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Airport Bird Hazard Risk Assessment Process

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Airport Bird Hazard Risk Assessment Process

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1. Abstract

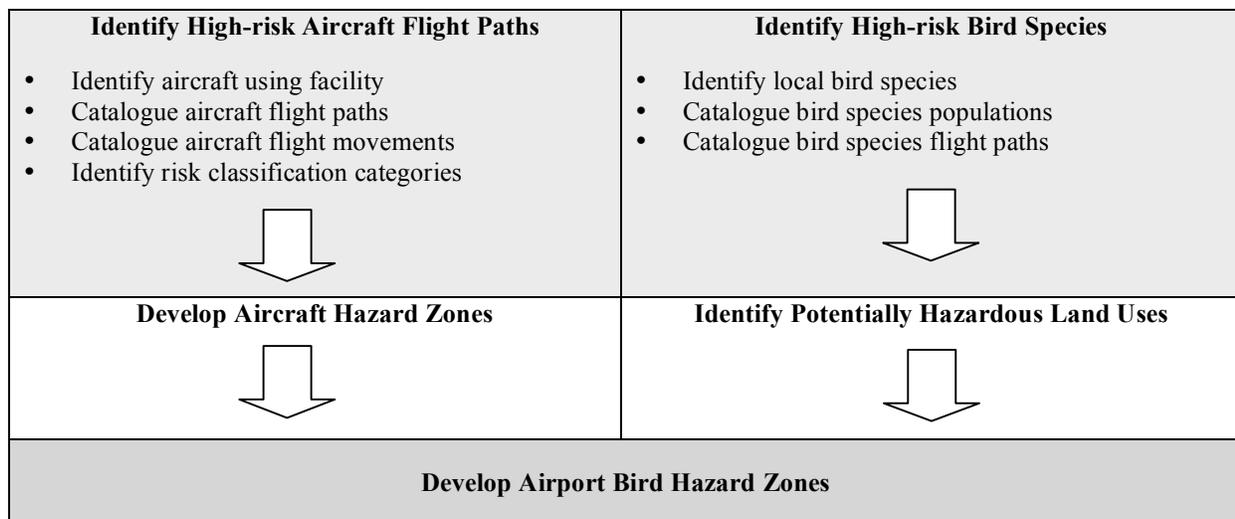
This paper presents an overview of Transport Canada’s airport bird hazard risk assessment process (ABRAP), which will be published in 2007.¹ ABRAP examines and categorizes the relationship between airport-area land uses and bird species to predict risks to aircraft in various phases of flight. The result is the creation of customized bird hazard zones that accommodate the unique features and challenges at each airport, and that differ dramatically from the circular zoning patterns traditionally drawn from an airport’s geographic centre.

The paper briefly describes ABRAP, lists the diverse ways in which it can be applied, and illustrates how the process can be integrated with an airport’s risk-based wildlife management program and broader safety management system (SMS).

2. Introduction

The goal of wildlife control on and near airports is to reduce the risk of aircraft² accidents due to collisions with birds and other forms of wildlife. The airport bird hazard risk assessment process (ABRAP; see Table 1) contributes to this goal by gathering data³ related to local land uses, wildlife species and aircraft movements. This data is then evaluated in terms of relative risk to aircraft and used to create site-specific bird hazard zones. ABRAP enables those responsible for managing hazardous lands and operations to mitigate the safety risks appropriately, and for those overseeing aviation safety to evaluate the effectiveness of mitigation.

Table 1 – Airport Bird Hazard Risk-assessment Process Map



¹ Supporting documentation will include detailed technical instructions and *Safety Above All: A coordinated approach to airport-vicinity wildlife management*. The latter is a promotional tool for a broad stakeholder audience. To learn more, see <http://www.tc.gc.ca/civilaviation/AerodromeAirNav/Standards/WildlifeControl/menu.htm>.

² The term aircraft refers to all fixed wing and rotary wing aircraft.

³ This data is also used in the development of airport wildlife management plans (AWMPs). In fact, the airport bird hazard zones produced through ABRAP are key components of an integrated risk-based AWMP. The zones maximize the effectiveness of an AWMP by mitigating the risk of hazardous land-use practices in the vicinity of an airport.

The risk-assessment process consists of five steps:

1. **Evaluate aircraft risks** by identifying and analyzing the types, frequency of movement, flight paths and generic phases of flight of the aircraft that arrive, depart and operate in the vicinity of the airport;
2. **Determine bird hazards** by identifying and analyzing the resident and migratory bird species that could pose a risk to aircraft operations;
3. Employing information from 1 and 2, **categorize relative risk** by aircraft type and phase of flight, and chart this information;
4. Employing information from 1 and 2, **determine high-risk bird species** and the land uses that may attract them, and chart this information; and
5. Employing information derived from 3 and 4, **plot bird hazard zones** by category of severity and land use.

This document describes the risk assessment process, which can be used to assess airport bird-hazard risks:

- When developing an airport wildlife management program at an existing airport, and to assist in compliance activities associated with wildlife planning and management regulations; or
- When determining bird hazard zoning requirements during the design phase of a new airport; or
- During the planning phase for expansions or modifications to airport runways and flight paths; or
- During the planning phase for development of potentially hazardous land uses in the vicinity of an airport.

3. Safety-risk Framework

ABRAP established a safety-risk framework that links land use to bird-related risks and aircraft operations, and categorizes the predictable relationships among:

- Different land uses found near airport sites;
- Bird species; and
- Different safety risks to aircraft during various phases of aircraft flight.

The results are hazard and risk matrices that, when applied to an airport setting, provide risk-based guidance on appropriate land uses on and near the airport. These land uses may range from ‘inappropriate’ (in cases where such land use should be prohibited or managed aggressively to reduce the risks to aircraft) to ‘appropriate’ (in cases where the severity or likelihood of a related occurrence is low).

4. Classification of Risk

ABRAP uses the following classification of damage or losses experienced by the aircraft or aircraft occupants:

Category A – Catastrophic loss, measured as either the complete loss of the aircraft or the loss of more than one life as a consequence of a bird strike event^{4,5}.

Category B – Major damage, measured as either significant damage to the airframe, failure of one or more engines, one or more aircraft systems, serious injury to one or more aircraft occupants, or the loss of life of no more than one aircraft occupant.

Category C – Minor damage to the airframe, engines or aircraft systems.

In employing these risk classifications, worst-case circumstances are considered and subsequently qualified in light of predicted frequencies, or ranges of frequencies.

5. Elements of Risk

Risk Element I — Aircraft Related

Identify and categorize exposure and severity by:

- Examining the categories of aircraft that currently, or may in the future, use the airport;
- Determining the aircraft departure, arrival and transit lateral and vertical flight paths;
- Determining, based on the aircraft types using the airport, the applicable bird strike certification standards; and
- Determining the differing degree of risk associated with different phases of flight.

Risk Element II — Bird-species Related

With regard to the potential severity of impact, identify and categorize the various bird species that could strike aircraft using the airport.

Risk Element III — Land-use Related by Hazardous Species

Identify land uses that provide nesting, feeding or night-roosting sites for hazardous species of birds identified in *Risk Element II*.

5.1. Risk Element I — Aircraft Related

To establish this risk element, evaluate the aircraft-related exposure and severity of bird strike events by determining the types of aircraft that currently (or may in the future) use the airport:

Exposure

- Aircraft types and certification categories.
- Aircraft movements (daily and monthly distributions by aircraft type).
- The location and dimensions of lateral and vertical flight paths.

⁴ The differentiation between *more than one death* in a Category A accident and *one death* in a Category B is intended to discriminate between a bird strike event that results in collision with the terrain (Category A) and an event that causes death to a flight crew member after windshield penetration by a bird (Category B). In addition to the greater loss of life, the former will have significantly broader operational, economic, commercial, and political ramifications, and needs to be treated differently than a Category B accident.

⁵ A bird strike event may include single or multiple bird strikes.

Severity

- Applicable airframe and engine certification standards associated with identified aircraft types.
- Applicable phase of flight, aircraft operating altitudes and bird strike vulnerability information.
- Flight crew and passenger carrying capacities for identified aircraft types.

5.1.1. Aircraft Types and FAR Certification Categories

Catalogue by FAR airframe and engine certification standards the types of aircraft that currently (or may in the future) use the airport. This is done by reviewing airport aircraft movement logs, assessing runway lengths and pavement load-bearing weights, and interviewing airport users and representatives of the airport authority.

5.1.2. Aircraft Movements

The number, frequency and distribution of aircraft movements are critical to the risk assessment process. This data can be acquired through a review of the airport aircraft movement logs and catalogued using aircraft-type and FAR certification categories as described in section 5.1.1.

5.1.3. Aircraft Lateral and Vertical Flight Paths

Aircraft operate to, from and in the vicinity of an airport with a high degree of predictability, enabling flight paths to be projected and mapped onto lands around the airport. Airport runways and other landing surfaces are the references from which the flight paths are mapped. The subsequent projections depict lateral and vertical zones in which aircraft operate, and that are the *potential* hazard zones for bird strikes.

Local flight paths are influenced by topographical features such as mountains, rivers and lakes as well as built-up areas. These flight paths may be further constrained by noise-abatement and air traffic management requirements. Lateral and vertical flight paths (IFR and VFR) to and from the airport are determined by examining applicable aeronautical charts, consulting with air traffic service providers and local users, and by identifying other nearby aircraft landing sites that may be available (e.g., heliports, water aerodrome facilities and nearby airports).

While aircraft flight paths are predictable, they are not precise; therefore, when depicting aircraft flight paths, reasonable margins should be allowed to account for pilot, controller and technology error, and environmental conditions (wind, severe weather).

5.1.4. Risk Category Classification

As explained in section 4, the damages or losses experienced as the result of a bird strike can be defined as Category A, B or C. Determining the potential risk categories for the particular aircraft types that use or may use the airport is essential.

5.1.4.1. Aircraft and Engine Certification Standards

Bird strike impact certification standards and aircraft operating performance are defined by the Federal Aviation Regulation (FAR) to which the aircraft or engine was

certified. A summary of the engine and airframe FAR bird strike certification standards is contained in Tables 1 and 2, Appendix I.

5.1.4.2. Aircraft Phase of Flight, Operating Altitudes & Bird Strike Vulnerability

Aircraft are vulnerable to bird strikes in varying degrees during different phases of aircraft flight. The degree of vulnerability is a function of the aircraft type, altitude, and operating envelope during a particular phase of flight, and the number of flight crew. Table 2 summarizes the various aircraft categories, approximate altitudes by phase of flight, and Category A or B damage events most likely to occur during these phases. A general description of the phases of flight is included below, ranked from highest to lowest risk.

1. **Take off and initial climb.** The highest risk from a bird strike occurs during take off. The aircraft is low to the ground; it is often operating at or near performance limits; it has a large fuel load; and it is at a critical angle of attack. Crew activity is high and coordination is imperative. As the climb out progresses and aircraft altitude increases, the risk of loss of control and collision with terrain is reduced. However, the risk of serious damage to the airframe and engine as a result of a bird strike increases because of higher impact forces from increasing airspeeds.
2. **Missed approach.** The most severe risk of a bird strike during this phase of flight is loss of control and subsequent impact with terrain. This would likely occur if a bird strike took place while initiating the missed approach—when the aircraft is low to the ground and in a low energy state, and the flight crew is reconfiguring the aircraft.
3. **Approach and landing.** The category of loss in these phases of flight is dependent on aircraft type. For FAR 23 (Commuter Aircraft) & 25 aircraft the most severe risk of a bird strike during the instrument approach is a Category B loss. A Category A loss is remotely possible if the event occurs in close proximity to the ground, such as a go-around because of unrelated and pressing operational conditions.⁶ For Normal Category Aircraft (FAR 23) and Helicopters (FAR 27 & 29), due to the fact that these aircraft have no bird strike impact certification requirements and use only one pilot, the likelihood of windshield penetration and crew incapacitation leading to a Category A loss is dramatically increased.
4. **Descent to approach.** For Far 23 (Commuter Aircraft) and 25 aircraft the most severe result of a bird strike during descent to approach is likely a Category B loss. For Normal Category Aircraft (FAR 23) and Helicopters (FAR 27 & 29), the likelihood of windshield penetration and crew incapacitation leading to a Category A loss is dramatically increased due to the factors discussed in Approach and Landing, above.

⁶ For instance, in the case of an unanticipated go-around from an altitude below the Minimum Descent Altitude or the Missed Approach Point. An example of such conditions occurred during the loss of an Air Canada CL-65 at Fredericton, New Brunswick in December 1998.

5. **En-route climb.** For Far 23 (Commuter Aircraft) and 25 aircraft the most severe result of a bird strike during the en-route climb phase is a Category B loss. For Normal Category Aircraft (FAR 23) and Helicopters (FAR 27 & 29), the likelihood of windshield penetration and crew incapacitation leading to a Category A loss is dramatically increased due to the factors discussed in Approach and Landing, above.
6. **Cruise.** For Far 23 (Commuter Aircraft) and 25 aircraft the most severe result of a bird strike during en-route climb is a Category B loss. For Normal Category Aircraft (FAR 23) and Helicopters (FAR 27 & 29), the likelihood of windshield penetration and crew incapacitation leading to a Category A loss is dramatically increased due to the factors discussed in Approach and Landing, above.

5.1.4.3. Aircraft Flight Crew

To assess the potential severity of a bird strike event it is necessary to evaluate the number of flight crew operating the aircraft. This information will help determine the availability of personnel to operate the aircraft should a crew member become incapacitated. Table 3 in Appendix I provides a range of values that may be used.

5.1.5. High-Risk Aircraft Flight Paths

Using the information derived above, high-risk aircraft flight paths (for the various aircraft types where Category A and B events are likely to occur) are developed and superimposed over maps of the local area. When mapping flight paths it is important to provide sufficient horizontal-distance buffer around direct flight paths to account for variations in aircraft speed within types, pilot technique and environmental effects such as wind.

Table 2 – Aircraft Phase of Flight Altitudes (ft. AGL) and Corresponding Loss Categories

Category of Aircraft	Phase of Flight (<i>A or B indicates predominant category of risk</i>)							
	Take Off	Initial Climb	Enroute Climb	Cruise	Descent	Approach	Landing	Missed Approach
Transport Category Aircraft (FAR 25)	A 0 – 400	A 400 – 3,000	B 3,000 – 10,000	B 10,000 +	B 10,000 – 3,000	B 3,000 - 400	B 400 - 0	A 0 – 1,500
Normal Category Commuter Aircraft (FAR 23)	A 0 – 400	A 400 – 3,000	B 3,000 – 10,000	B 3 - 10,000 +	B 10,000 – 3,000	B 3,000 - 400	B 400 - 0	A 0 – 1,500
Normal Category Normal, Utility and Acrobatic Aircraft (FAR 23)	A 0 – 500	A 500 – 1,000	A 1,000 – 10,000	B* 1,000 – 10,000 +	B* 10,000 – 1,000	A 1,000 - 500	A 500 - 0	A 0 – 1,000
Transport Category Rotorcraft (FAR 29)	A 0 – 500	A 500 – 1,000	A 1,000 – 5,000	B* 500 – 5,000	B* 5,000 – 1,000	A 1,000 - 500	A 500 - 0	A 0 – 1,000
Normal Category Rotorcraft (FAR 27)	A 0 – 500	A 500 – 1,000	A 1,000 – 5,000	B* 500 – 5,000	B* 5,000 – 1,000	A 1,000 - 500	A 500 - 0	A 0 – 1,000

* Due to the fact that normal category aircraft (FAR 23) and helicopters (FAR 27 and 29) have no bird strike impact certification requirements and are flown by only one pilot, windshield penetration and crew incapacitation that leads to a Category A loss is possible.

5.2. Risk Element II — Bird-species Related

Whereas aircraft fly on relatively predictable flight paths, bird movements are not nearly as consistent. Their flight patterns vary, for example, under differing weather conditions, seasons, and times of the day. The physical dimensions of bird hazard zones must therefore be adjusted to account for variations in bird behaviour.

Additionally, the consequence of a bird strike varies with the weight of the bird, the impact speed and the number of birds struck. Information regarding the physical characteristics of bird species and their nesting, feeding, flocking and flying characteristics helps establish a generalized category of risk for each species or group.

The following section presents a generalized ranking system that distinguishes among bird groups by the degree of risk that they pose to aircraft safety.

5.2.1. Bird Hazard Ranking System

The bird hazard ranking system (see Table 3) is based on bird size (average weights), flocking characteristics, and flight behaviour. Obviously, large birds cause more damage than smaller birds. Weight is more important than overall size because it is the density of the bird that determines actual damage.

Flocking behaviour is important because it affects the probability that more than one individual may be involved in a bird strike. A strike involving a flock of birds can lead to

multiple ingestions into more than one aircraft engine, thereby greatly increasing the risk of an accident.

Flight behaviour of birds is an important consideration when assessing risk to aircraft. During annual migrations, birds can fly at high altitudes, often at several thousand feet above ground. These birds may be attracted to land uses in the vicinity of an airport as an intermediate stop for food, shelter or water. In the vicinity of an airport, it is local, daily movements that are most relevant to aircraft safety. Some species always fly close to the ground; others, such as gulls and hawks, regularly fly at higher altitudes of 1000 to 1500 ft AGL. Birds at those altitudes can pose a risk to aircraft on approach and departure.

Dolbeer et al. (2000) have analyzed U.S. civilian bird strike data from the Federal Aviation Administration (FAA) database to rank wildlife species in terms of the damage caused by strikes with each species. The ranking system shown here is consistent with their results.

The general categories used in the Bird Hazard Ranking System are listed from highest risk (Level 1) to lowest risk (Level 6) based on the mean bird species weight and flocking behaviours in relation to airframe and turbine engine certification standards. Based on the worldwide history of bird strike incidents, it is clear that each of levels 1 to 4 can present significant safety hazards.

Birds in hazard levels 5 and 6 generally have not caused significant accidents with civilian aircraft, although some minor damage could occur. There are a large number of strikes with these species, particularly where both birds and aircraft are close to the ground in the airport environment. Many of those strikes go unnoticed by flight crew and airline maintenance staff, but are detected by the presence of dead birds found on or near airport runways by bird control and runway patrol staff. It should not be assumed, however, that all strikes with Level 5 species are harmless. For example, a single American Kestrel caused significant damage to a Boeing 737 at Louisville Airport in a Category C incident.

Table 3 – Bird Hazard Ranking System

Severity of Risk	Species Characteristics	Illustrative Species
Level 1	Very large (>1.8 kg), flocking	Geese, cranes, cormorants
Level 2	Very large (>1.8 kg), solitary or Large (1-1.8kg), flocking	Vultures, Mallards Great Black-backed Gulls
Level 3	Large (1-1.8 kg), solitary or Medium (300-1000 g), flocking	Red-tailed Hawk, American Crow
Level 4	Medium (300-1000g), solitary or Small (50 – 300 g), flocking	European Starling
Level 5	Small (50-300 g), solitary or Very small (<50 g), flocking	Eastern Meadowlark, swallows
Level 6	Very small (<50 g), solitary	Warblers, vireos, sparrows

5.3. Risk Element III — Land-use Related by Hazardous Species

The next step is to evaluate land uses that support and attract the bird species of concern; that is, species in severity levels 1 through 4.

5.3.1. Risk Considerations

There are six major risk considerations when assessing airport-vicinity land uses:

Species attracted

All land uses that attract hazardous species are of potential concern.

Numbers associated with a land use

Sites that attract large numbers of hazardous species are of more concern than those attracting only a few individuals.

Behaviour

Because birds on the ground do not create a hazard, it is necessary to examine the behaviour of the birds over and in transit to and from the site. Some species, such as Turkey Vultures and gulls, soar or tower high into the air above the ground— and potentially into aircraft flight paths.

Many birds that feed at landfills spend nights at remote communal roosts. Daily flights to and from a landfill may take the birds through aircraft arrival and departure paths. This can occur even if the landfill and the night roost are not close to the airport.

Frequency of use

A key factor for discriminating between high and low risk land uses is the frequency of visits by hazardous species. A site that is used on a daily basis creates a higher risk than a site that is used infrequently. For example, a small landfill may be visited by several hundred gulls every day, while a recently ploughed farm field may attract the same number of gulls for only a few days in spring or fall.

Location

Location often determines whether a land use creates a safety risk. In the most obvious case, a land use that attracts low-flying and feeding birds would likely create a hazard if it were adjacent to an airport runway, but not if it were two to three km away from the runway. A major attraction, such as a landfill, may create a safety hazard if the night roost used by visiting birds is on the opposite side of the airport—thereby drawing birds through air traffic zones—but may not create a hazard if the landfill and the roost are on the same side of the airport.

Nature and scope of land use

Taking into account the other risk considerations listed above, airport operators must assess the nature and scope of each land use to accurately determine its potential to attract birds. Any site that offers food, shelter, roosting or loafing locations to species in the vicinity of an airport should be examined (see section 5.3.2 for a partial list of land uses). A small fast-food outlet may offer some of these attractants, but not be of the scope to draw a significant number of birds. A large seafood-processing plant, however, has the potential to attract thousands. A sprawling recreational area could provide safe refuge for even more hazardous species.

5.3.2. Hazardous Land Uses

Table 4 presents a range of land uses in terms of risks that could be posed to aircraft. This list is not exhaustive; it is intended to identify representative land uses. Similar but unlisted sites and operations could pose equal or greater risk.

Table 4 – Potentially Hazardous Land Uses

Level of Potential Risk			
High	Moderate	Low	Limited
Putrescible waste landfills	Open or partially enclosed waste-transfer stations	Dry waste landfills	Vegetative compost facilities
Food waste hog farms	Cattle paddocks	Enclosed waste transfer facilities	Natural habitats
Fish processing/packing plants	Poultry factory farms	Wet/dry recycling facilities	Inactive agricultural fields
Horse racetracks	Sewage lagoons	Marshes, swamps & mudflats	Inactive hay fields
Wildlife refuges	Marinas/fishing boats/fish cleaning facilities	Stormwater management ponds	Rural ornamental & farm ponds
Waterfowl feeding stations	Golf courses	Plowing/cultivating/haying operations	Residential areas
	Municipal parks	Commercial shopping malls	
	Picnic areas	Fastfood restaurants	
		Outdoor restaurants	
		School yards	
	Community & recreation centers		

6. Airport Bird Hazard Zone Development

Integrating the analyses of hazardous bird species, aircraft movements and aircraft flight paths enables the delineation of bird hazard zones around an airport.

6.1. Airport Bird Hazard Zone Definitions

Airport Bird Hazard Zones are divided into four categories; Primary Bird Hazard Zone, Secondary Bird Hazard Zone, Category B Event Zone and Special Bird Hazard Zone as defined below.

Primary Bird Hazard Zone

The area in which aircraft are at or below 1,500 feet AGL during critical phases of flight. These altitudes are also most populated by hazardous bird species, and where bird-aircraft collisions are most likely to result in a Category A event. For FAR 23 Recreational Aircraft and FAR 27 and 29 Helicopters, due to the lack of bird impact certification standards and their operating altitudes for airport traffic patterns, Category B event flight paths may need to be included in the Primary Bird Hazard Zone.

Secondary Bird Hazard Zone

A buffer zone beyond the Primary Bird Hazard Zone that accounts for variation in such factors as pilot technique, environmental conditions, air traffic control and bird behaviour.

Category B Event Zone

This zone defines the area in which Category B events are most likely to occur. Generally, the Category B Event Zone is used at airports that host a complex range of aircraft, accommodating flight activity and paths that often run in directions that are not parallel to runways (such as those by FAR 23, 27 and 29 aircraft).

Special Bird Hazard Zone

Although land uses within the Primary, Secondary or Category B Event Bird Hazard Zones may attract and sustain hazardous wildlife, activities beyond these zones can also present hazards. Though often distant from airports, Special Bird Hazard Zones encompass specific land uses that, due to their geographic location, may regularly attract potentially hazardous species across other zones. For example, daily flights of gulls may transit through airport arrival and departure paths on their way from nesting sites to feed at a landfill even though neither location falls within either Primary or Secondary Bird Hazard Zones. In this case, the landfill would be designated a Special Bird Hazard Zone.

6.2. Airport Bird Hazard Zone Dimensions

Airport bird hazard zone dimensions and shapes are dependant on the flight paths for the critical phases of flight and the aircraft types that use, or will eventually be accommodated at, a particular airport. The critical phases of flight are those below 1,500 ft AGL: takeoff, initial climb, approach, landing and missed approach (see section 5.1.4.2).

Based on the FAR certification standard for the aircraft types, and using the accepted industry standard (normal arrival, departure and maneuvering, lateral and vertical flight paths), predictable shapes with definable bird-hazard zone dimensions can be plotted.

The Primary, Secondary and Category B event-zone *shapes* are the same from airport to airport regardless of the aircraft FAR certification category; however, the dimensions of these zones varies depending on the aircraft FAR certification category. Special Bird Hazard Zones are site-specific; their location and shape are determined by individual land-use circumstances at each airport.

To facilitate plotting of the bird hazard zones, a dimension-labeling schema is necessary. The zone dimensions are labeled A through H (see Table 5 for a breakdown by FAR category).

The zone shapes with their respective dimension labels are shown as follows:

- Primary Bird Hazard Zone Figure 1
- Secondary Bird Hazard Zone Figure 2
- Category B Event Zone Figure 3

The following principles were applied to develop the bird hazard zone shapes and dimensions:

1. Departure Paths:
 - Compliance with obstacle clearance requirements for FAR 25 second segment climb; no turns are made below 400 ft AGL;
 - Aircraft will fly runway heading with no wind drift correction;
 - Wind drift allowance will be made within the bird hazard zone dimensions; and
 - The termination point of the lateral departure path will be the lower of the following two points: where an aircraft reaches 1,500 ft AGL, or where an aircraft commences a turn to join the airport traffic pattern.

2. Airport Traffic Patterns:
 - Constructed using accepted industry standard lateral and vertical paths as described in the Canadian Aviation Regulations and AIM.

3. Arrival Paths:
 - The start point of the lateral arrival path will be the lower of the following two points: where an aircraft would intercept a 3° descent path to the runway at 1,500 ft AGL, or where an aircraft commences a turn from the airport traffic pattern to the final approach course;
 - Allowance will be made to the bird hazard zone dimensions to compensate for wind drift and turns from the airport traffic pattern or instrument approach procedure to the final approach course; and
 - Allowance will be made to the bird hazard zone dimensions to compensate for descent paths less than 3° due to shallower glidepaths, non-precision approaches and aircraft descent below the glidepath as a result of pilot technique.

4. Missed Approach Paths:
 - The start point of the lateral missed approach path will be where the aircraft would commence a missed approach from 50 ft AGL at the arrival end of the runway;
 - Aircraft will fly runway heading with no wind drift correction;
 - Wind drift allowance will be made to the bird hazard zone dimensions; and
 - The termination point of the lateral missed approach path will be the lower of the following point: where an aircraft reaches 1,500 ft AGL, or where an aircraft commences a turn to join the airport traffic pattern.

Figure 1

(See Table 5 for a breakdown of measurements by FAR category.)

Primary Bird Hazard Zone

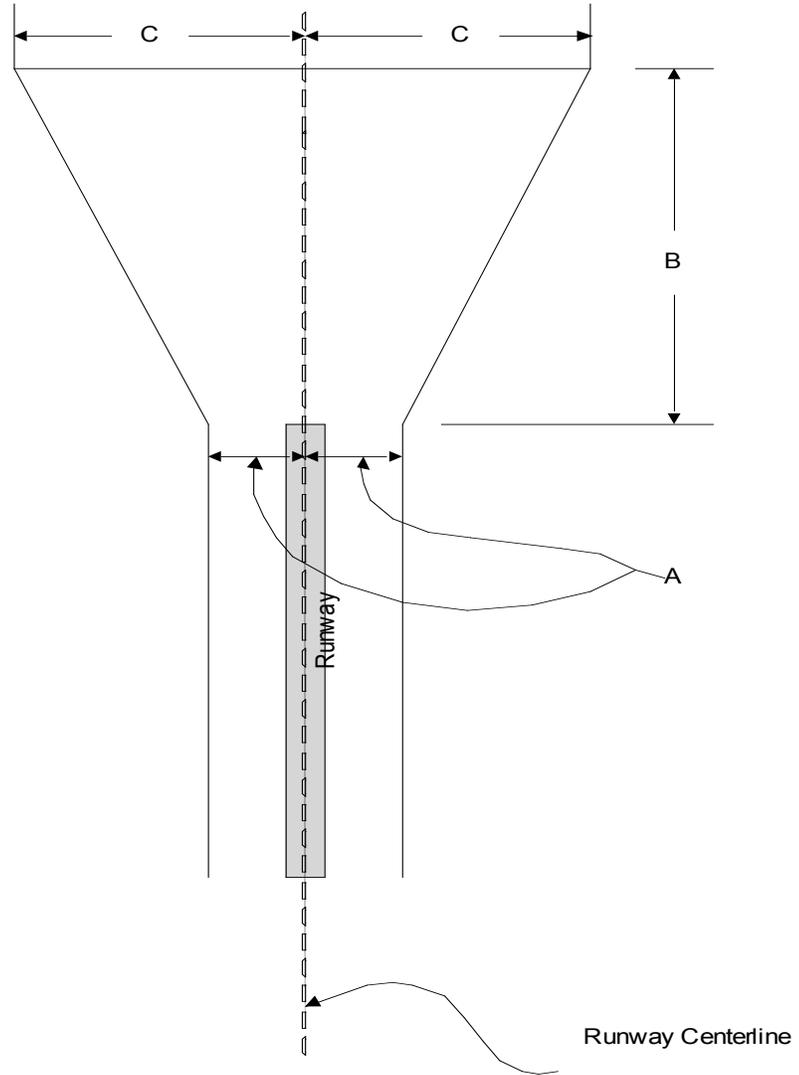


Figure 2

(See Table 5 for a breakdown of measurements by FAR category.)

Secondary Bird Hazard Zone

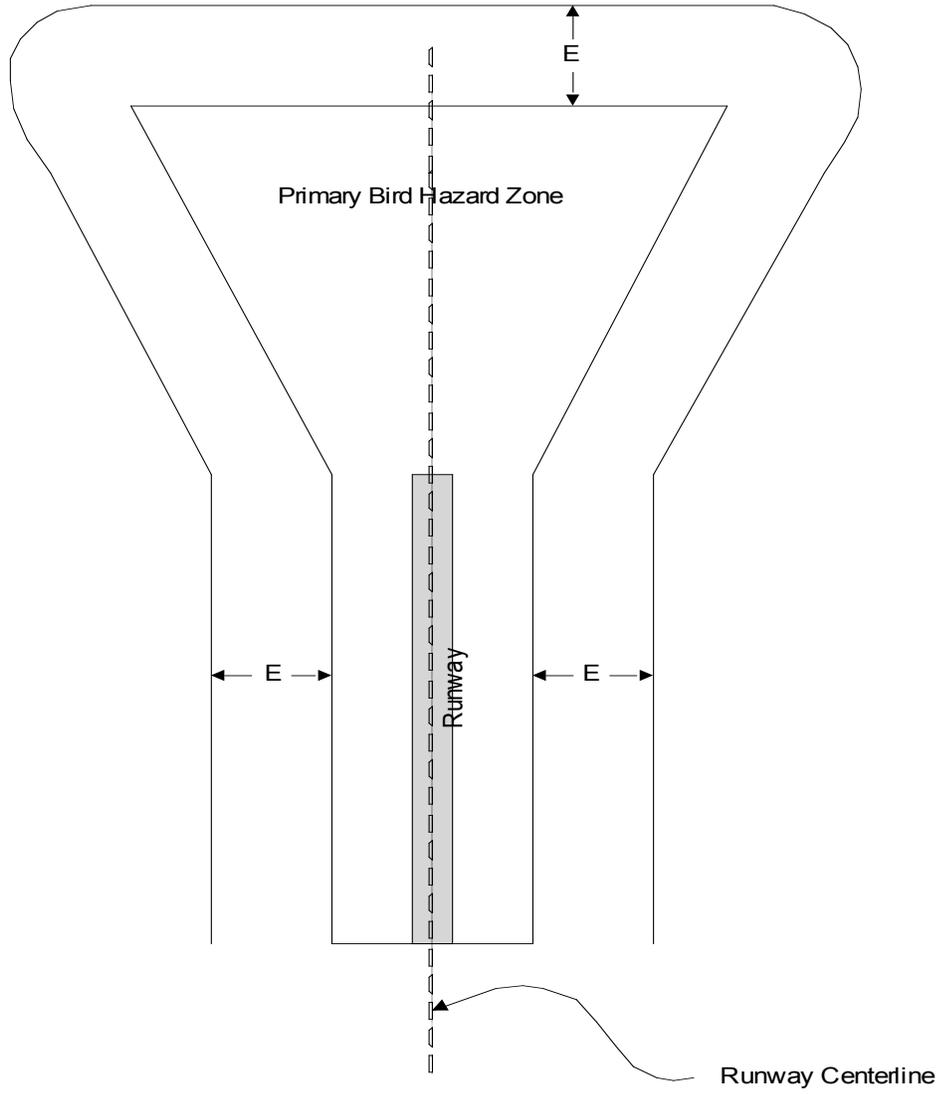


Figure 3

(See Table 5 for a breakdown of measurements by FAR category.)

Category B Event Zone

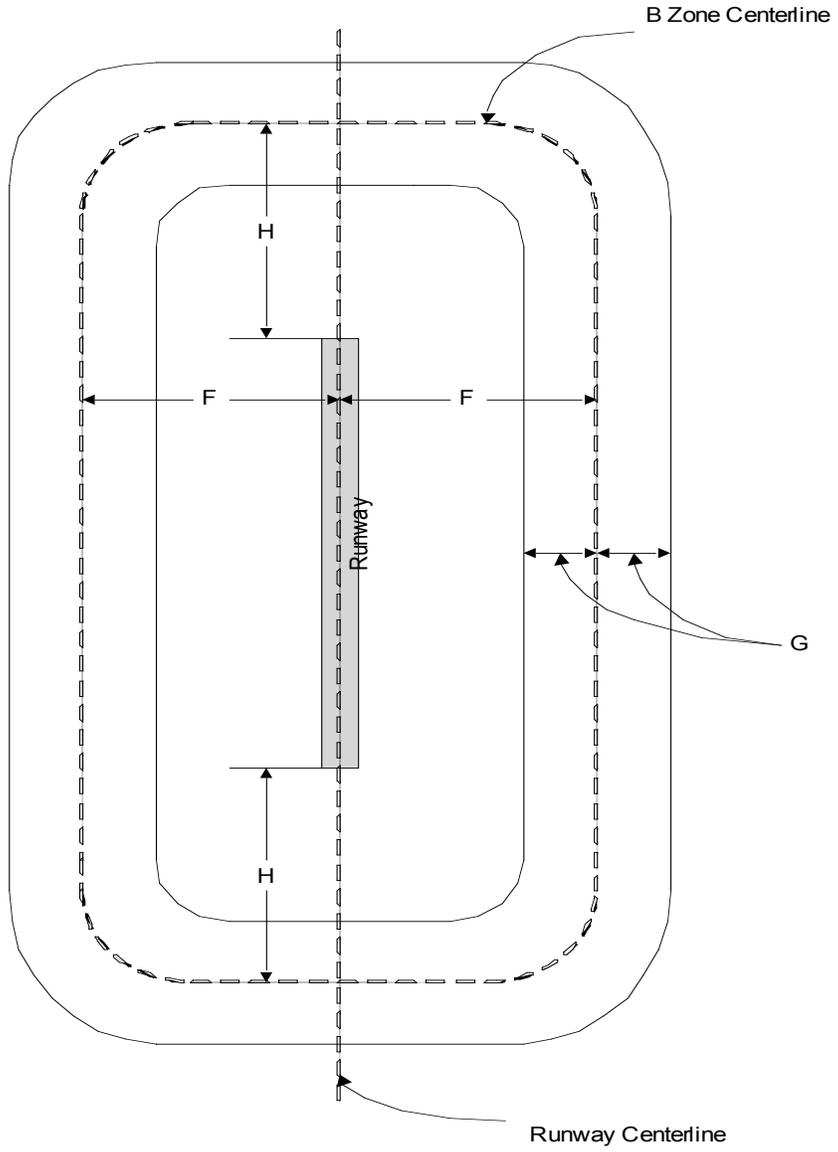


Table 5 – Bird Hazard Zone Dimensions

FAR 25

Dimension Label	Dimension (Meters)		
	A	B	C
Primary Bird Hazard Zone	2,000	9,000	4,000

Dimension Label	Dimension (Meters)
	E
Secondary Bird Hazard Zone	4,000

Dimension Label	Dimension (Meters)		
	F	G	H
Category B Event Zone	6,000	2,000	9,000

FAR 23 Commuter

Dimension Label	Dimension (Meters)		
	A	B	C
Primary Bird Hazard Zone	2,000	9,000	4,000

Dimension Label	Dimension (Meters)
	E
Secondary Bird Hazard Zone	4,000

Dimension Label	Dimension (Meters)		
	F	G	H
Category B Event Zone	6,000	2,000	9,000

FAR 23 Recreational

Dimension Label	Dimension (Meters)		
	A	B	C
Primary Bird Hazard Zone	1,000	3,000	2,000

Dimension Label	Dimension (Meters)
	E
Secondary Bird Hazard Zone	2,000

Dimension Label	Dimension (Meters)		
	F	G	H
Category B Event Zone	1,500	1,000	3,000

FAR 27/29 Helicopter

Dimension Label	Dimension (Meters)		
	A	B	C
Primary Bird Hazard Zone	1,000	3,000	2,000

Dimension Label	Dimension (Meters)
	E
Secondary Bird Hazard Zone	2,000

Dimension Label	Dimension (Meters)		
	F	G	H
Category B Event Zone	1,500	1,000	3,000

6.3. Land Use in Bird Hazard Zones

The appropriateness of land use within bird hazard zones can be determined using the analysis of the hazardous land uses described in Risk Element III. The appropriateness of land use within bird hazard zones is described below, and summarized in Table 6.

Primary Bird Hazard Zone Land Uses

Land use categorized as high, moderate or low risk is not appropriate in this zone without effective risk mitigation. High-risk land use, in particular, must be aggressively managed to reduce safety risks to aircraft operations. Land use judged to be of limited risk is acceptable.

Secondary Bird Hazard Zone Land Uses

Land use categorized as high and moderate risk is not appropriate in this zone without effective risk mitigation. Land use judged to be of low or limited risk is acceptable.

Special Bird Hazard Zone Land Uses

Land use categorized as high risk is not appropriate in this zone, and must be actively and effectively mitigated. Land use that is judged to be of moderate, low or limited risk is acceptable.

Table 6 – Appropriateness of Land Use Within Bird Hazard Zones

Risk	Land Use	Land-use Appropriateness by Zone		
		Primary ⁷ & Category B ⁸	Secondary ⁹	Special ¹⁰
High	Putrescible waste landfills	No	No	No
	Food waste hog farms	No	No	No
	Fish processing/packing plants	No	No	No
	Horse racetracks	No	No	No
	Wildlife refuges	No	No	No
	Waterfowl feeding stations	No	No	No
Moderate	Open or partially enclosed waste transfer stations	No	No	Yes
	Cattle paddocks	No	No	Yes
	Poultry factory farms	No	No	Yes
	Sewage lagoons	No	No	Yes
	Marinas/fishing boats/fish cleaning facilities	No	No	Yes
	Golf courses	No	No	Yes
	Municipal parks	No	No	Yes
	Picnic areas	No	No	Yes
Low	Dry waste landfills	No	Yes	Yes
	Enclosed waste transfer facility	No	Yes	Yes
	Wet/dry recycling facility	No	Yes	Yes
	Marshes, swamps & mudflats	No	Yes	Yes
	Stormwater management ponds	No	Yes	Yes
	Plowing/cultivating/haying	No	Yes	Yes
	Commercial shopping mall/plazas	No	Yes	Yes
	Fastfood restaurants	No	Yes	Yes
	Outdoor restaurants	No	Yes	Yes
	School yards	No	Yes	Yes
	Community & recreation centers	No	Yes	Yes
Limited	Vegetative compost facilities	Yes	Yes	Yes
	Natural habitats	Yes	Yes	Yes
	Inactive agricultural fields	Yes	Yes	Yes
	Inactive hay fields	Yes	Yes	Yes
	Rural ornamental & farm ponds	Yes	Yes	Yes
	Residential areas	Yes	Yes	Yes

⁷ The risk of land-uses that are not appropriate within a Bird Hazard Zone can be reduced if purposeful mitigation is actively employed. The appropriateness and effectiveness of such mitigation must be regularly evaluated, and the mitigation modified when required.

⁸ Since FAR 23 Recreational Aircraft and helicopters are subject to no bird impact standards, operate at low levels and are flown by only one pilot, Category B events may often become Category A events that result in the loss of aircraft and crew. For this reason, the Category B event zone should be considered a primary bird hazard zone for the purposes of determining land-use appropriateness.

⁹ See footnote 7.

¹⁰ See footnote 7.

Appendix I

Table 1 – Summary of FAR 33 Turbine Engine Bird Strike Airworthiness Requirements

Mass of Ingested Birds	Number of Ingested Birds	Bird Impact Requirements
3 ounces	Maximum of 16 birds in rapid succession	Impacts may not cause more than 25% power or thrust loss, require engine to be shut down within 5 minutes, or result in a hazardous situation.
1.5 pounds	Maximum of 8 birds in rapid succession	Impacts may not cause more than 25% power or thrust loss, require engine to be shut down within 5 minutes, or result in a hazardous situation.
4 pounds	1	Engine is not to catch fire, burst, or lose the capability of being shut down.

Table 2 – Summary of FAR Airframe Bird Strike Airworthiness Standards

Category of Aircraft	Airframe Component	Bird Impact Requirements
Transport Category Aircraft (FAR 25)	Entire airplane	Able to safely complete a flight after striking a 4 pound bird at design cruise speed (V_c)
	Empennage	Able to safely complete a flight after striking a 8 pound bird at design cruise speed (V_c)
	Windshield	Able to withstand impact of a 4 pound bird, without penetration, at design cruise speed (V_c)
	Airspeed indicator system	The pitot tubes must be far enough apart to avoid damage to both in a collision with a bird
Normal Category (FAR 23) Commuter Aircraft (10 - 19 Seats)	Windshield	Able to withstand impact of a 2 pound bird at maximum approach flap speed (V_{fe})
	Airspeed indicator system	The pitot tubes must be far enough apart to avoid damage to both in a collision with a bird
Normal Category (FAR 23) Normal, Utility and Acrobatic Aircraft	All components	No requirements
Transport Category Rotorcraft (FAR 29)	Windshield	Able to continue safe flight and safe landing after impact by a 2.2 pound bird
Normal Category Rotorcraft (FAR 27)	All components	No requirements

Table 3 – Aircraft Flight Crew & Passengers

Category of Aircraft	Required Flight Crew	Approximate Number of Passengers
Transport Category Aircraft (FAR 25)	2 – 3	4 – 10 for business aircraft 20 – 500 + for airliners
Normal Category (FAR 23) Commuter Aircraft	2	10 – 19
Normal Category (FAR 23) Normal, Utility and Acrobatic Aircraft	1	1 – 9
Transport Category Rotorcraft (FAR 29)	1 – 2	2 – 30 +
Normal Category Rotorcraft (FAR 27)	1	1 – 6