management of replacement facilities, including but not limited to reducing and/or eliminating vegetated bottom conditions, and installation of wire and/or other measures to deter birds and other wildlife.

If the EQ basins are allowed to be relocated to the south within the Airport property, land acquisition issues will be eliminated from the relocation time frame, as will significant redesign of piping and pumping station(s) to and from the basins. As such, the design and construction of the replacement EQ basins would likely require at least a year, assuming there is approximately 6 – 9 months available for design and approvals prior to a full construction season. Once replacement EQ basins have been constructed and are available for use, the existing EQ basins could be abandoned. No “remnant” material is expected in the EQ basins, however, testing to prove such could be conducted if required by the DENR. Approval of the replacement EQ basins would likely be required by the DENR, along with closure/abandonment plans for the existing basins. General site grading work associated with the

runway re-alignment (a general grading permit / Notice of Intent will likely be required as part of the airport runway re-alignment project and would presumably incorporate site grading around closure/abandonment of the EQ basins.

**Author's Note: The High Flow Events Chart in this letter was updated Courtesy of Mr. Witt with the following updated information:**

**High Flow Events**

| Year | Storm / High Flow Event | Approximate Days Water in EQ Basins |
|---|---|---|
| 1999 | May 6-7 | 7 |
| 2000 | Not used | 0 |
| 2001 | April 22-24 (1st event), May 7-8 (2nd event) | 21 (Back to Back Storm Events) |
| 2002 | Not used | 0 |
| 2003 | Not used | 0 |
| 2004 | Sep 23-24 | 7 |
| 2005 | Sep 8-12 | 14 |
| 2005 | Oct 5-8 | 10 |
| 2006 | Apr 1-2 | 7 |
| 2007 | Apr 21-22 | 7 |
| 2007 | May 4-6 | 10 |
| 2008 | May 13-16 | 10 |
| 2009 | Not used | 0 |
| 2010 | March 12-25 (14 days flow diversion) | 30 (estimated) |
| 2010 | June 11-21 11 days flow diversion) | 19 (estimated) |
| 2010 | June 26-28 (3 days flow diversion) | 16 |
| 2010 | July 17-19 (3 days flow diversion) | 6 |
| 2010 | July 23-24 (2 days flow diversion) | 5 |
| 2010 | Sep 2-5 (4 days flow diversion) | 8 |
| 010 | Sep 22-30 (9 days flow diversion) | 23 |